UNDER THE MEDITERRANEAN I

Studies in Maritime Archaeology

edited by

STELLA DEMESTICHA & LUCY BLUE

WITH KALLIOPI BAIKA, CARLO BELTRAME,
DAVID BLACKMAN, DEBORAH CVIKEL, HELEN FARR
& DORIT SIVAN

HONOR FROST FOUNDATION

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Contents

HARBOURS

Editors: Kalliopi Baika, David Blackman, Lucy Blue, Helen Farr, Dorit Sivan

MARITIME LANDSCAPES

Editors: Kalliopi Baika, David Blackman, Lucy Blue, Helen Farr, Dorit Sivan

‘Under the Mediterranean’ in the 21st century

Constants, trends, and perspectives in Mediterranean Maritime Archaeology

Stella Demesticha and Lucy Blue

The world of maritime archaeology has undoubtedly grown far beyond the point when Honor Frost wrote her seminal volume, *Under the Mediterranean: Marine Antiquities* (1963). In that volume, she reveals aspects of her own experience in *marine* (not yet maritime*)* archaeology, as a ‘journey of ideas that follows its own specious time’ (Frost 1963: xi). At that time a new sub-discipline was born, from ‘eclectic communities possessed of remarkable energies’, who would be ‘in a constant need for more nautical data and the development of methodologies’ (Adams, 2013: 4-6) for several decades to come.

Nautical archaeology was, indeed, the first term used in established academic circles to define our then-burgeoning field (on the prevalence of shipwrecks in maritime archaeology, see Adams and Gibbins, 2001). The trend manifested itself through one of the most successful symposium series, the International Symposium of Boat and Ship Archaeology (ISBSA), which commenced in 1976. Its scope was broad but mostly oriented toward medieval and post-medieval periods and was largely northwest European in geographical focus; none of the 23 papers of the first volume of its proceedings (McGrail, 1977) was concerned with the Mediterranean, or antiquity in general. In fact, it took almost a decade for the first Mediterranean papers to appear in an ISBSA volume following the fourth conference, held in Porto, Portugal, in 1985 (Filgueiras, 1988). The domain had been growing fast, however, so a need had arisen for more geographically and thematically focused discussions, such as nautical experimental archaeology and ancient Greek ships (Tzalas, 2019). Such trends triggered the first International Symposium on Ship Construction in Antiquity, which commenced that same year (1985) in Piraeus, Greece, and was called TROPIS (‘keel’ in ancient Greek). It concerned almost exclusively the Mediterranean and was clearly oriented toward antiquity. Despite the specificity of the title, however, and although the main focus remained on ships, papers about diverse research themes began to be accepted from the second symposium onward (Fig. 1). A closer look at the Tables of Contents of the proceedings reveals a similarly inclusive tendency regarding the periods concerned; although ‘antiquity’ remained in the title, a small number of contributions about Byzantine and later periods did appear from the first symposium (Fig. 2). These incongruities only highlight the kind of institution that TROPIS gradually grew to be. It was not necessarily a conference strictly focused on ancient shipbuilding, but was the only symposium where maritime archaeologists conducting research in the Mediterranean met and shared discoveries and ideas. The papers presented conveyed a blend of excitement, fed by the

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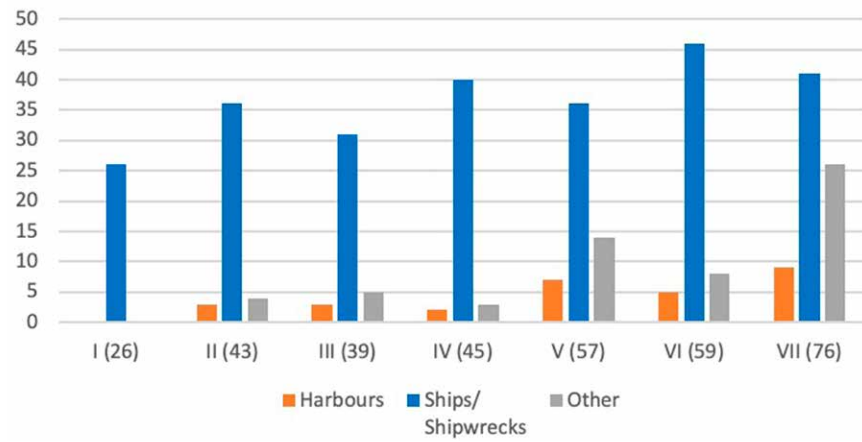

Figure 1. Papers presented at the TROPIS symposia by subject. The total number of papers presented is given in parenthesis. Based on the Table of Contents in Tzalas, 1989-2002.

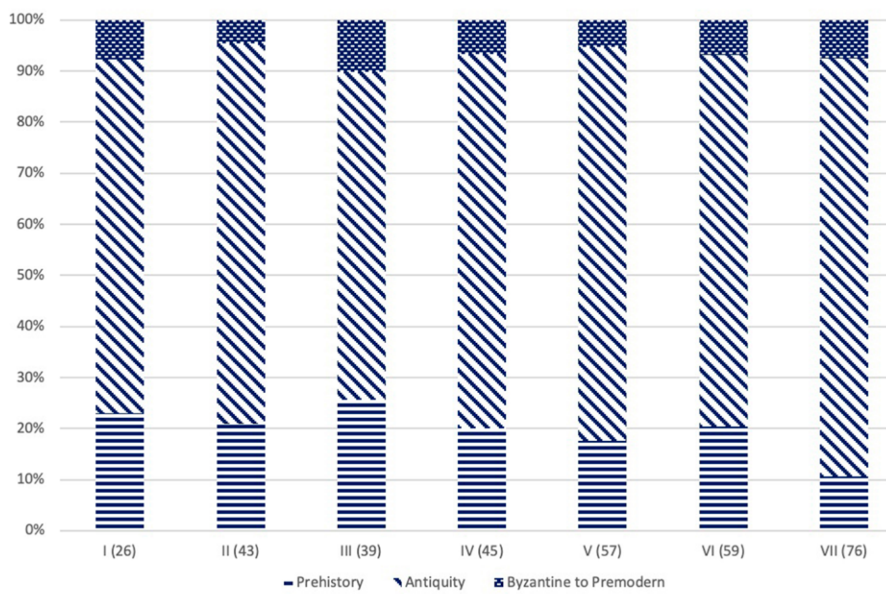

Figure 2. Distribution of the papers presented at the TROPIS Symposia by historic period concerned, based on the Table of Contents in Tzalas, 1989-2002.

rapid progress of underwater archaeology at the end of the 20th and the beginning of the 21st century. This was coupled with the prevalent tendencies of Mediterranean archaeology, such as the predominance of Classical and Roman antiquity, the new expansion of prehistoric archaeology in the 1980s and the much slower development of archaeology within Byzantine and Medieval studies. The dynamic interaction between new challenges and long-established archaeological traditions, so well reflected in the seven volumes of TROPIS Symposia proceedings, is, in fact, a distinctive feature of Mediterranean Archaeology, one that had a strong impact on the different trajectories that maritime archaeology followed in each Mediterranean country.

Under the Mediterranean I: the conference

On 27 October 2017, 100 years had passed since the birth of Honor Frost, one of the pioneers of Mediterranean maritime archaeology. Her legacy lives on both in the significant contribution she made to her field of research and in her creation of the Honor Frost Foundation (HFF), another milestone in the history of maritime archaeology (Cathie, 2019). To mark this event and honour her work and that of her Foundation, an international conference was organized 20-23 October 2017, in Nicosia, Cyprus, the place of her birth (henceforth, the Nicosia Conference). With a remarkable number of 300 registered participants and more than 180 abstract submissions, this meeting also aspired to bring together archaeologists working in the Mediterranean, almost ten years after the last TROPIS had taken place on the island of Hydra, Greece, in 2008. The lively interest shown by the community highlighted the need for an inspiring symposium that would continue TROPIS's legacy and expose the work of Mediterranean maritime archaeologists; a forum where new discoveries could be shared, methodologies or ideas could be discussed, and, most importantly, established scholars could meet early career archaeologists and fuel the dynamics of the domain.

The challenges of such an endeavour started early. When it came to the selection of papers, even defining the Mediterranean was not straightforward. Broodbank's (2013: 57) argument that 'the search for edges finds no single answer' proved right, especially since the concept of the maritime cultural landscape had broadened the scope of the domain considerably. Moreover, the term 'Mediterranean maritime archaeology' itself could be conceived in diverse ways by scholars from different countries or areas of expertise; for example, it was not easy to reject papers about sites on the Black Sea coasts (see Bivolaru *et al.*, this volume) or the 'Mediterranean Atlantic', along the coasts of Iberia and Morocco (Appendix, Paper no. 29), because the archaeology of these regions is so very closely linked to the Mediterranean. Also, the discussion often reached more complex issues, such as the maritime zone, which is hard to define because it differs between regions and cultures; for instance, submerged lake settlements (*e.g.* Appendix, Poster no. 11) could be a fine underwater archaeological subject, but did not necessarily fit so well in a conference strictly focused on the maritime Mediterranean.

'Representative coverage of the region is no easy task' as 'a title can only go so far before other powerful factors intervene': Susan Alcock (2005, 333-334) made these comments about journals on Mediterranean History and Archaeology, but they seem to be true of conferences as well. Cyprus's location, at the eastern-most end of the Mediterranean, did not favour low-cost travel, which could have had a toll on the meeting's success. To address this, paper submissions from the entire Mediterranean were encouraged and, thanks to HFF's generosity, 19 travel grants were offered to young scholars. Nonetheless, the coverage remained partial (Fig. 3); half of the contributions (oral presentations and posters) concerned research in the eastern Mediterranean, which was the result of both the conference venue and the boost that HFF initiatives and funding have triggered in the region. By the same token, almost 14% of all contributions, or 25% of the eastern Mediterranean ones, were about research on Cyprus, whereas key countries in the domain, such as Italy, France, and Spain, were less well represented, with contribution percentages of 8.5, 4.9 and 4.2% respectively. Also, the Arab Mediterranean countries were less visible, in general. There is little doubt that the very low numbers of papers about Syria and Turkey, in particular, were affected by war and political constraints.

All the above factors notwithstanding, some useful conclusions can be drawn about the current state of the discipline after a conference of this size, which can function as a gauge, at least regarding research trends and capacity. For example, if there was any doubt that maritime archaeology is now well integrated into the world of archaeology, this conference has removed it. The thematic sessions included subjects ranging from ships, shipwrecks, harbours, and maritime cultural landscapes (MCL), to digital applications, management and conservation, archaeological science, connectivity, maritimity, and new technologies (Appendix). The subjects of the vast majority of the papers, however, revolved around the three traditional thematic components of the domain, that is shipwrecks, harbours and maritime landscapes (Fig. 4). Subjects outside this 'traditional' focus, such as maritime transport containers (Appendix, Poster nos 27-30, 40-41), or fishing (Mavromichalou and Michael 2020/SR 6; Appendix, Paper no. 28, Poster no. 9) did appear but in small numbers. Likewise, it is interesting that although there was certainly a notable preference for diachronic approaches, especially when it came to MCL studies or surveys, only 17 out of 142 contributions concerned post-Roman periods, indicating that antiquity still prevails in Mediterranean maritime archaeology. This might also be related to general bias in Aegean archaeology, which was rather over-represented with a total of 27 contributions (19.1% of the total and 34.1% of the eastern Mediterranean ones).

The demographics of the research teams that participated in the conference have also an interesting story to tell (Fig. 5). The 50 projects on ships and shipwrecks presented at the conference (29 oral presentations and 21 posters) were conducted mainly by teams from five Mediterranean countries (Israel, France, Greece, Italy, and Croatia), followed by non-Mediterranean teams from universities with long traditions in the domain in USA, UK, and Australia. By contrast, it seems that projects on harbours and MCL were conducted by researchers from many different countries, both from within and beyond the Mediterranean. If these statistics can be considered representative, ship archaeology remains a specialized domain that has not penetrated Mediterranean academic research to the same degree as have harbours and MCL. This could be associated with capacity development and funding issues (for a recent discussion on capacity development in maritime archaeology in the Mediterranean, see Demesticha *et al.*, 2019; McKintosh, 2019). Underwater projects involving ship archaeology are usually more costly than those that take place on the coast or in shallow waters. Such projects are also less demanding in terms of expertise and can tap into more diverse funding sources, such as science and environmental studies or even private developer companies that invest in the coastal zone. Moreover, studies of harbours and MCL attract the interest of many more scholars than ships do, because they offer opportunities for inter- and multi-disciplinarity, *i.e.* collaboration between maritime and terrestrial archaeologists, but also between archaeologists and geomorphologists.

Maritime landscapes, harbours, and ships

The coast was definitely in the foreground of the picture painted by the participants in the Nicosia conference. This is directly connected to the growing interest in submerged landscapes and palaeoenvironments during the past decade (Flemming *et al.*, 2017; Bailey *et al.*, 2017; Sturt *et al.*, 2018), with a focus on prehistory, which was clearly the case at the Nicosia conference (Fig. 4, Appendix, Paper nos 14, 16, Poster nos 6 and 7).

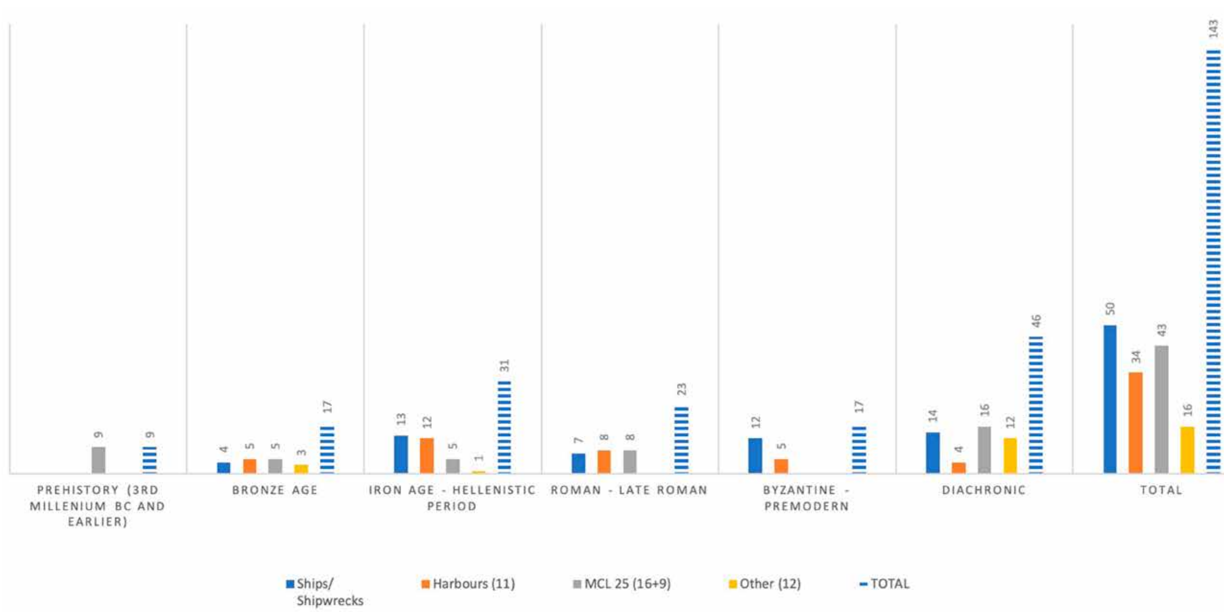

Figure 3. The 143 contributions of the Nicosia Conference arranged by the country where the site or area discussed is located within their broader Mediterranean regions. The total numbers of presentations and posters is given by region.

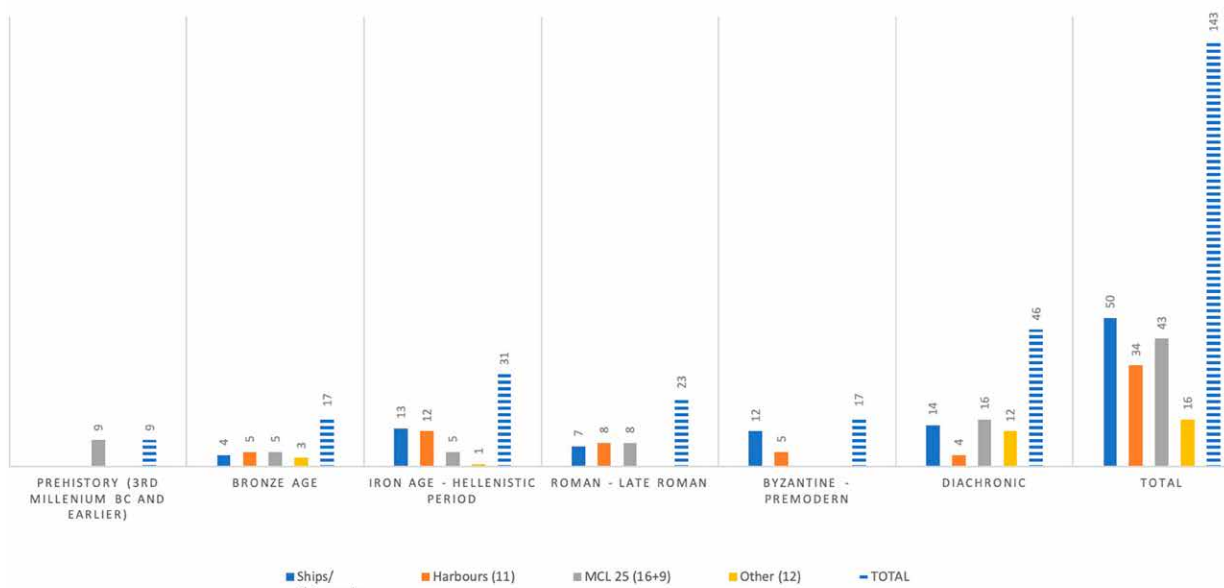

Figure 4. The 143 contributions of the Nicosia Conference arranged by theme (Ships/Shipwrecks, Harbours, Maritime Cultural Landscape/ MCL) and the historical period concerned.

Submerged settlements of later periods were the subject of only four of 143 contributions, keeping their position on the fringes of maritime areas of concern; that is, where Muckelroy placed them 40 years ago (1978: 9) (Appendix, Paper no. 17, Poster no. 11; Euser, 2020/SR 10; Lolos and Simosi, 2020/SR 12). There is little doubt that coastal archaeology and harbour geoscience have been the new frontier of maritime archaeology (Marriner and Morhange, 2007), with an incredibly large number of projects that constantly change the picture of the Mediterranean coasts (Morhange *et al.*, 2016).

Given all the above, it is perplexing how difficult it still is to locate harbours physically. This is especially true for urban ones, when their existence is attested in literary and epigraphic evidence but they have invariably been built over, in some cases continuously, since their first conception. The harbour of Classical Torone in the Aegean (Beness and Hillard, this volume), of Istros on the Danube Delta, Romania (Bivolaru *et al.*, this volume), or the less known Rhizon on the Adriatic coast (Bajtler and Trusz, 2020/SR 1), are only a few examples of these 'phantom ports'. Even well-surveyed and excavated ancient cities, such as Akko, Israel, (Artzy *et al.* and Sharvit *et al.*, this volume), lack evidence for many phases and aspects of their harbour topography, due to coastal changes and modern use. Wooden constructions are preserved only under certain taphonomic conditions, rare in the Mediterranean, so their remains are often archaeologically elusive or enigmatic, such as those of pilings, bollards or possible slipways found off Ashkelon, Israel (Galili *et al.*, this volume). Monumental constructions have traditionally been at the centre of harbour studies (see, for example the enigmatic submerged structures at the Roman harbour of Fossae Marianae linked to the Rhone River, France, in Fontaine *et al.*, this volume). The presence of shipsheds, especially after the seminal publication by Blackman *et al.* (2014), have been a decisive factor for the characterization of ports as naval bases and have consequently attracted the attention of archaeologists, regardless of their period or region of expertise (see Dundar and Kocak for Classical Patara, Cabrera Tejedor and Amores Carredano for Islamic Seville, both this volume). Fortifications, a purely terrestrial feature, are also well integrated into the discussion of ports of strategic importance and the fluctuation of their role over their long histories, from Classical Patara in Lycia (Dundar and Kocak, this volume) to fortified Crusader ports along the Levantine Coast (Antaki-Masson).

Apart from urban harbours, coastal zones with anchorages that varied in size, depth, and exposure to winds can shed light on a more inconspicuous but still intriguing aspect of maritime activity by full- or part-time seafarers. Rural anchorages are usually surveyed, not excavated, and when multiple-period use is documented, local diachronic maritime capacities and cultures can be detected (see, *e.g.* Khalil, 2020/SR 4 on Marsa Bagoush, Egypt, and Papakosta, 2020/SR9 on Petounda, Cyprus). At the same time, seafront industries, such as quarrying, are hard to date or to distinguish from functions that preceded or followed them – a characteristic case is Dana Island in Cilicia (Jones, this

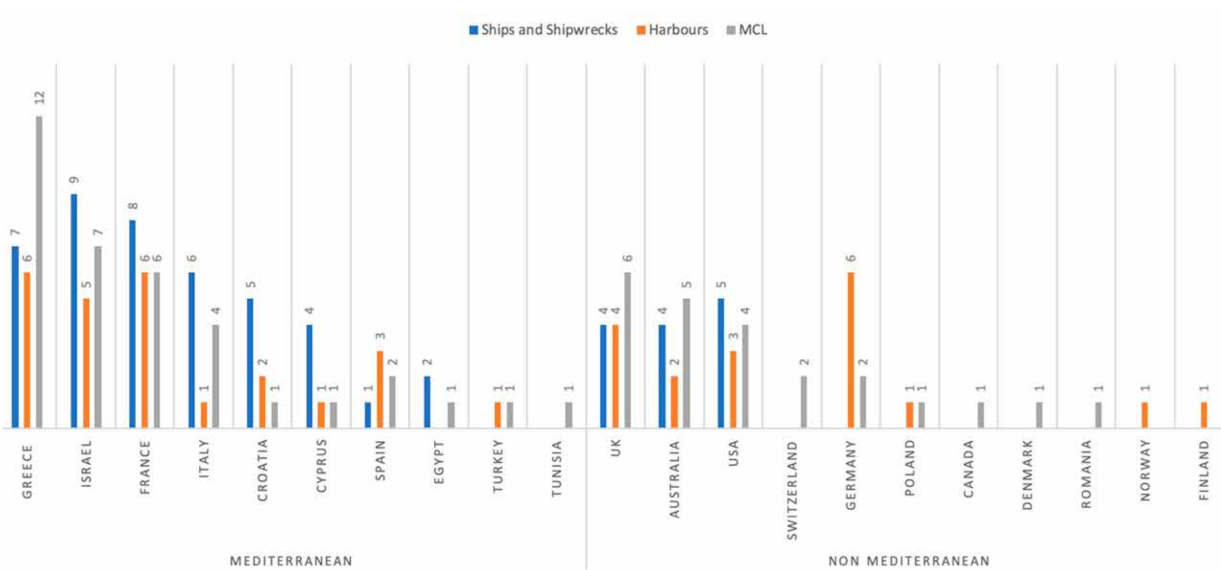

Figure 5. Contributions (oral presentations and posters) at the Nicosia Conference arranged by the presenter's country of origin. Since there were several collaborative projects, the total number is higher than the number of papers (157 vs 143).

volume). Such glimpses into the maritime *longue-durée* can be better contextualized through more theoretical or historical approaches, in which concepts such as 'seascapes' and 'coastscapes' have been used extensively and mark a rather recent trend in maritime archaeology (see for example in this volume Howitt-Marshall's paper on maritime connectivity in Early Neolithic Cyprus, and Obied's critical approach to geographers' descriptions of Roman Levant).

Harbours, where ancient Mediterranean seafarers left their most conspicuous traces, are not only where geoscientists, terrestrial and maritime archaeologists meet, but also the places where the 'small worlds' of maritime archaeology, created around ships, harbours, and landscapes, work alongside each other. Excavations of silted harbours, for example, have a long history of shipwreck discoveries that have contributed significantly to the history of shipbuilding. Starting in the 1990s, with the discovery of the iconic ships at Place Jules Verne in the port of Marseilles (Pomey, 1998), these projects demonstrate the high potential of ship archaeology, when it is free of underwater environment constraints. Seven shipwrecks at the ancient harbour of Naples, Italy (four of which are discussed in this volume by Boetto *et al.*) and the Mandirac 1 ship, found built into the Narbonne port channel in France (Jezegou *et al.*, this volume), are also very characteristic examples of the wealth of information that can be gleaned from such sites. Not only do they add to our knowledge about small crafts and port vessels (Boetto *et al.*, 2011), but they also provide unique insights into shipbuilding craftsmanship, for example, through the detailed study of repairs and maintenance practices. Such studies that delve into the specifics of shipbuilding techniques build on previous work about Roman traditions, particularly in the western Mediterranean, where a large number of shipwrecks have been excavated. Shallow-water harbours have also yielded a rich record of shipwrecks. A typical example is the submerged harbour of Thonis-Heracleion, in Egypt, where more than 70 ancient vessels have been discovered by the Institut Européen d'Archéologie Sous-Marine (Robinson, 2018; Appendix, Paper no. 47). An accidental discovery of three ships in the modern harbour of Rhodes is one such rare site in the Aegean; Wreck No. 4 is dated to the 12th century CE (Koutsouflakis and Rieth, this volume) and adds an important piece to the puzzle of Byzantine shipbuilding after the 11th century CE.

Late Bronze Age shipwrecks seem to retain a central place in archaeologists' attention in the eastern Mediterranean, as three recent discoveries can attest. One of them, a Minoan cargo assemblage found at Koulenti, off the coasts of Laconia, Greece (Spondylis, 2012; Appendix, Poster no. 23), has not been excavated yet, whereas investigation is ongoing at two other sites: a Late Helladic shipwreck at Modi, Argolid, Greece (Agourides and Michalis, this volume), and an oxhide-ingot cargo dated to the 16-15th centuries BCE, recently discovered off the shores of Kumluca, Antalya, Turkey (Öniz, 2019; 2019a). As far as the date of the sites under consideration is concerned, the remaining shipwreck-related contributions at the Nicosia conference presented a new tendency, not seen at the TROPIS symposia. The numbers are almost equally divided between sites dated to 1st millennium BCE and those dated to medieval or pre-modern periods (Fig. 3). This growing Mediterranean interest in medieval ships began with the Late Roman shipwrecks excavated in the shallow Dor/Tantura lagoon, Israel, among others, because of their significant contribution to the key issue of the transition from shell-first to frame-first construction (Kahanov, 2011; Pomey *et al.*, 2012). Byzantine ships attracted a lot more scholarly attention after the discovery of 37 shipwrecks dating from the 5th to the 11th centuries CE at Yenikapı, Istanbul (Kocabaş, 2015, Pulak *et al.*, 2015). Promising research in the same periods continues in Israel, with the early Islamic-period shipwreck of Ma'agan Mikhael B (Cohen and Cvikel, 2019; Cohen and Creisher, 2020/SR 2) as well as the Ottoman ones, Akko 1 and Akko Tower (Appendix, Paper no. 77, Poster no. 22; Cvikel, 2016). Two important 16th-century ships, the Gnalic (Rossi and Castro, 2012; Appendix, Poster nos 28, 39) and Girolamo (Appendix, Paper no. 81), have also been recently been investigated in Croatia, and the *Paragan*, a late 17th- early 18th-century wreck, is under study in Corsica (Appendix, Poster no. 29).

Numerous shipwreck survey projects have been conducted recently in the open sea, triggered by significant progress in remote sensing in both deep and shallow waters. A positive remark is that these regional projects aim primarily at understanding the maritime cultural landscape and contextualizing the discovered shipwrecks within it, instead of looking for well preserved, iconic shipwrecks, suitable for full excavation. A characteristic example is the survey of Fournoi, a small group of islands in the northeastern Aegean. Following a tradition of good collaboration with the local community, established by the Institute of Nautical Archaeology (INA) in Turkey decades ago, the team has mapped 58 new shipwreck sites, which they attempt to place in their maritime and historical contexts (Campbell and Koutsouflakis, this volume). A similarly seamless approach between shipwreck and landscape archaeology was also adopted by the Delos and Rheneia Underwater Survey (Zarmakoupi and Athanasoula, 2018; Appendix, paper no. 27). Away from the coast, deepwater surveys are often more shipwreck-centric, following a tradition now at least three decades old (Wachsmann, 2011). Although they often happen on the back of geomorphology surveys, for example the Eratosthenis Seamount Project (Ballard *et al.*, 2018), they are increasingly conducted with archaeology as one of their prime focuses, such as the large-scale Maritime Archaeology Project (MAP) in the Black Sea (https://blackseamap.com). In the Mediterranean, several deepwater archaeological surveys have enriched the map of shipwrecks considerably; for example, one along the southwestern coast of Turkey that resulted in the discovery of 30 shipwrecks (Brennan *et al.*, 2012), the Illyrian Coastal Exploration Program (Royal, 2012), the Battle of the Egadi Islands Project (Tusa and Royal, 2012), the Archeorete Eolie 2010 at the Aeolian islands (Appendix, Poster no. 26), or the Atlantis Project in the straits of Messina (Bazzano *et al.*, 2020/SR 5).

Photogrammetry and 3D-imaging applications have also been developed into a fast-expanding interdisciplinary research trend in maritime archaeology (McCarthy *et al.*, 2019; for an interesting history of the techniques used at the port of Alexandria, see Hairy, 2020/SR 11). When digital mapping is used on shipwreck sites during excavation, not only does it save precious fieldwork time, but it also allows for a very comprehensive reconstruction of the site's topography (for a very characteristic example, see the work conducted at Modi by Vlachaki *et al.*, 2020/SR 8). Moreover, it can create the basis for constructive hypotheses regarding the cargo stowage system, such as that suggested for the Mazotos shipwreck, Cyprus (Demesticha, this volume; on a similar approach for marble cargoes see Balleti *et al.*, 2016). Apart from saving time in the field, a very promising application of 3D-imaging lies with current developments in cultural heritage studies that prioritize public awareness. The idea that virtual- and augmented-reality technologies should be used to bring underwater archaeological sites closer to non-experts has great potential and reveals a very dynamic impact from public and digital archaeology (Costa *et al.*, 2020/SR 3; Appendix, Paper nos 63 and 66).

Digital applications have also been used extensively for ship reconstructions, which have proven very informative in advance of, but also during, the full-scale build (see for example Tanner *et al.*, 2020, for Sutton Hoo and Poveda, 2015, for *Gyptis*). It is worth noting that they have improved rather than discouraged the construction of full-scale replicas. *Ma'agan Mikhael II*, (Cvikel and Hillman, this volume) is the third Mediterranean ship reconstruction based on an excavated shipwreck, following on the legacy of the *Kyrenia II*, a successful experiment in shipbuilding (Katzev and Katzev-Womer, 1985) and navigation (Katzev, 1990), as well as of *Gyptis*, built in Marseilles in 2013 as a 'sailing replica, based on the archaeological remains and structural analysis of the 6th-century archaic Greek sewn boat Jules-Verne 9' (Pomey and Poveda, 2018). There are always some tantalizing questions, such as the hull's depth, that are still open for debate, and some concessions remain unavoidable, such as the use of modern tools in construction or the adherence to modern security regulations during sailing. There is little doubt, however, that experiments on construction, processes, and function are valuable ways to test scientific hypotheses about ancient shipbuilding and seafaring (Reynolds, 1999: 390) and in any case they are not expected to replicate processes of the past (see, *e.g.* Appendix, Poster no. 24 about the Kyrenia ship anchor, and Poster no. 31 on ways of bending wooden planks). What is more, these projects' post-test life cycles are also of interest and add intriguing values to the biographies of the original ships; *Kyrenia II* became so emblematic that it grew into a national symbol in the Republic of Cyprus (Dimitriou, 2016: 68), whereas *Gyptis* 'enabled the city [of Marseilles] to reconnect with its earliest maritime heritage' (Pomey and Poveda, 2018: 55).

Under The Mediterranean I: the book

The 13 papers presented in the first three sessions of the Nicosia conference, devoted to Honor Frost and her legacy, have already been published in a separate volume (Blue, 2019). As far as the remaining 143 (89 oral presentations and 54 posters) are concerned, we decided against publishing a proceedings volume, acknowledging two main factors: i) the large number of papers (Appendix), and ii) the fact that conference proceedings are no longer credited very highly in academic evaluations. This is especially true for volumes with short papers that summarize results already published, or already planned to be published elsewhere in better detail. Instead, our strategy was to publish original articles, written by those of the conference participants that wished to work on longer versions of their original papers. Therefore, we gave the participants three options: a) not to contribute, if no new data or ideas could be presented, or if their work was already in press at the time of the conference; b) send a short report of their work in progress, to be published online on the HFF webpage (https://honorfrostfoundation.org/publications/short-reports/under-the-mediterranean/); and c) send longer versions of their papers to be published in a peer-reviewed volume, of which this book is the product.

The three overarching themes were the subjects of the vast majority of the conference contributions (Fig. 3): ships and shipwrecks, harbours, and maritime cultural landscapes. The final number of papers submitted proved to be remarkably low: 12 appeared as short reports and 23 long articles were submitted for publication, of which 19 appear in this volume, after a peer-review process. This small percentage (13.3%) of the overall contributions to the conference could be the result of many different parameters and is indicative of how competitive academic conditions have shaped archaeological realities in the 21st century. The editors' frustration notwithstanding, this is a useful inference from this conference that provides a good lesson for the future. Archaeological *fora* are important and there is no question that the community should try and keep them alive because fervent discussions and exchange of ideas cannot happen only through published articles and books. But alongside printed books and journals, maybe it is time to establish more alternative ways to disseminate our work and promote scholarly dialogue.

'Corrupting' 'Boundless' or 'Transmitting' (Horden and Purcell, 2000; Abulafia, 2011; Broodbank, 2013), the Mediterranean provides the overall cohesion of these papers. The uniqueness of this sea that has given its name to the landscapes and cultures that surround it has created the basis for a sophisticated historiography of seas, or a 'new thalassology' (Horden and Purcell, 2006), alongside which various Mediterranean archaeologies have also been developed (Knapp and van Dommelen, 2014). Still, maritime archaeology does not seem to have a distinctive place among them, although ships and boats, harbours and ports, coasts and seascapes, connectivity and exchange, all play a prominent role in their making. The reason is not the lack of research, because activity is robust, as was demonstrated at the Nicosia conference. It may lie closer to the fact that maritime archaeology itself developed as a *thematic* sub-discipline without engaging with pervasive issues of Mediterranean archaeology, such as the (until recently) lack of theoretical debate, the chronological and conceptual divide between prehistoric and later periods, or the lack of comparative work (Renfrew, 2003). However, with the significant progress made in all these matters, and an exponential increase of underwater- and land-oriented literature, time seems ripe for new syntheses and more assimilated narratives about the maritime Mediterranean.

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SHIPS AND SHIPWRECKS

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Carlo Beltrame, Deborah Cvikel, Stella Demesticha

The Arduous Voyage of Underwater Research on the LBA Shipwreck off Modi Islet

Christos Agouridis and Myrto Michalis***

This paper aims to provide an overview of the ongoing underwater excavation of a Late Bronze Age shipwreck off Modi islet (southeast of Poros island, Greece), conducted by the Hellenic Institute of Marine Archaeology during four field seasons. As the excavation has revealed, the ship's cargo consisted mainly of transport vessels with a typological and chronological homogeneity, which can be dated to the Late Helladic III B-C period (13th-12th century BCE). This paper examines the archaeological context and analyses the main factors which have affected the processes of field research and documentation.

Keywords: Mycenaean shipwreck, underwater excavation, Late Helladic III B/C, transport jars, hydriae, site-formation process.

During a systematic underwater archaeological survey in selected areas of the Argo-Saronic Gulf (Fig. 1), carried out since 2003 by the Hellenic Institute of Marine Archaeology (HIMA), under the direction of Christos S. Agouridis, a Late Bronze Age (LBA) shipwreck was located off the north-northwestern rocky coast of Modi islet, near Poros island, at a depth of 23-37 m (Fig. 2) (Agouridis, 2004: 28-32; 2007: 18-27; 2008; 2012: 70-82).

Modi is situated at the southwest end of the Saronic Gulf, at a distance of less than one nautical mile (1.8 km) east-southeast from the nearest coast of Poros (ancient Kalavreia). The rocky, uninhabited islet reaches a height of 102 m above sea-level and extends about half a mile from southwest to northeast. Its steep coastline offers limited access to a safe anchorage. Modi's remarkable shape, like a seated lion (Fig. 3), explains its second name Liontari (lion, in Greek) and makes it an important landmark on one of the most frequent sea routes in the Aegean throughout the centuries. Ships sailing from the Saronic Gulf, the Euboean Gulf, Attica, and the NE Peloponnese to the Argolic Gulf, the Cyclades, Dodekanese, and Crete, or vice versa, would have passed close to its rocky slopes.

The Modi Survey Project, conducted during the 2005, 2006, and 2007 field seasons, and the preliminary study of surface finds recorded on the islet's rocky, steep, northwestern seabed confirmed the existence of a shipwreck dated to the LHIII B-C (late 13th/12th century BCE), for the following reasons:

The site area was submerged during the LBA. The estimated sea-level when the Mycenaean ship wrecked would have been about 2.7 m below present sea-level. The coastal zone would have reached the present configuration around the same period, according to existing information on relative sea-level changes incorporating predic-

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Figure 1. Underwater Archaeological Research in the Argo-Saronic Gulf. Survey area marked in red. The area of investigation includes the islets of Korakia, Trikeri, Stavronisi, Petasi, Vlychos and the Trikeri and Loney reefs, in the north-northeastern part of the Argolic Gulf; and the islet of Modi and the east coast of Poros island (from Cape Aherdo in the north to Cape Kokoreli in the east and Zoodohos Pege Bay in the south), in the southwestern part of the Saronic Gulf (Imagery: 2003 Google; Landsat, Copernicus; Map data: 2003 Google).

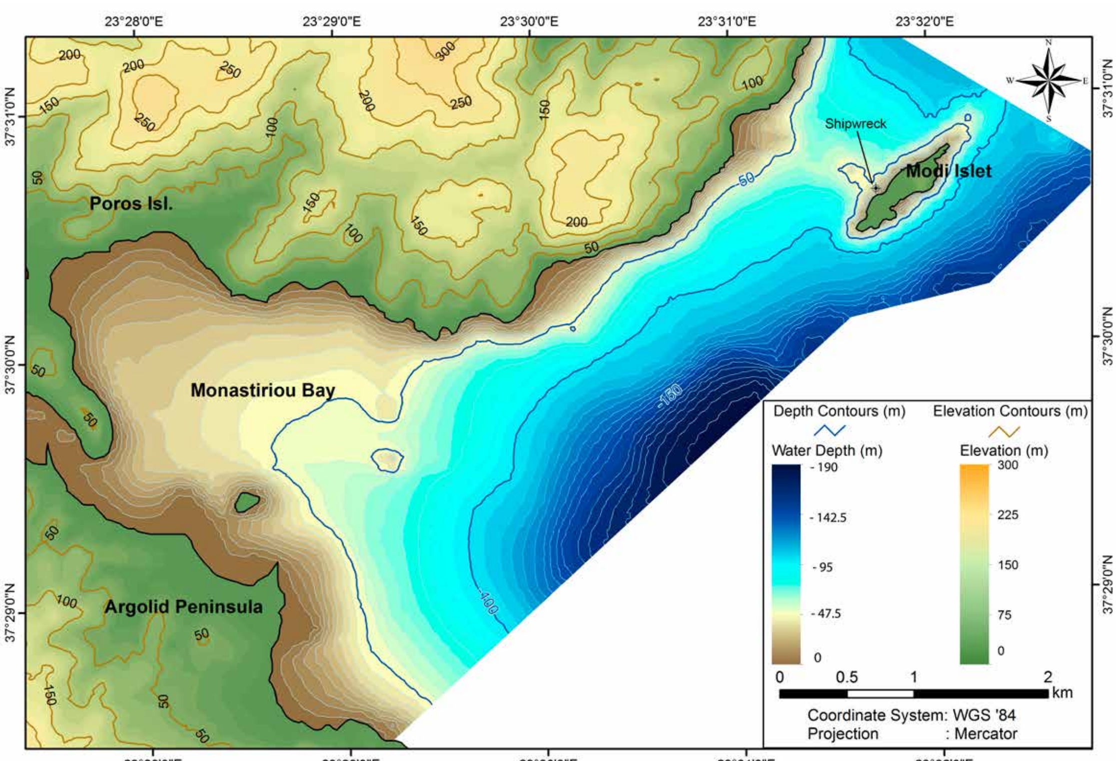


Figure 2. Poros island and Modi islet. Bathymetric map of the survey area, with the location of the shipwreck (© LMGPO, University of Patras).

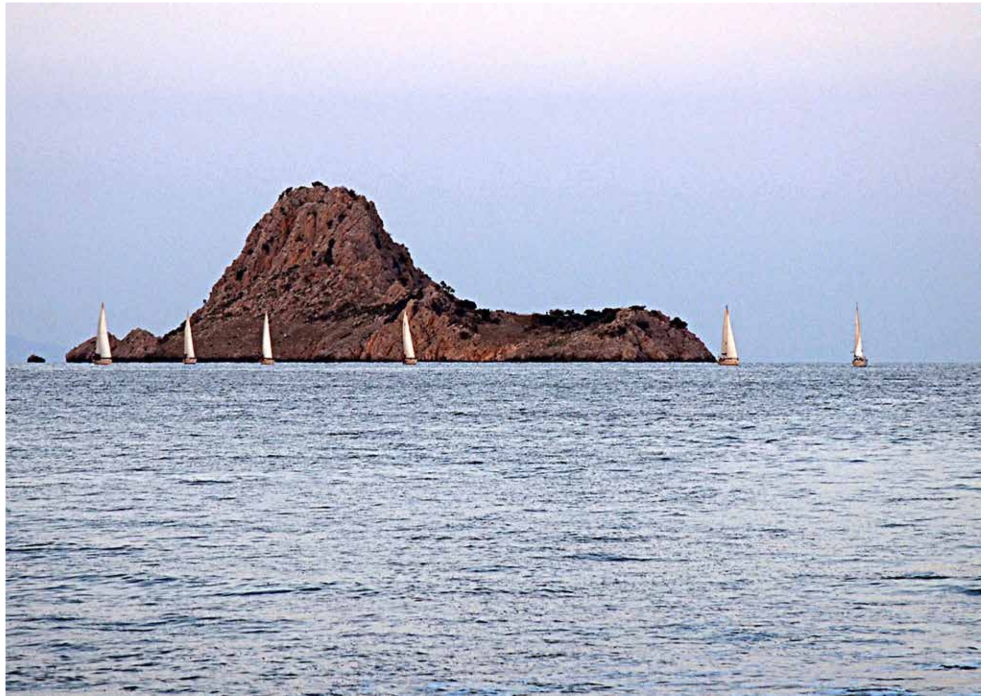


Figure 3. Modi islet, the 'seated lion'; view from the northwest (© HIMA).

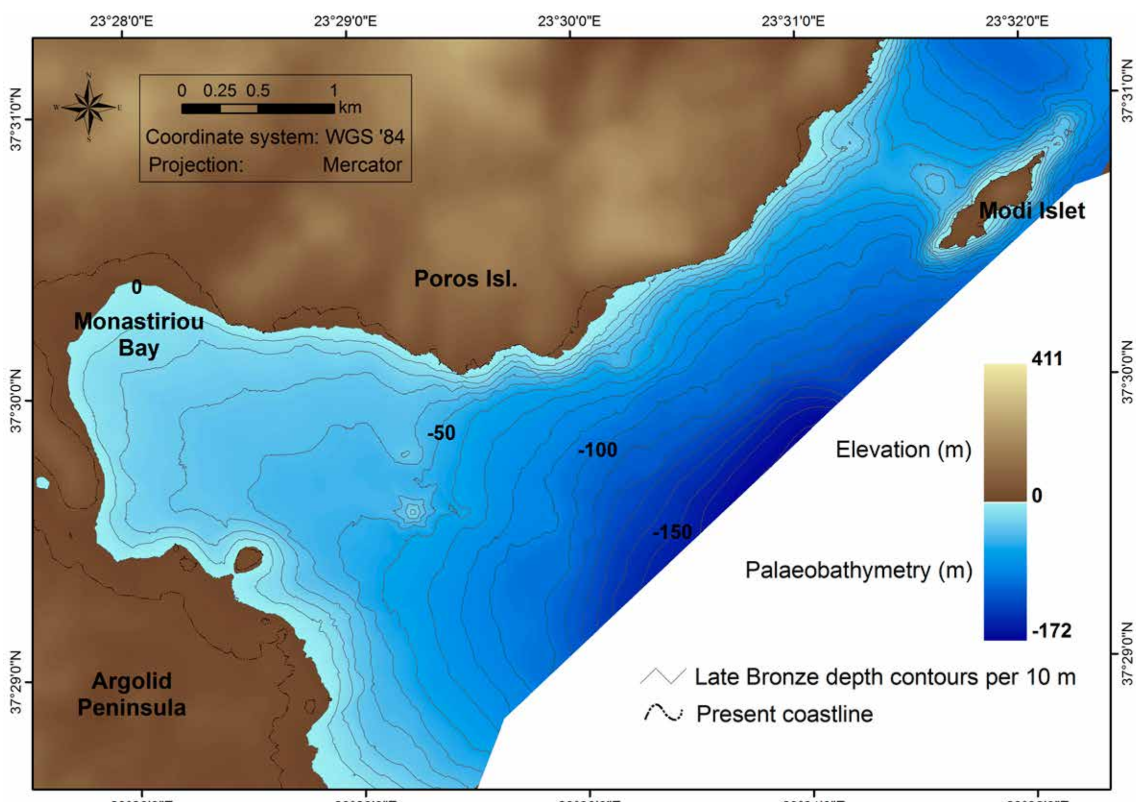


Figure 4. Poros island, Modi islet. Map showing reconstructed coastal zone during the Late Bronze Age (© LMGPO).

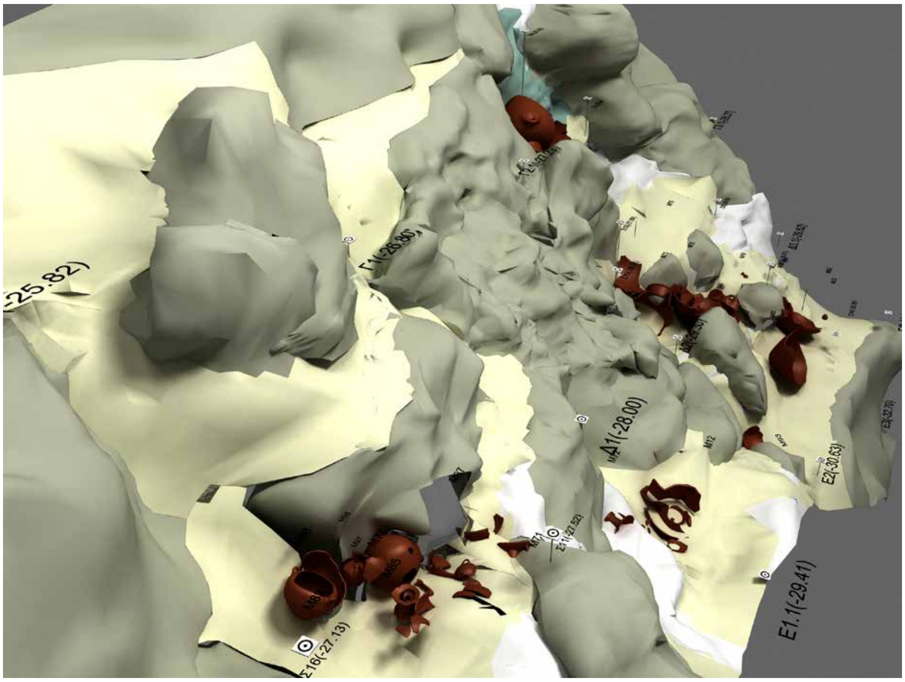


Figure 5. Modi shipwreck. 3D plan showing the excavation sectors of 2013, from the east (G. Farazis, © HIMA).

tions for eustatic, isostatic, and tectonic changes, together with local sedimentological data (Fig. 4) (Geraga *et al.*, 2017: 816, 813, table 2).

The pottery assemblage would have belonged to a ship that was wrecked with its cargo at a specific moment in time. Along the northern coast of Modi islet, only four fragments of Late Mycenaean pottery were located, at a significant distance from the main concentration, and it cannot be confirmed that they belonged to the same ship. The ship was most probably trapped as it tried to avoid the strong winds, which kept pushing it against the rocky coast until it broke apart and wrecked lying in a southwest-northeast direction. Most of its cargo was found alongside, covering an area of approximately 100 m^2, while other parts were scattered before coming to rest on the seabed, along a wider area of 170 m^2. For reasons explained below, no wooden remains of the hull have been found yet. Heavily concreted groups of overlapping ceramic wares, mainly vessels for transporting commodities, were found buried one on top of the other (Fig. 5). The smaller jars were found on top, often buried upside down within the broken body of a larger vessel and can provide evidence of how the cargo was originally stowed. Their typological features place them all within the same chronological horizon.

Excavation was the only appropriate method to gain further information from the inhospitable and complicated environment within which the Modi shipwreck had been buried. Our arduous 'voyage' of underwater research started in 2009 and, after four excavation seasons, is still ongoing. HIMA's team strive together as a crew committed to unravelling the geomorphological and natural hazards that proved fatal for the Mycenaean merchant ship.

In this article, we discuss various factors that have affected the progress of the project, explaining how every phase of a standard procedure is conducted with a degree of difficulty within the context of the underwater archaeological project at Modi.

Field research management

For the successful outcome of the project, which has been an *ad hoc*, complex effort limited by time, budget, and human resources, and to ensure productivity, safety, scientific grounding, and continuity, an interdisciplinary team was recruited, a proper surface support vessel hired, minimal but sufficient funding raised, and a proper dive plan formulated.

Coming together each year, an interdisciplinary team of approximately 35 people, mostly divers, with various academic credentials, has been operating in the field at Modi.

In tandem with the archaeological excavation, a marine geophysical survey was carried out in collaboration with the Laboratory of Marine Geology and Physical Oceanography, University of Patras (LMGPO), under the coordination of George Papatheodorou, with Maria Geraga supervising the data processing and analysis. The geophysical survey, which employed echo-sounding, sub-bottom profiling, sidescan sonar systems, and sediment coring, extended over the area between Poros island, Modi islet, and the Argolid peninsula. It had the following aims: a) to define the evolution of the coastline around Modi islet over the past 18,000 years, based on mapping palaeoshoreline features; b) to define the sub-bottom stratigraphy of the recent sediment sequence; c) to detect targets (surface and subsurface) of potential archaeological interest; d) to obtain detailed bathymetry of the northwest coastal zone of Modi islet, specifically around the area of the shipwreck; and e) to study the site-formation processes that have affected the wreck-site.

Furthermore, a collaboration has been established with the Goulandris Natural History Museum, under the coordination of Eve Vardala, to study the site's marine life and how it has contributed to the process of sedimentation. Three main classes of molluscs have been identified so far, the *Gastropoda* (15 families), the *Scaphopoda* (1 family) and the *Bivalvia* (14 families) (Vardala-Theodorou, 2017: 95).

Research support vessel

A 20 m-long traditional wooden fishing boat, *Agios Nikolaos* (τρεχαντήρι), was used as a support vessel for HIMA's research campaigns between 2009 and 2013. Among its notable advantages, this vessel proved trustworthy navigating in bad weather; possessed adequate space to store the necessary mechanical, technical, and diving equipment; and allowed the large team to conduct its daily tasks of excavation, archaeological documentation, maintenance of diving gear, and first aid conservation. It was also possible, with the owner's consent, to make extensive repairs and adaptations to support, according to need, the underwater archaeological expedition on Modi.[1] After the *Agios Nikolaos* was returned to its owner, a 20 m-long wooden liberty was hired, *Agios Georgios,* which had been outfitted as a dive boat, with two low- and high-pressure compressors, storage space for diving equipment, an electrical generator, and an onboard recompression chamber.

The diving plan

The project's dive plan, initially formulated by the late Phaedon Antonopoulos, the team's divemaster until 2013, follows a combination of air/oxy tables (COMEX) and two diving software applications (Proplanner and GAP). The dives were adjusted to a maximum depth of -31 m below sea-level (BSL). Repeat dives were occasionally conducted. In order to work safely under water and be more productive, a mixture of Enriched Air Nitrox (EAN 36 = 36% Oxygen) was used. To accommodate this, a Nitrox mixer had to be installed on the support vessel, together with the adequate amount of 99% medical grade oxygen (20 tanks of 50 l each at 200 bars pressure). Each dive lasted for 45 minutes with a ten-minute decompression. To date, we have accomplished 939 dives, working underwater for 783 hours, in groups of two and sometimes three divers.

Diving at this particular site requires a certain level of expertise and skill certification, factors that have prevented a considerable number of students interested in the field of underwater archaeology, as well as some of HIMA's members, from participating. The members of the archaeological team, through the years, have had to gain nautical experience that has allowed them to operate on board as the boat's crew. Sailing and anchoring are conducted by the team, who are always ready to carry out their duties, even when the weather gets really rough, as is often the case. A diverse team in terms of age, gender, physical condition, and experience, together with the demanding nature of the dives and the added fatigue from working intensively for a long period, led to the institution of compulsory days-off. Finally, in addition to the above, it should be noted that within the limited six-week time frame imposed by the Greek authorities for each archaeological campaign, one week is usually missed due to bad weather conditions (mainly strong northerly winds). In 2009, for example, there were ten days when no work could be done at the site and about seven days when work was conducted under very difficult weather conditions. At these times the boat could not be securely anchored over the site for at least half the day, so the dives were made from zodiacs with a compressor working on the adjacent rocky slope of the island.

The excavation

During four research campaigns, 12 out of 20 sectors have been excavated in the area A0-A3-E3.1-E0 (Fig. 6), all but three down to bedrock, at a depth of 0.60-1.20 m below the seafloor. Stratigraphy was recorded as follows: a) a surface layer of loose, coarse sand and limestone rocks and boulders that have rolled down the slope from the islet; b) layer (1) of coarse-to-medium sand, stones, pottery sherds, and molluscs (living or fossilized); dispersed lithified layers of sediment (concretions of sherds and conglomerates connected with biogenic marine encrustations); c) layer (2) of silt comprising a small number of stones and seashells; d) limestone bedrock.

1 During the time of the boat's operation (2009-2013), most of its repairs were conducted by HIMA's members, under the technical supervision of our recently departed colleague Markos Garras.

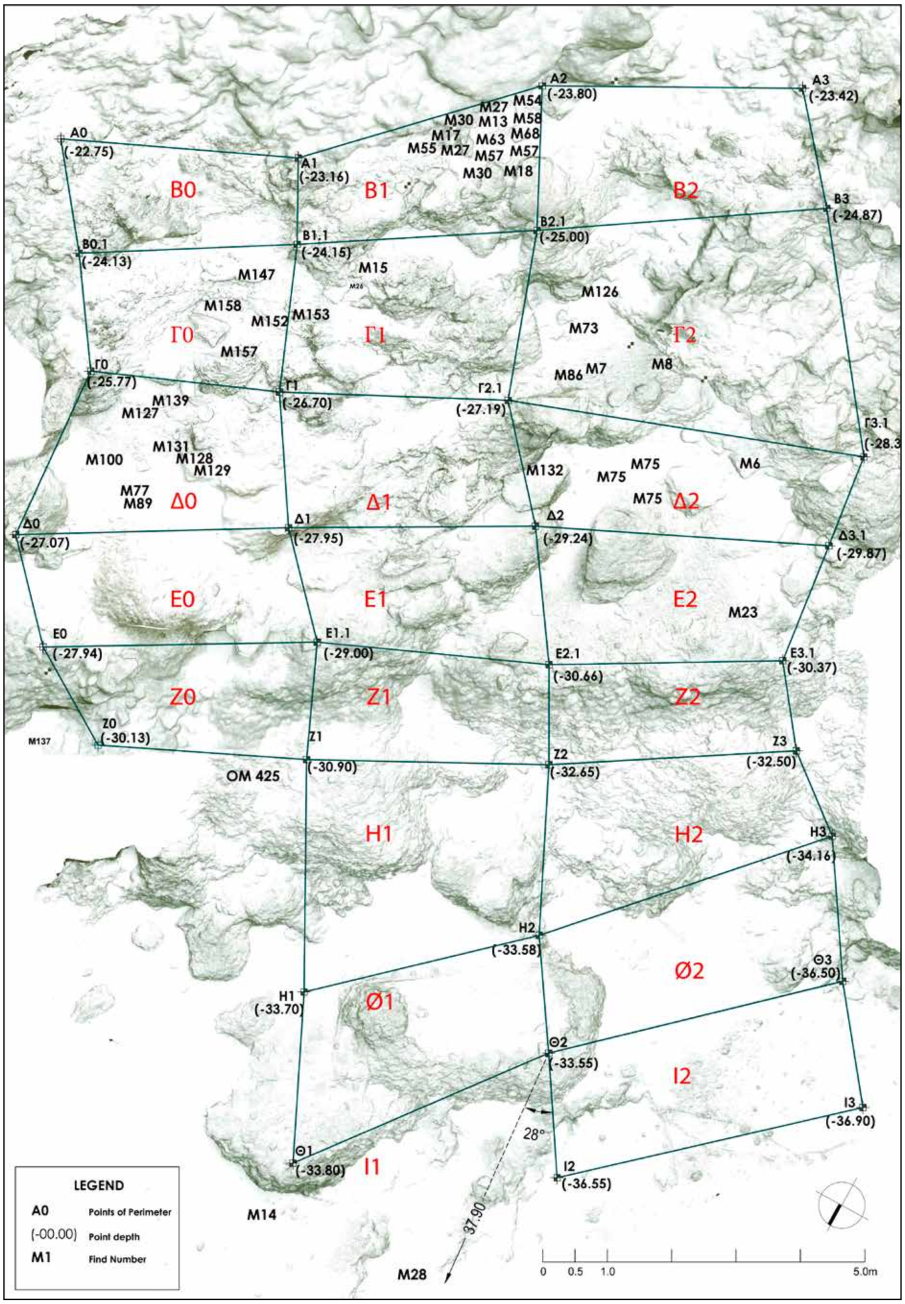


Figure 6. Modi shipwreck. General plan, created in 2016, with the location of the artefacts mentioned in the text (F. Vlachaki, E. Diamanti, G. Farazis, © HIMA).

The geomorphology of Modi seabed presents peculiarities that greatly obstruct and delay the excavation. Often, because of the steep slope (Fig. 7), a retaining wall of sediment-filled bags has been necessary to prevent further landslides from the shallows as excavation proceeded. Bathymetry results have revealed that the seafloor around Modi is steep, with slopes ranging between 26° and 37° degrees (Geraga *et al.*, 2017: 810).

A large number of boulders have rolled down from the rocky islet onto the sectors under investigation and have covered large parts of the ship's cargo, and excavation has had to proceed slowly. An example is sector Δ0 at the southeast end of the site's perimeter, which has earned the nickname 'the sector of hydriae' (Fig. 8). In 2010, seven hydriae were found in fragmentary condition, and in 2013, further excavation into the southern part of the sector brought to light another seven hydriae with painted decoration in a good state of preservation (Fig. 9). This happened mainly because the sector was partially 'sealed' by a large limestone boulder, weighing approximately four tonnes, which covered the northern part of sector Γ0 and the southern part of sector Δ0 (Fig. 10). In 2016, the boulder was removed with underwater airlift bags and as excavation

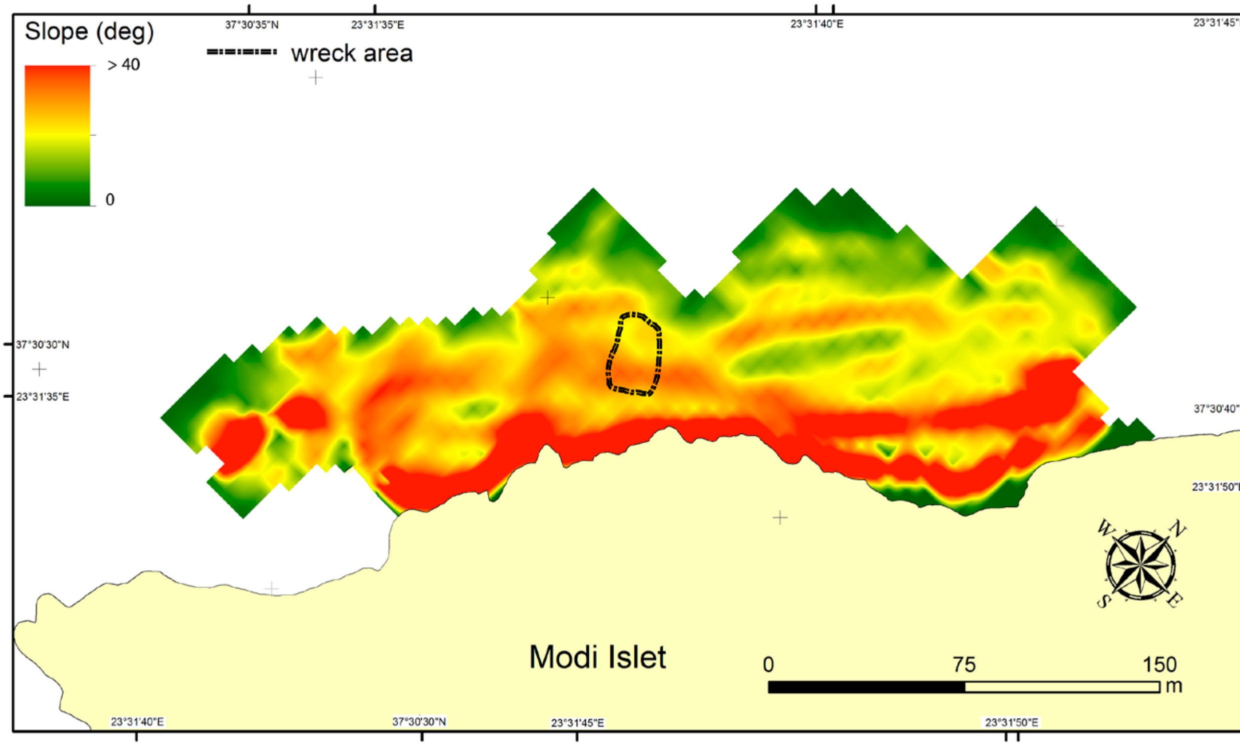


Figure 7. Modi shipwreck. Slope Map, general view (M. Geraga, © LMGPO).

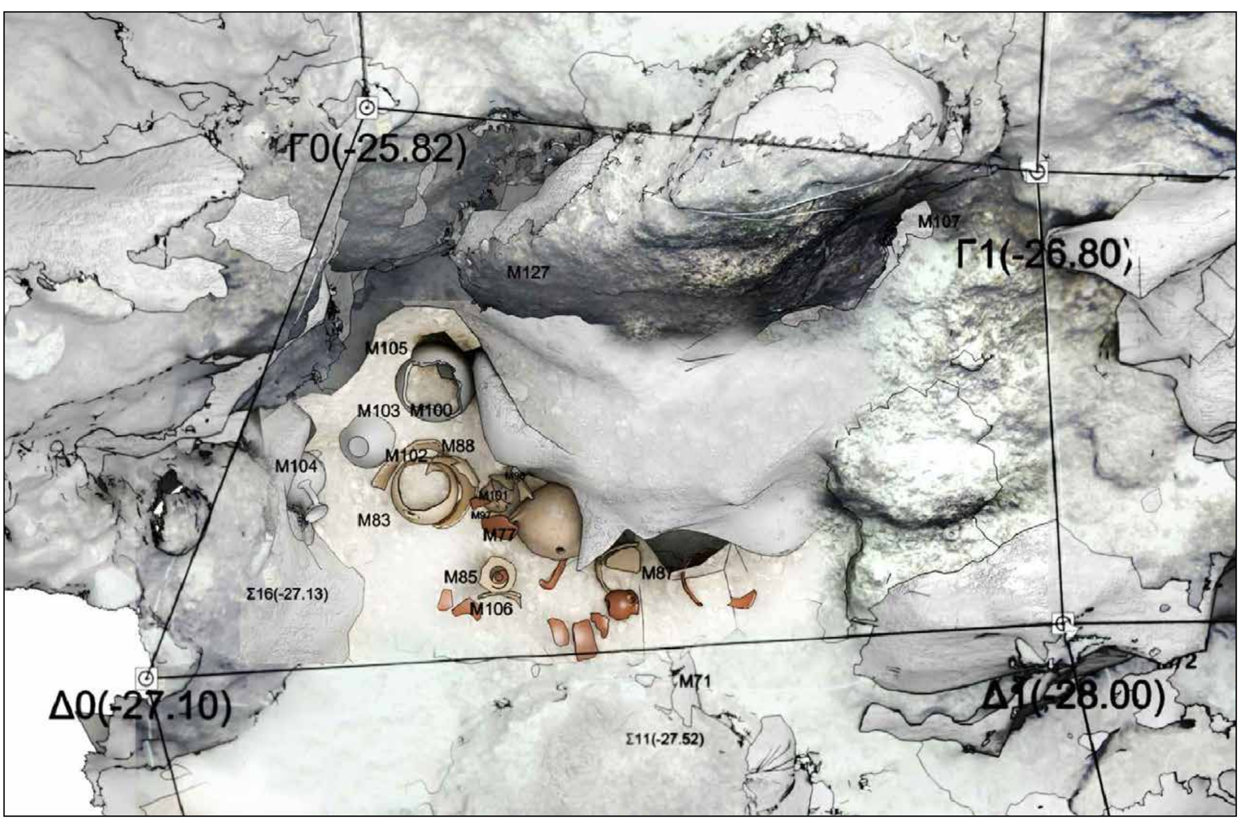


Figure 8. Modi shipwreck, excavation season 2013. Δ0, 'the sector of hydriae' (G. Farazis, E. Diamanti, F. Vlachaki, © HIMA).

Figure 9. Modi shipwreck, excavation season 2013. Hydria M131, during the excavation of sector Δ0 (A. Agathos, © HIMA).

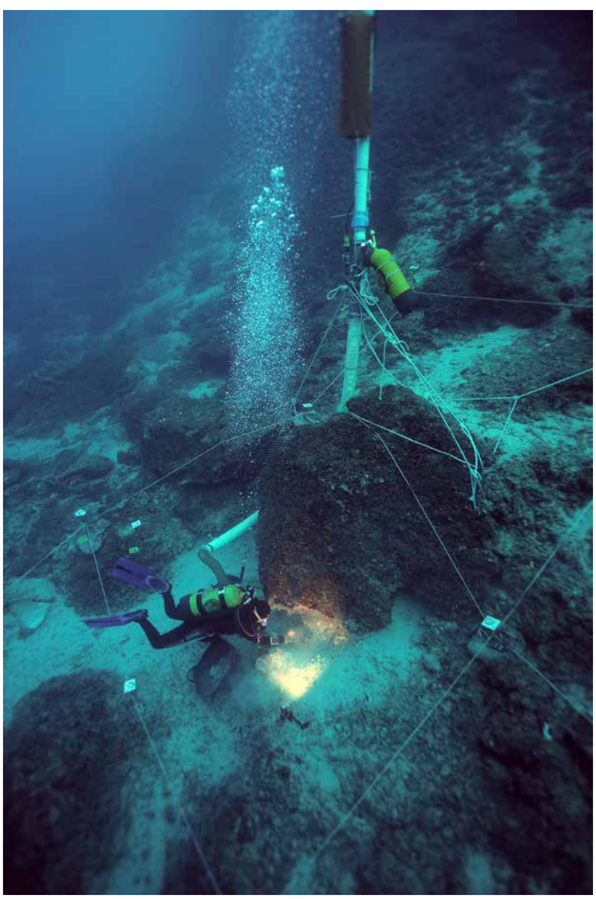


Figure 10. Modi shipwreck. Excavating under the limestone boulder in sectors Γ0 and Δ0 (A. Agathos, © HIMA).

progressed, 14 additional, partially preserved, hydriae were recovered.

Furthermore, during all phases of excavation, numerous limestone rocks, weighing from 50 to 200 kg, and boulders, weighing from 500 kg to 4 tonnes, have been removed (Fig. 10). Beneath them, a considerable number of pottery sherds and partially preserved vessels have been recovered. For instance, in 2016, an almost intact deep bowl (M157) was recovered from sector Γ0 after the removal of a large rock that had rolled down from the rocky islet and settled between three blocks, thus creating a shelter for this finely decorated and fragile vessel (Fig. 11). It was found broken but with all its pieces *in situ*. Thus far, we estimate that a total of 15 m^3 of deposit have been removed from the excavation area.

Sedimentation and site-formation processes have affected the geomorphology of the seabed and have created a complicated lithified marine environment (Fig. 12). Thick layers of biogenic concretion have been created over a long period and have completely incorporated numerous ceramic artefacts. Evidence documented so far strongly suggests that part of the ship's cargo has been buried beneath this hard biogenic formation. For example, krater M153 (Fig. 13) was heavily concreted and had to be detached from its surroundings with a hammer and chisel, an operation that required great effort and working time, especially if one considers the diving limitations imposed by the site's depth. Calcification has created a context that makes it very difficult for finds to be removed. Therefore, when possible, sections of this lithified sediment are raised to the surface and the removal or cleaning of the ceramics is conducted onboard the research vessel.

Figure 11. Modi shipwreck. Deep bowl M157 during excavation. It was found broken, with its fragments in situ (A. Agathos, © HIMA).

Figure 12. Modi shipwreck. Lithified sediment, showing the upper part of hydria M152 below, from the east (N. Golfis, © HIMA).

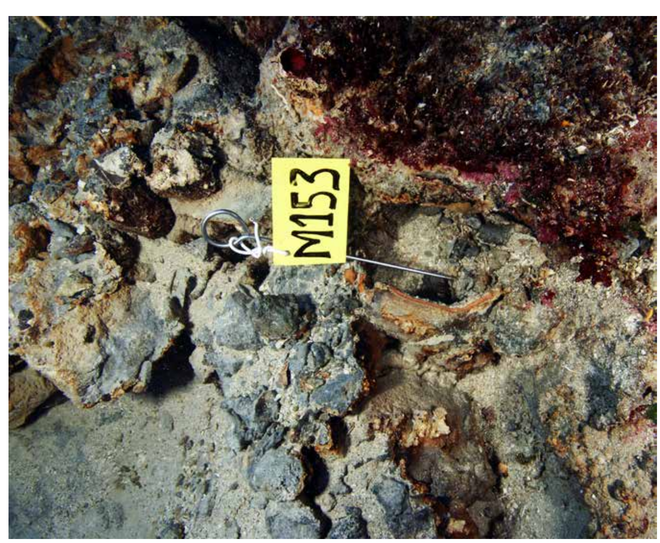


Figure 13. Modi shipwreck. Krater M153, from the north (V. Mendogiannis, © HIMA).

Examination of the seabed composition at the wreck-site suggests that natural processes have created unfavourable conditions for the preservation of wooden remains (Geraga *et al.*, 2017: 812, 817). The detection of archaeological finds by acoustic means was not possible, due to the short distance between the artefacts and the rocks (Geraga *et al.*, 2017: 815). The rocky surroundings reflect more energy and overshadow the return signal from the desired object. The effects from the long exposure to light before the wreck was buried, clearly visible on the pottery, indicate that wooden remains could not have survived at the shallower area of the perimeter where most of the ship's cargo came to rest. Under similar conditions, the ship's hull of the late 13th-century Point Iria wreck did not survive, even though the time interval before the cargo was buried would have been shorter, since the layer of marine concretions attached to the surface of the jars was thinner and the level of surface deterioration and decrease on their wall thickness was significantly smaller (Papanikou, pers. comm.; Saramanti *et al.,* 2005). Therefore, excavation of trial trenches at the deepest part of the site (33-37 m BSL) has been planned in the near future, where rocks meet the sandy seafloor (in sectors Θ2, I2, and to the northeast). Here, probing has shown that thick layers of sand deposits could still hold finds in a good state of preservation.

Excavations carried out on Modi islet, under the direction of Dr Eleni Konsolaki, Ephorate of Piraeus, following the discovery of LBA occupation remains by Adonis Kyrou, provided evidence for the existence of a well-planned, prosperous settlement, established during the late phase of LH III B2, which would have flourished during the early and middle LH III C period (Konsolaki-Yannopoulou, 2003: 417-432; 2007: 171-198; 2009: 514-518). An intriguing problem has been that pottery sherds from this settlement were found embedded in the sediments that had tumbled down the sloping sides of the islet and come to rest within the wreck-site. They belong to vessels of different type and size (pithoi, bowls, hydriae, kylikes, alabastra, tripod cooking pots, lids, etc), either plain or covered with painted and/or relief decoration.

In this respect, the underwater assemblage differs significantly from other shipwreck sites, expected to be found as a closed unit, within a well-stratified archaeological layer, regardless of their state of preservation, as seen in the case of Hishuley Carmel in Israel (Galili *et al.,* 2013: 2-23), among others. Moreover, other sites with evidence of archaeological finds from different periods have been explained by the site lying either on a busy sea route, as was the case at the Point Iria wreck, Greece (Agouridis, 1999: 27), or in an anchorage, such as the Tantura Lagoon, Israel (Wachsmann and Raveh, 1984: 224).

For the detailed documentation of the stratigraphy and the bulk of LBA pottery sherds, which have been recovered from a disturbed context, together with the finds belonging to the shipwreck, a database has been created. Furthermore, photogrammetric surveying has been applied daily during the excavation to be able to record changes in the geomorphology of each sector caused by the removal of boulders and lithified layers of sediment. The orientation of the photographs, the plotting of reference points, and the production of a detailed, textured, 3D surface model of the photographed area, were implemented with the use of Agisoft PhotoScan Professional 1.2.6 software. All images were radiometrically preprocessed into Adobe Photoshop and Irfanview software, before they were imported into Agisoft Photoscan, for colour and edge enhancement. Datasets of orthophoto mosaics, 2D, and 3D plans, and 3D models, acquired from earlier excavation periods (Agouridis, 2011: 27-28), have been used as reference tools for planning, organizing, and connecting the recording work to an existing coordinate system. In order to reproduce the location of artefacts and changes in the stratigraphy below the surface layer as excavation proceeded, a continuously updated 3D model was created. Each geo-referenced mesh produced through photogrammetric documentation was imported in 3Ds Max software, as FBX or obj file formats. From those annotated 3D models, it has been possible to extract 2D plan and section drawings daily. In addition, scale drawings and sketches were made when a detailed record of selected finds or concentrations of finds was necessary.

Conservation

Another task that has proven arduous throughout the Modi research has been the conservation of ceramics, due to their poor state of preservation and level of encrustation.

Care of the finds in the field

As explained above, the detachment of the finds from their concretions has often been a labour-intensive, time-consuming procedure. Conservators work under water with mallets and chisels of different sizes, occasionally using a soft foam cushion to absorb vibrations and gauze strips wrapped around the artefacts to ensure the safe removal of fragmented finds.

For the conservation of recovered finds, the upper deck of *Agios Nikolaos* and part of the deck of the *Agios Georgios* were adapted to accommodate the necessary procedures. Storage tanks and lidded jars were secured. Instead of starting desalination, the finds were immediately stored in seawater from the area of the wreck, without the use of biocide. For the mechanical removal of marine encrustations, a variety of tools has been used, including scalpels, picks, hammers, and a Dremel multitool with burr drill bits made of diamond or oilstone and marble-cutting blades.

The priority has been the removal of the living marine biota, calcareous depositions, and organic residues, rather than elaborate cleaning. This work also accelerates the process of desalination during the next stage of conservation back in the lab. During treatment, finds are constantly kept wet by regularly moistening their surfaces with fresh seawater or by covering them with hessian sacks soaked in seawater.

In the conservation laboratory

Desalination and systematic conservation procedures have been conducted at the laboratory of the Ephorate of Underwater Antiquities (EUA). The desalination process has been completed for the finds recovered from the 2009, 2010, and 2013 field seasons, and most of the artefacts have been transferred from the storerooms to the lab for further treatment. Therefore, some preliminary general remarks can be made on their state of preservation.

The concretions covering the surface of the finds could be up to three times the thickness of the vessel's walls; however, it has been observed that site-formation processes have had varying effects on the finds. Sherds belonging to the same ceramic vessel, but

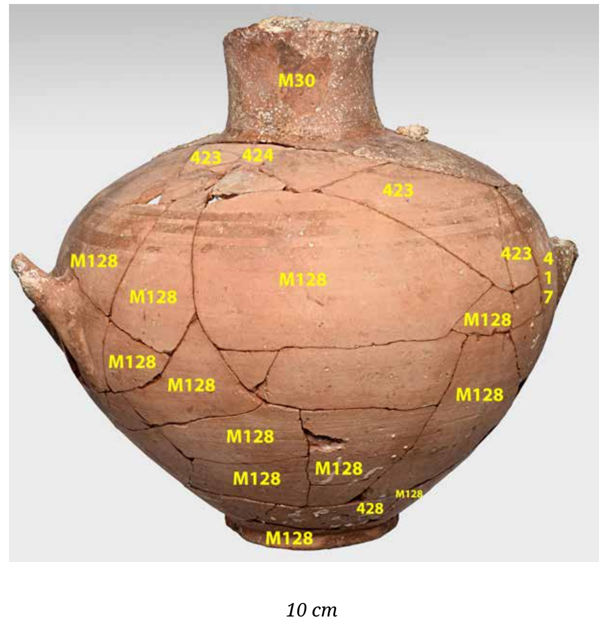


Figure 14. Large fragments and scattered sherds, which belong to the same hydria, M30-128 (S. Papanikou, © HIMA).

Figure 15. Large transport jars from the LBA Modi wreck. From left to right, above: M7, M8-M73.1, M75; below: M6-M23, M14, M58, M28 (P. Vezyrtzis, © HIMA).

Figure 16. Jar M7, following conservation (Photo P. Vezyrtzis, Drawing by Y. Nakas, © HIMA).

Figure 17. Jar M58, showing its relief and incised decoration (P. Vezyrtzis, © HIMA).

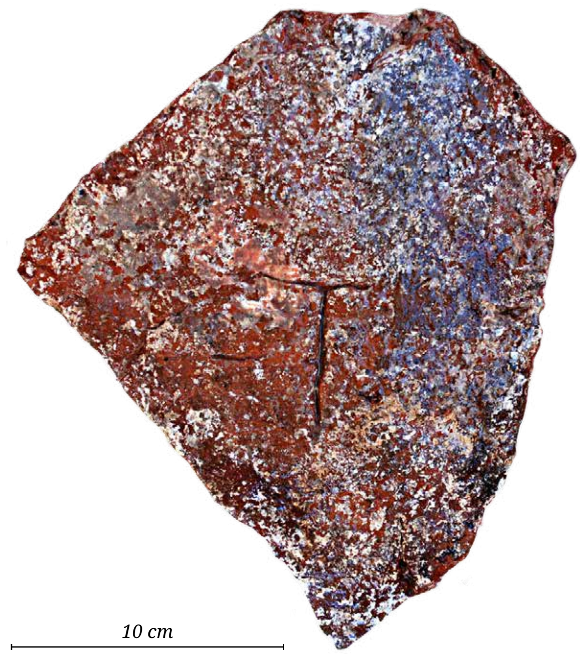


Figure 18. A fragment from a jar (group 425) with a T-shaped incision (P. Vezyrtzis, © HIMA).

recovered from different sectors (Fig. 14), were found covered with concretions of different types (calcareous or chloride) and different thicknesses. Furthermore, differences are apparent in the state of preservation of the artefacts (surface deterioration, reduction of wall thickness etc.).

Many of the recovered ceramics are decorated with either painted, incised, or relief decoration. As observed in 2015, during the procedure of cleaning the hydriae assemblage, marine concretions in many cases have protected the original surfaces of the ceramics and their painted decoration. In contrast, the surfaces of the ceramics found buried under coarse sand deposits were unaffected by marine concretions, but exhibited extensive mechanical erosion and loss of their painted decoration.

Conservation of the large jars presented difficulties due mainly to the thickness of the marine concretions attached to their surfaces. Their size and weight made them cumbersome to handle. For example, as the cleaning of the calcareous encrustations progressed, the surface of M28 suffered from deterioration (Fig. 15). Surface flakes that had been removed together with concretions were cleaned carefully and glued back in their original positions. Sometimes concretions were left on fragile vessels, as it served to hold them together, as in the case of jar M7; concretions thicker than the wall of the neck were not removed from the interior of the jar.

Refitting individual vases also proved a long endeavour. For example, hydria M54-57 (see Fig. 19), today an almost complete vessel, consists of sherds recovered from three different sectors (B1.1, B2.1, and Δ0), during three campaigns (2005, 2009, and 2010), and a total of 18 dives.

The difficulties encountered in conserving the pottery assemblage have prolonged the analysis of the site. However, an overview of the typology and dating of the cargo pottery, together with some general remarks, can now be advanced.

Figure 19. Hydriae from the LBA Modi wreck. From left to right, above: M18, M131, M100, M77; below: M15, M13, M54-57 (P. Vezyrtzis, © HIMA).

To date, it appears that the largest part of the ship's cargo space was occupied by large transport jars (either with two handles or without handles) (Fig. 15).

Eleven undecorated two-handled jars have so far been recovered. Two survived almost intact (Figs 15, 16), while the rest were preserved in a fragmentary condition. They belong to the same type, with some variation in size and shape. They have a piriform, ovoid, or ovoid-conical body with two handles, a flat base and a collar neck (Agouridis, 2011: 30; Agouridis, 2012: 76). Their capacity averages 130-165 litres. Their closest parallels are from the Point Iria wreck (Lolos, 1999: 45, 55, fig. 5) and LH III B/C settlement sites in the Peloponnese, such as Prosymna (Blegen, 1937: fig. 430) and the Palace of Nestor at Pylos in western Messenia (Blegen and Rawson, 1966: figs 373, 374). Christina Marabea has reported that a fragment from a two-handled jar was found in the rear room of the House Megaron, in the Central Building of the Mycenaean Acropolis at Kanakia-Salamis, dated to LH III B2-III C early (phase 1) (Lolos and Marabea, 2017: 435).

Jar M58 (sector B1) differs slightly from the others (Fig. 15) as it bears a relief and incised decoration consisting of two parallel bands with triangles that alternate in orientation between them (Fig. 17). Two deep incisions are evident under the handles, possibly representing the potter's marks. Many fragments of the jar survived, which apparently make up most of the vessel. It is worth noting that on a fragment from another jar (group 425), a T-shaped incision was detected (Fig. 18), which in *Linear B* represents a dry measure unit (weight or volume) used for wheat and barley (Chadwick, 1967: 153; Ventris and Chadwick, 1973: 55, 59, 60, 216).

Two handle-less pithoi have been found. Pithos M14 (Fig. 15 below, second from the left) was discovered intact, northeast of point Θ1 (Agouridis, 2011: fig. 13); its volume capacity is 107.25 litres. It bears one relief band with an incised fishbone pattern on the junction between the neck and the body. Parallel evidence was documented in a Late Helladic III B2 context at Mycenae, dating around 1200 BCE (Iakovidis, 2006: 50, pl. 15, figs 23, 26). Pithoi as vessels used in long-distance trade, to store and transport liquids or other commodities, are known from three other wrecks of the 14th and 13th centuries BCE: Cape Gelidonya (Bass, 1989: 13; Pulak and Rogers, 1994: 20), Uluburun (Bass, 1986: 293; Pulak, 1997: 242, fig. 10) and Point Iria (Lolos, 1999: 44).

To date, hydriae far outnumber all other pottery vessels found at Modi wreck; 36 have been recorded so far, most of them surviving in fragmentary condition (Fig. 19). The main assemblage has been recorded in the south-southeastern area of the site's perimeter (Fig. 6). Three of them, M13, M18, and M54-57, were buried within the broken bodies of the jars M27 and M58 (sectors B1 and B2) while M86 (Γ2) was found broken in many fragments, attached to the mouth of jar M7 (Agouridis, 2011: fig. 15).

They bear a dark-on-light painted decoration consisting of one line around the base of the neck, three on the shoulder, and two below the side handles (Fig. 20). They have a globular or ovoid body, ring base, tall neck with a flaring rim, and a pronounced or slightly hollow lip. The vertical handle, either elliptical (Agouridis and Michalis, 2017: 88, fig. 17) or rectangular in section (M54-57, M13, M15, M131, Fig. 20), extends, in most cases, from the rim, or the neck to the shoulder. The handle often slants inward and may have borne a linear decoration extending lengthwise (M54-57, M131). In some examples, there is a loop around the base of the handle and a large hook below it (M131). The two horizontal, side handles are often painted with a brushstroke lengthwise and along their roots (M54-57, M15, M131, Fig. 20), ending near the linear decoration of the lower body. On most of the hydriae, the handles have been pierced with narrow vertical holes before firing.

Their decoration and general shape resemble Phylakopi II examples (Mountjoy, 1998: 109, fig. 124), dated to LH III B, but are more closely paralleled by hydriae from Mycenae (Mountjoy, 1999: 177-178, fig. 51.390), Asine (Mountjoy, 1999: 163-164, fig. 44.337), and Korakou (Mountjoy, 1999: 228-229, fig. 73.175-176), all assigned to the LH III C horizon. Their average capacity has been measured as between 10 and 22 litres. To measure the volume of jars and hydriae, they were filled with expanded polystyrene micro-beads, 0.5 mm in diameter. Experiments conducted in advance proved that micro-beads can be used to fill a void like a liquid and, because of their light weight and texture, they do not cause damage to fragile artefacts.

The evidence recovered so far points to the possibility that hydriae might have held commercial goods and at least some could be characterized as Maritime Transport Containers (Knapp and Demesticha, 2017). The complete absence of Transport Stirrup Jars (TSJs), a vessel type used extensively in the LBA III Aegean world (Haskell *et al.*, 2011) and in most of the eastern and central Mediterranean (Day, 1999: 65), is remarkable and may suggest that in the case of the Modi ship's cargo, TSJs could have been replaced by hydriae, which have similar capacity. The volume of TSJs, ranges between 12 and 18 litres (Knapp and Demesticha, 2017: Appendix), a value which resembles the average capacity of the Modi hydriae. If this is indeed the case, a different sphere of influence and interaction could then be supposed. The Modi hydriae point toward mainland Greece and the Argo-Saronic Gulf, whereas in the case of TSJs, Crete would have played a key role in their production and widespread diffusion (Day, 1999: 65-71; Day *et al.*, 2011: 517). The absence of TSJs at the Modi shipwreck site would then coincide with the 'disappearance' of large stirrup jars during the Post-palatial period (Dickinson, 1994: 87). The significant presence of hydriae on the Modi cargo suggests that during this period an additional container was distributed as an alternative to TSJ's, other than the dominant amphora type (Pratt, 2016: 27).

Vessels such as hydriae could have been used by the crew onboard, but it is highly unlikely that all 36 found to date served this purpose, since a ship such as the one that foundered at Modi may have been crewed by only two or three sailors. The size of the pottery assemblage and absence of copper ingots indicate that a smaller ship than the one that sunk at Uluburun would have been needed to undertake this journey: the Uluburun ship is estimated to have been 15 m long, with a cargo capacity of 20 tons, with over 350 four-handled ingots weighing 10 tons (Pulak, 1997: 248-249; 1999: 210; 2005: 37).

Knapp and Demesticha (2017: 101) argued that the Modi hydriae were carried solely as tablewares, but stratigraphic evidence suggests otherwise. If they were to be exchanged as commodities themselves, to be traded as tablewares, and did not hold any contents, then it is

Figure 20. Hydria M131, showing its painted decoration (Photo P. Vezyrtzis, Drawing Y. Nakas © HIMA).

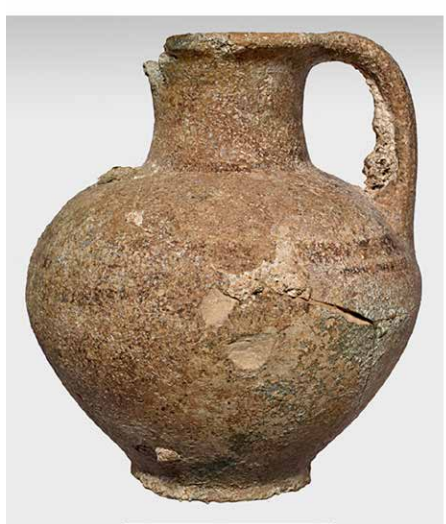
difficult to explain their dense concentration within the site's perimeter and the archaeological context within which they were found. Pithos M7 and hydria M86 must have reached the seabed simultaneously. If they were being transported empty, they would likely have drifted away, as has been suggested for the Şeytan Deresi cargo, due to its distribution on the seabed (Wachmann, 1998: 206). Since M7 was found almost intact within the main concentration of pottery, it must have sunk quite rapidly under the weight of its contents (even if simply water or dried food to be consumed by the crew during the journey). If a jar of this size was empty, it would have floated before it filled with seawater and sank and, if that was the case, the current proximity of M7 and M86 is difficult to explain.

The discovery of lead rivets and additional holes, clearly visible on the hydria M147 (Fig. 21), attest to the repair of some of these vases. It is possible, therefore, that at least some of the hydriae were valued for their utility as containers, having a large capacity, and would not have been traded as commodities in their own right.

As well as the pithoid jars and hydriae, three jugs, M68 (Fig. 22) (sector B1), M84 (Δ0) and M129 (Δ0), were found almost intact and parallel in form to vessels found at Prosymna (Mountjoy, 1999: 133-134, fig. 31.233) and Mycenae (Mountjoy, 1998: 148-149, fig. 176.1-2; 1999: 154-155, fig. 40.308), dated to LH III B and C, respectively.

An amphora (M127, Δ0), a small stirrup jar (M126, Γ2), the upper half of an alabastron (M89, Δ0), four deep bowls (M17, B1; M63, B2; M139, Δ0; and M157, Γ0) and a krater (M153, Γ1) have also been recovered from the site and might not be considered as trading commodities. A bronze curved blade of a knife or tool (M132, Δ2) (Fig. 23) may have belonged to a member of the crew for shipboard use. Last but not least, among the miscellaneous artefacts, two partly preserved terracotta figurines (M55, B1 and M158, Γ0), possibly of the hollow-Ψ (Psi) (Fig. 24) and T (Tau) (Fig. 25) types, have been distinguished. They fit chronologically into the LH III B/C horizon (Vianello, 2010: 75, fig. 1) and could be interpreted as offerings to a female divinity and as religious charms (Vasilikou, 1995: 261). Although Vianello (2010: 76), has argued that the circulation of Mycenean figurines does not necessarily point to specific cultural and religious practices, we cannot rule out that these items on the Modi shipwreck

Figure 21. Hydria M147. Detail of a lead rivet, outer surface and inner surface (P. Vezyrtzis, © HIMA).



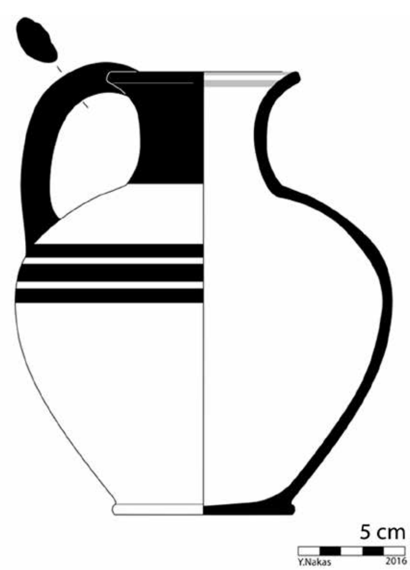


Figure 22. Jug M68, showing its painted decoration (Photo P. Vezyrtzis, Drawing Y. Nakas, © HIMA).

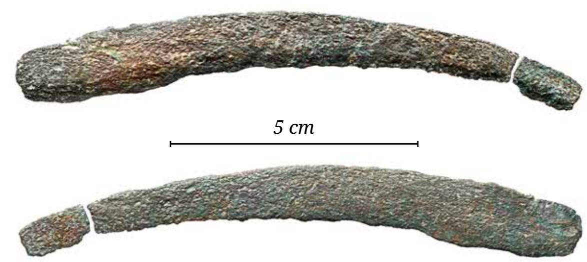


Figure 23. M132. Curved blade of a knife (P. Vezyrtzis, © HIMA).

Figure 24. M55. Part of a terracotta figurine, Psi type (P. Vezyrtzis, © HIMA).

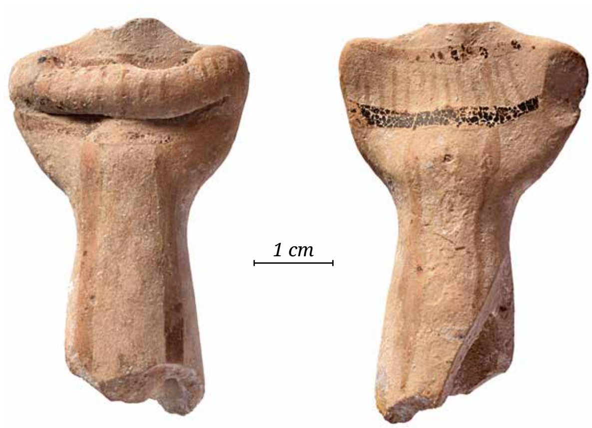


Figure 25. M158. Part of a terracotta figurine, Tau type (P. Vezyrtzis, © HIMA).

might reflect the crew's way of asking divine providence for a safe journey. Other finds recorded to date from the excavation area include small pieces of carbonized wood, animal bones, fruits, beads, and lithics, as well as lead rivets used for the repair of clay vessels.

General remarks

The ancient ship that wrecked and sank off Modi islet was making its voyage during a critical period in the LBA when the Mycenaean palaces and their centralized economies had collapsed and Modi's rocky ground had been occupied for its geographical advantages as an important port of call on the maritime trade routes extending through the Argo-Saronic region and beyond.

At the close of the 13th century BCE (late phase of LH III B2), the Mycenaean world was radically changing (Dickinson, 1994: 86). The large-scale movement of people to somewhat more remote regions, fleeing from administrative power centres that had been destroyed by natural hazards or invasions, marked the beginning of an era of restructuring at the dawn of the 12th century BCE (LH III C-Phase 1), which also shows up in the Cyclades (Barber, 1994: 34). Even settlements that were not completely abandoned were rebuilt differently; for example, Tiryns (Kilian, 1988: 135) and Mycenae (Vasilikou, 1995: 151, 174). The occupation remains and imported objects of intrinsic value found on Modi suggest that some settlements even managed to prosper during the early and middle LH III C period (Konsolaki-Yannopoulou, 2009: 515, 516). The evidence of the Modi wreck further strengthens the argument for active commercial exchange.

At present, we cannot determine whether the ship was *en route* to another port or if Modi was its intended destination, where its cargo would have been transferred onto smaller vessels to be further distributed via coastal trading (cabotage). The ship's cargo was mainly contained in large transport vessels, such as pithoi and hydriae of significant volume. Given the lack of evidence, the hull's basic dimensions must remain speculative. The distribution of the artefacts on the seabed, their total number and potential capacity would account for a medium-sized vessel, possibly similar in length and cargo capacity to the ship that wrecked at Cape Gelidonya (Bass, 1996: 29; 2005: 55) and somewhat larger than that wrecked around the same time at Point Iria, proposed to have been 7 m long carrying a total weight of 3 tons (Vichos, 1999: 83, 86).

'Diving' into prehistory and attempting to elaborate conclusions has proved, once again, a most challenging and laborious task; as encountered in the Uluburun (Hirschfeld, 2011: 115-120), Cape Gelidonya (Hirschfeld and Bass, 2013: 99-104), and Point Iria case studies (Agouridis, 1999: 25-42; Vichos, 1999: 77-98). The scarcity of LBA shipwreck assemblages, on the other hand, gives the archaeological data added value, because each case study supports a different scenario with respect to the dominant exchange mechanisms. Over time, the Modi wreck has been overshadowed by its surroundings and all evidence is concealed within the lithified marine environment. On top, boulders and large rocks; within the surface layer, a motley deposition of 'intruders', material that came from the settlement above. Wherever there are sand patches, the fine patterns of painted decoration survive less well. The thicker the concretions, the longer the arduous recovery of an artefact but, in the end, its original surface is better preserved. The detachment of hard biogenic layers was a necessity; otherwise, most of the ship's cargo would still be invisible. The undertaking is supported by daily photogrammetric survey and all the conservation procedures make the reassembly of broken pieces possible. We expect nothing less than this to be a long 'voyage'.

Further research and study of the finds, currently in the process of being conserved, will give us a more precise date for the wreck. Additionally, residue analyses will offer valuable information about the contents of the ceramic jars containing the cargo, while provenance studies through petrographic analyses are expected to shed light on the origins of the containers, sea routes, and trade networks during this critical period of Aegean prehistory. We may even be able to interpret the role that the settlement on Modi would have played as a maritime stopover and point of distribution for goods in the Argo-Saronic Gulf and the Aegean in general.

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The Mazotos Shipwreck, Cyprus

A preliminary analysis of the amphora stowage system

Stella Demesticha

Although amphora cargoes have been extensively used for the calculation of a ship's carrying capacity, less has been done about the reconstruction of their spatial arrangement – partly because well-preserved, coherent shipwrecks are rare in the archaeological record. New applications in digital mapping and 3D parametric modelling techniques have been used in the interpretation of the Mazotos shipwreck cargo, a 4th-century-BCE site off the south coast of Cyprus. The methodology, based on stratigraphic analysis, is presented in detail in this paper, with particular emphasis on the reconstruction of the cargo arrangement at the fore end.

Keywords: spatial analysis, Greek transport amphorae, shipwreck archaeology, 3D visualization.

Amphora cargoes, abundant in the Mediterranean, are an important source of information for diverse aspects of seaborne trade and economy. When little or nothing of the ship's hull is preserved, such cargoes are also the only piece of evidence at the archaeologist's disposal for estimating the ship's carrying capacity or, at least, its freight at the time of wrecking. Furthermore, well-preserved shipwrecks, with coherent stratigraphic units, can provide comprehensive information about the reconstruction of the ship's space, especially if their cargoes are accurately recorded. This is a rare class of shipwreck sites, however, with very few fully excavated examples in the archaeological record. The Mazotos shipwreck, currently under excavation, belongs to this class of site. It was found at -44 m, 1.5 nautical miles off the south coast of Cyprus, near the modern village of Mazotos, in the Larnaca District (Fig. 1). The University of Cyprus in collaboration with the Cypriot Department of Antiquities completed six excavation seasons between the years 2010 and 2018.

The shipwreck lies on a sandy, almost flat seabed and before any excavation took place consisted of an oblong concentration of amphorae, which were partly or totally visible. From the beginning of the project, careful recording, use of digital 3D technologies, and detailed stratigraphic documentation have been prioritized. Thus, although excavation is still ongoing, spatial analysis has already been possible and has shown that two to four amphora layers were stowed in several parts of the hold. Where excavation has advanced, in specific parts of the cargo, digital applications and 3D technologies have been used to reconstruct the stowage arrangement. The preliminary results are discussed in this paper, which aims to demonstrate the importance of amphora cargoes in the study of ancient ships, the potential of 3D technologies, and the methodological issues involved in building a comprehensive hypothesis of spatial reconstruction.

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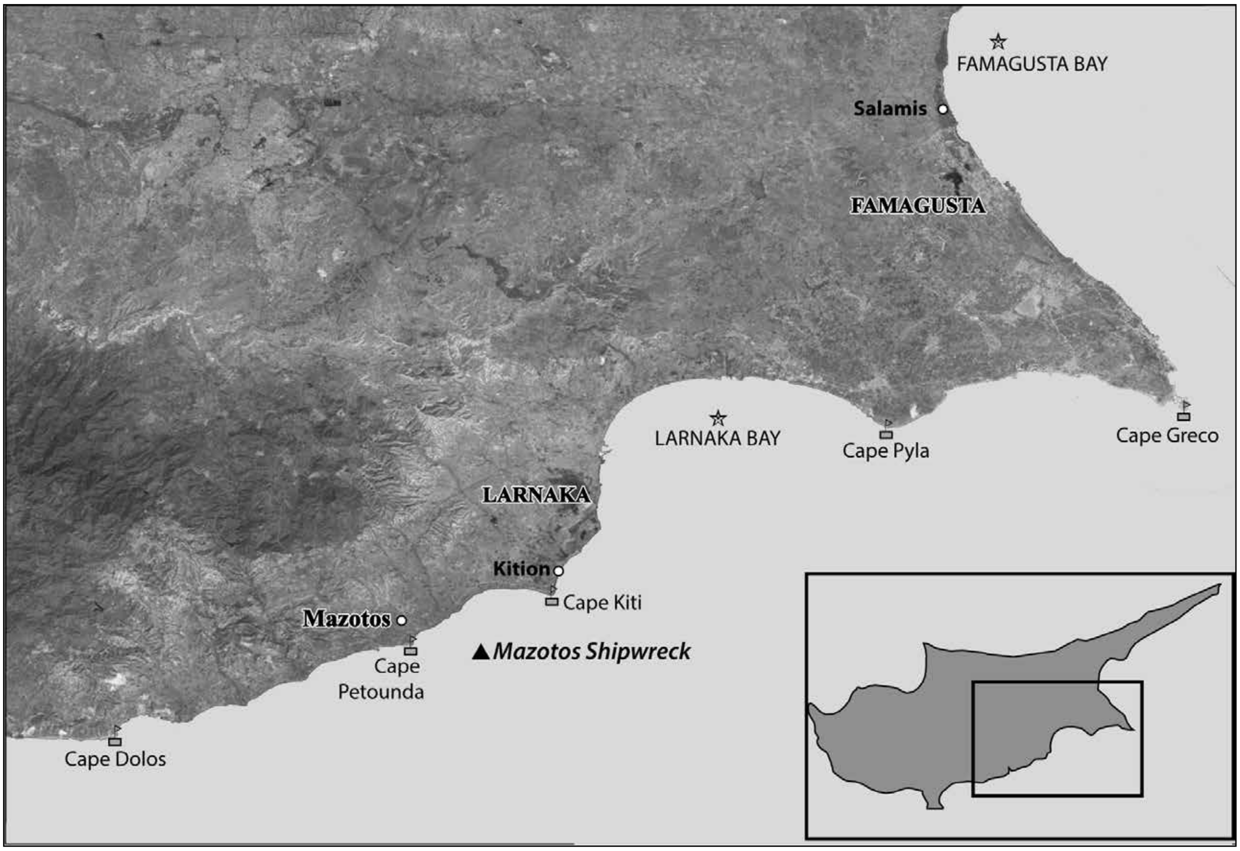


Figure 1. Map of Cyprus showing the location of the Mazotos shipwreck (Map: Andonis Neophytou, Irene Katsouri).

Reconstructing amphora stowage systems

The relationship between the shape and function of transport amphorae has been discussed in the literature either in general terms (Grace, 1979: 9; Radić-Rossi, 2006) or with reference to specific types (*e.g.* Vandiver and Koehler, 1986: 202-203 for the Corinthian amphorae). One of the commonly shared conclusions is that their elongated body shape, and their narrow bases ending in knobbed or stem-toes, made these containers suitable for stowing firmly and effectively, so that cargo shifting, and hence casualties, was avoided. A lading experiment with amphora copies carried out by the team of the Kyrenia shipwreck showed how important cargo stowage-patterns could be for the reconstruction of the ancient ship, even in cases where the hull was well preserved. Copies of 384 amphorae were loaded into the hold of *Kyrenia Liberty*, a full-scale replica of the Kyrenia ship, but 'the sheer volume of the jars excavated from the wreck was not fitting comfortably into the conjectured hull' (Katzev, 2008: 78); this made Steffy, who reconstructed the ship, reconsider the ship's lines and add 0.70 m to its height amidships. The cargo could not be taken into consideration in the cases of other replica ships, like those of Ma'agan Mikhael (Ben Zeev *et al.* 2009; Cvikel and Hillman, this volume) and Jules-Verne 9 (*Gyptis*) (Pomey and Poveda, 2018), because it had been seriously disturbed in antiquity in the former and was completely absent in the latter.

Hypothetical reconstructions of cargo-amphorae stowage systems have been studied since the very early days of shipwreck archaeology, particularly after Roman shipwrecks with hundreds of amphorae were excavated in France and Italy. Fernard Benoît (1961; see also Long, 1987) suggested that the Dressel 1A excavated from the shipwrecks of Grand Congloué were stowed in staggered rows ('*en quinconce*'). According to his schema, the amphorae of the upper layer were set down halfway into the lower layer. Herman Wallinga (1964: 28-36) called on the experience of a professional stevedore (a person responsible for safe stowage of cargo in modern shipping) to argue that Benoît's system would jeopardize the cargo; he proposed a more compact configuration that took dunnage – the brushwood used to secure the cargo – into consideration.

Wallinga (1964: 31) was rather pessimistic about the possibility of understanding stowage systems from shipwrecks because of the site-formation processes that affected the amphorae positions – although he certainly didn't use this term. Almost a decade later, however, after the excavation of the Madrague de Giens shipwreck (Tchernia *et al.*, 1978), things had fallen into place – or at least stowage systems were no longer just hypothetical. André Tchernia and Patrice Pomey meticulously studied the positions of the cargo items in the wreck's assemblage; not sharing Wallinga's pessimism, they tried to make the best out of an exceptionally preserved shipwreck and the accuracy that stereo-photography could provide at the time. Although three amphora layers were documented, the stowage system was reconstructed in detail only in the first two, because the upper one had been disturbed (Tchernia *et al.*, 1978: 19, 21). Nonetheless, some key observations were made, the most important being that it would be very difficult to apply any single stowage pattern all along the hold because of the ship's complex geometry. Four different patterns were suggested for Madrague de Giens, in staggered rows or square configurations. Stowage in staggered rows was the most space-efficient and the predominant configuration found in that shipwreck. Excavation also confirmed Wallinga's suggestion about the dunnage: pieces of juniper, heather, and rushes were found wedged between the amphorae of the first layer.

The method developed at the shipwreck of Madrague des Giens was also used for conjectural stowage reconstructions of less well-preserved Roman sites. For the dolia wreck of Grand Ribaud D (Hesnard *et al.,* 1988: 139-140), the arrangement fore and aft of the central compartment was reconstructed with both stowage configurations, which resulted in two different quantities of stowed amphorae. However, in most reconstructions, for example of the Cala Culip IV (Nieto *et al.,* 1989: 229-231) or the Dramont C shipwrecks (Joncheray, 1994: 21, 33), the excavators opted for staggered rows both in the main part of the hold and in the ship's extremities, where the ship's shape is irregular, because it is an easily applied pattern. Even the Canaanite jars in the Late Bronze Age shipwreck of Uluburun cargo (Lin, 2003; Pulak, 2008: figs 92, 94) were 'digitally stowed' in staggered rows. This pattern was confirmed archaeologically when marks left on the outer walls of the Dressel 7-11 amphorae excavated from the Bou Ferrer shipwreck were plotted in a 3D digital environment (De Juan *et al.*, 2011: 101-102). Interestingly, in this case, the distance between the amphorae was almost 100 mm, that is much farther than the 10-30 mm attested in the main hold of Madrague de Giens. Random stowage has only been suggested for the Late Roman ship Dramont E, which carried a heterogeneous cargo (Poveda, 2012).

In all cases discussed above, the stowage-patterns were tested for one or two tiers but not more. The gap for the dunnage was not taken into consideration for the hypothetical reconstructions, except for the two cases where it was archaeologically attested – that is, in Bou Ferrer and Madrague des Giens. However, excavation of the latter showed that this gap was modified according to the position within the ship and that it played a key role in the configuration of the upper layers, and hence the height of the cargo assemblage. Moreover, room for dunnage around the containers must have been crucial if random stowage configurations were applied. Such must have been the case of heterogeneous cargoes, where unavoidable gaps created between containers of different shapes should be filled because they would jeopardize the cargo's safety. The same must be true for parts of the hold with irregular geometry, such as the bow or the hull sides.

The Mazotos shipwreck

Before any excavation took place, what was visible of the Mazotos shipwreck was an assemblage of partly buried or totally exposed amphorae lying on a flat seabed. This ship-shaped concentration was 17.5 m long and 8 m wide. Thus far, excavation has focused on the two extremities, the southern and the northern ends of the site (Fig. 2), and has provided evidence that they were the fore and aft parts of the ancient ship, as initially suspected. At the southern end, three anchors and a stone weight were found. Comparison with other shipwrecks with anchors found in situ (Haldane, 1984: 63 note 147), such as the Ma'agan Mikhael (Rosloff, 1991) and Kyrenia (van Duivenvoorde, 2012), shows that they were usually carried to the fore of the ship. The most important evidence came from the northern end of the site, however, where a cooking pot, a mortarium, and seven small vessels of tableware indicated that this was the stern cabin of the ship.

The keel was preserved to a length of 15.2 m. Only small parts of it were excavated at each end and these were found broken and partly destroyed, obviously having been exposed to woodborers for a while before the ship was buried. The starboard side of the hull is better preserved than the port side because the ship seems to have tilted to starboard after it landed on the seafloor: as a result, the cargo shifted westwards into the starboard pile, covering this side and thus protecting it from decaying.

Three pairs of lead cores and one pair of heavily conglomerated, iron arm-tips was what survived of the bow anchors (Demesticha/Δεμέστιχα, 2017: 287-288), which belonged to a known, 4th-century-BCE, wooden type, with two arms and a stock filled with molten lead – type IIA in Douglas Haldane's typology (1990: 21). The arm-tips were associated with the starboard anchor; they were found 2.2 m south of the pair of lead stocks, in a position that implies that they fell off the arms when the wood deteri-

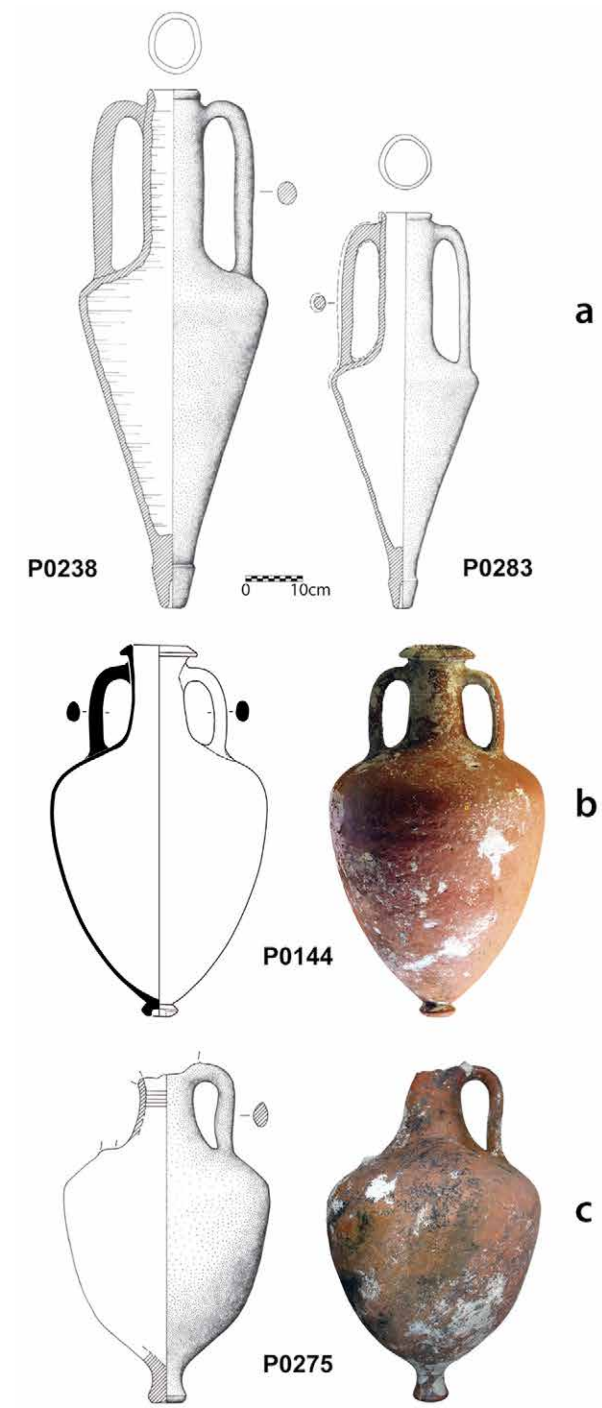


Figure 2. The Mazotos shipwreck. 3D models of the excavated amphorae have been added to the original 3D point cloud of the site to show the progress of the excavation at the bow and stern of the ancient ship (3D model and image composition: Irene Katsouri, MARELab).

Figure 3. Amphorae from the Mazotos wreck: a) the two sizes of Chian amphorae, large (l) and small (r); b) A Solokha 1 ('Mushroom-Rim') amphora; c) possibly Lycian amphora (Drawings: Alvaro Ferreira, Jean Humbert, Image composition: Irene Katsouri, MARELab).

orated. If this was the case, then the distance between the lead cores and the tips provides a good indication of the minimum length of the anchor (Demesticha *et al.*, 2014: 146, fig. 10). A third anchor, half the size of the other two, was found next to the starboard bower anchor and under three amphorae lying on their sides; they had either fallen on top of the small anchor after the starboard side of the hold collapsed, or the anchor was stored inside the hold, next to or under them.

Between 2010 and 2016, a minimum number of 149 individual transport amphorae (MNI) were raised from the seabed. The vast majority of them belonged to a well-established type of Greek maritime transport containers from the island of Chios (Fig. 3a). They bear the typical 4th-century-BCE features of the series – a long cylindrical neck with a simple, rounded rim, a sharp-edged shoulder that continues to a conical body, and a 'dunce cap'-shaped, hollowed toe (Anderson, 1954: 170; Grace and Savvatianou-Pétropoulakou, 1970: 259-260; Lawall, 1998: 80-81). Chian amphora production has been attested since the Archaic period, with a wide distribution in and outside the Aegean. The island's wine, praised by ancient authors (Salviat, 1986: 187-92), must have been their principal content. In the 4th century BCE, in particular, it seems that Chios was one of the main exporters of Aegean wine, especially to the Black Sea, which can be associated with the involvement of Chian merchants with the transport of grain (Sarikakis, 1986: 123-124; Bylkova, 2005: 219-223). The distribution of Chian amphorae in the eastern Mediterranean during the same period seems to have been significantly smaller (Demesticha, 2009), with the Mazotos shipwreck being the only one in the region thus far with Chian amphorae as cargo.

All recovered amphorae from the shipwreck have been documented in three dimensions and their digital models have been plotted in the 3D model of the site (the process is described in Demesticha *et al.,* 2014). In order to proceed with preliminary stowing experiments of the Mazotos cargo in a digital environment, however, an average Chian amphora model was used for amphorae found in a fragmentary condition. To do this, the dimensions of 74 containers with preserved profiles were taken into consideration. They formed two consistent groups – one of large and one of small amphorae. The vast majority, 67 out of 74, belonged to the large variant: their height was 910-980 mm and their capacity (up to the top of the neck) was 22-24 litres.

Based on their capacity and linear measurements, a parametric 3D model was created with the average dimensions as follows: total height, 940 mm; neck height, 287 mm; rim diameter (external), 99.4–116 mm (oval shape); maximum shoulder diameter, 360 mm (Fig. 4a).

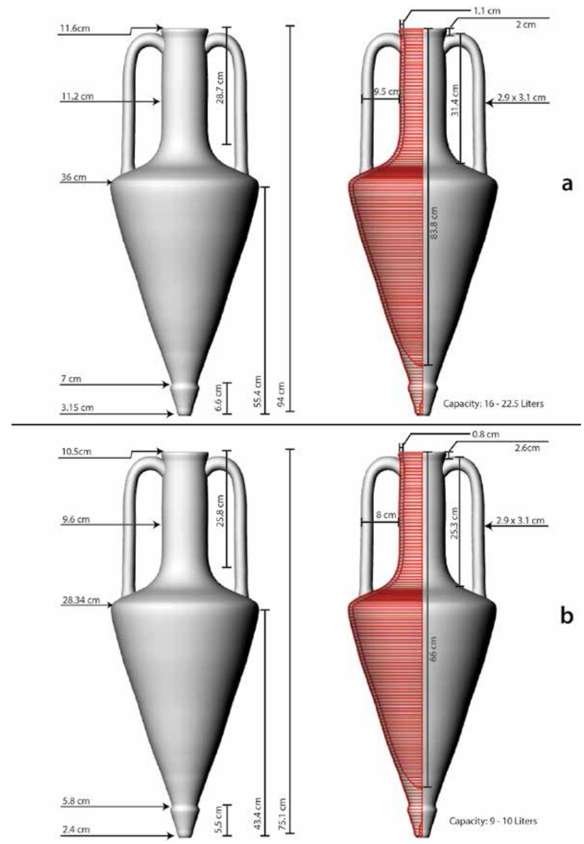


Figure 4. Average models of Chian amphorae with their dimensions: a) large; b) small (3D model and image composition: Irene Katsouri, MARELab).

The capacity of the average model was 21.5 litres, which is close to the value range of the measured containers.

The dimensions of the remaining seven, small-sized amphorae were more consistent: their height was 738-775 mm and their capacity 9.7-10 litres. The dimensions of the small-sized parametric model were as follows: total height, 751 mm; neck height, 258 mm; rim diameter (external), 105 mm; maximum shoulder diameter 283.4 mm (Fig. 4b).

More types were found in the cargo but only in insignificant numbers. No more than nine containers (MNI) could be classified within a broad amphora family known as Solokha I or Mushroom-Rim amphorae (Fig. 3b) (Lawall, 2005: 33, n. 14). They were very common in the Aegean from the beginning of the 4th century BCE and come from diverse centres. Their production has been verified by kiln discoveries in Klazomenai (Doger, 1986), Paros, Ephesos, Knidos, the Datça peninsula, Rhodes (Empereur *et al.*, 1999: 289; Garlan, 2000: 73) and Cos (Kantzia/ Κάντζια, 1994: 335-337). In the Mazotos shipwreck, they were found in the top layers, mostly in the front half of the assemblage.

Figure 5. North Aegean amphorae, still standing in the aft part of the hold (Photo: Andreas Kazamias, MARELab).

Figure 6. One of the 55 jugs excavated from the aft part of the hold (Photo: Irene Katsouri. Drawing: Jean Humbert / image composition: Irene Katsouri, MARELab).

A third amphora group comprises six containers, of north Aegean origin with characteristic stem-toes (Lawall, 1997: 114-118). The Mazotos type presents more similarities with amphorae from Mende (Papadopoulos and Paspalas, 1999; Filis, 2012), but it is difficult to attribute them to a specific workshop before any fabric analysis is conducted. They had been stowed in the bottom layer of the aft part of the hold, under and among the amphorae from Chios (Fig. 5), and more of them are likely to be found in the unexcavated part of this area.

A few non-cargo amphorae were also found in the hold. At the starboard side of the bow, the upper part of a Coan amphora was found broken *in situ*. Characterized by their double-barrelled handles, Coan amphorae appeared at the beginning of the 4th century BCE and were widely distributed and imitated in the Hellenistic and Roman periods (Georgopoulos, 2004; Moore, 2011). The Mazotos examples belong to the early variants of the series. Close to the Coan amphorae, two partly preserved containers of a less-known type were excavated. Their base ends in a short stem and their shape and features are very similar to amphorae attested in Lycia and Pampylia, with only a regional distribution (Fig. 3c) (Dündar, 2012: 47-50).

Apart from foodstuffs packed in transport amphorae, the Mazotos ship was also carrying tableware: at least 55 jugs were excavated at the aft part of the hold (Fig. 6). A layer of pitch on their interior associates them with serving wine. They have a squat body and fabric very similar to that of the Chian amphorae, although no analysis has been done as yet. A jug with a similar body was found on the Chios-Oinnousses wreck (Foley *et al.*, 2009: 290). Similar jugs with ring foot and a characteristic ridge below the rim were also common in Hellenistic layers of Athens, appearing at the end of the 4th and continuing to the 1st century BCE (Rotroff, 2006: 73-76).

Amphora stowage and the ship's interior space

From the beginning of the Mazotos shipwreck project, we have tried to estimate the total number of cargo amphorae: in the first preliminary report, approximately 500 amphorae were counted on the photomosaic (Demesticha, 2011). As the excavation has progressed and we have gained a better sense of the site and what part of the cargo was still completely buried under the sand, the estimated number has increased to approximately 800 amphorae (Demesticha *et al*., 2014). It soon became obvious that a more consistent method had to be applied for the study of the ship's carrying capacity. The first step was to determine the stowage system. Thanks to the detailed documentation used in the project, the positions of all finds have been plotted in a 3D model of the site, which is updated after every new field season. Thus, all stratigraphic data were documented and could be used for the stowage-system reconstruction, at least for the areas where excavation has advanced adequately.

One of the first issues to be tackled was relocating the original positions of amphorae that have been disturbed since the wreckage, mainly as a result of site-formation processes. A few amphorae must have bounced off the assemblage when the ship reached the flat seabed. Most of them either, however, broke *in situ* or were shifted (or tilted) from their original position. This happened when the ship listed as it settled on the seafloor, or later, when they lost their support-surface as the wooden hull gradually disintegrated. This was especially true for the upper and side layers of the assemblage. The fact that the ship listed to its starboard side after it reached the seafloor is demonstrated by the position of the amphorae on the western (starboard) side; most of them are inclined outwards along the entire assemblage, from bow to stern. Some have been found away from the main concentration lying on their sides; having come from the upper tiers, they possibly fell on the seabed when the exposed parts of the hull decayed (for a very instructive plan of this procedure, see Tchernia *et al*., 1978: fig. 14).

The stratigraphy of the centre of the hold, where the bulk of the cargo is concentrated, was the least affected by the post-wreckage formation processes. Even before excavation, there were places where amphorae had preserved their upright positions and it was obvious that no less than three amphora tiers had been stacked. Excavation is still ongoing at this part and has not yet fully exposed the lower tier. Plotting the amphora positions in three dimensions, however, has corroborated the initial hypothesis that three or four amphora tiers were stowed in the main part of the hold (Fig. 7). At the current stage of research, it is difficult to determine which stowage pattern was used: nonetheless, the square configuration seems to be the most likely choice. Careful study of the 3D point cloud also showed that there was a distance of about 80 mm between the amphorae at the centre of the assemblage. This, of course, can only be used as an indicative value, because the amphora positions have been affected by the wreckage and because no dunnage, which may have been used to maintain a distance between them, has been preserved.

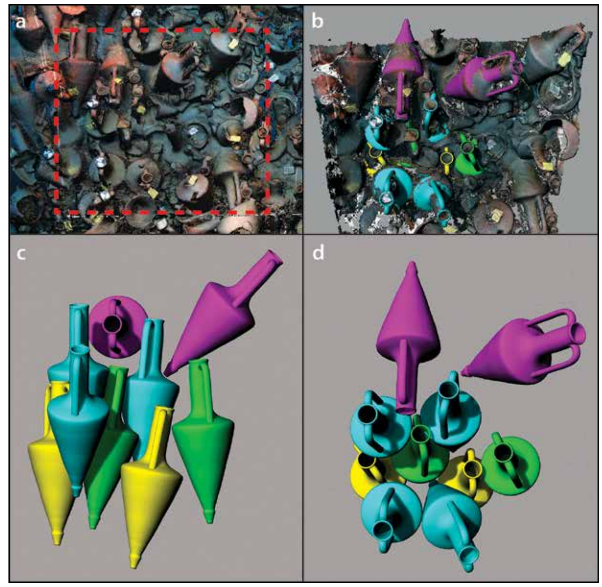


Figure 7. Reconstructing the stowage system in the partly excavated central part of the assemblage: a) 3D point cloud of a section where different tiers are visible; b) and d) the same section with the Average Large Chian amphora models, in situ; c) a side view of the position of the amphora models (3D model and image composition: Irene Katsouri, MARELab).

The excavated part of the stern seems to correspond to the area between the aft end of hold and the cabin (Fig. 8). The hull and the keel were found broken, but towards the centre of the assemblage the hull was better preserved under amphorae still standing in their original position. Although the bulkhead was not preserved, the location of the finds left little doubt of the spatial arrangement: the cargo amphorae that were originally standing against the bulkhead were found lying on the seafloor, in a south-to-north orientation, over non-cargo items that must have been stored in the stern cabin. This seems to have been a rather dramatic episode of collapse: jugs, most probably having fallen from somewhere higher up, broke the amphorae within which they were later found, and other cargo items spilled far from the main assemblage.

The excavation of the bow area is in a more advanced stage and has completely exposed the fore end of the hold (Fig. 9). Stratigraphic analysis showed that no more than two layers of amphorae were stowed in this part

Figure 8. Plan view of the northern end of the assemblage, which corresponds to the aft end of the hold. Cargo amphorae and jugs were found scattered, having spilled off the main assemblage after the hull collapsed (3D model and image composition: Irene Katsouri, MARELab).

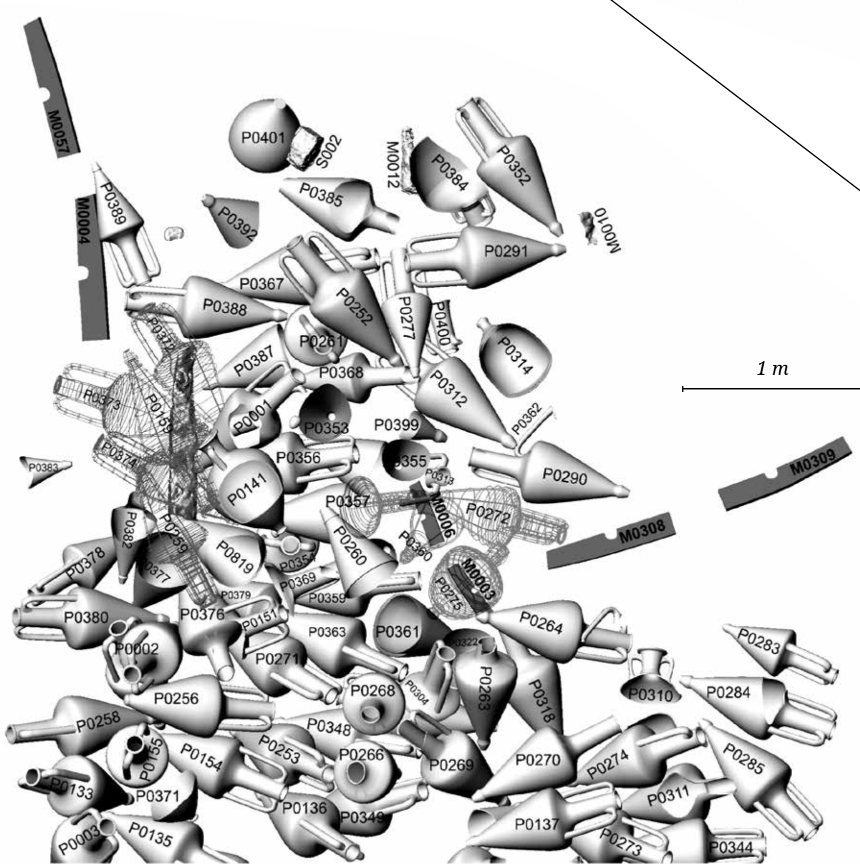
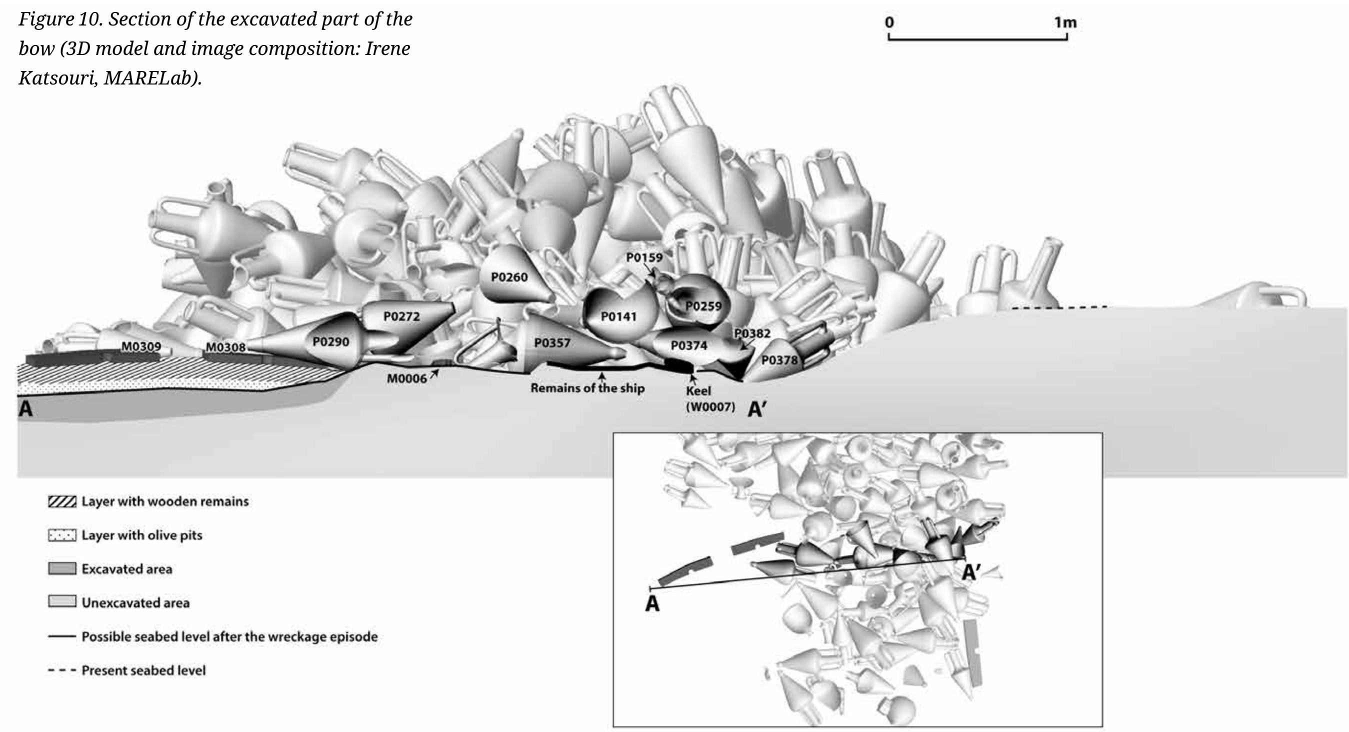


Figure 9. Plan view of the excavated part of the bow. The lead cores of the small anchor (M0006-M0003) can be distinguished under the wire-frame models on the right, and the preserved part of the keel under the models on the left. M0308 and M0309 are parts of the starboard bower's stock; M0010 and M0012 are its arm-tips. M0004 and M0057 belong to the port bower (3D model and image composition: Irene Katsouri, MARELab).

Figure 10. Section of the excavated part of the bow (3D model and image composition: Irene Katsouri, MARELab).



of the ship (Fig. 10). Most of them were either broken *in situ* or had fallen on their sides and shifted – not far from their original positions. This small movement must have been the result of an impact, after the collapse of the foredeck under which the amphorae were stacked. The location of the three anchors is indicative of this collapse: after the ship tilted to starboard, the anchors must have fallen to the seabed, one to port and one to starboard of the bow. No artefacts were found underneath them, so most probably the anchors were stored outside the gunwale, not on the deck.

The 42 excavated amphorae that comprise this cargo block at the fore end of the hold were found between the two bowers. These anchors must have created a barrier that prevented the amphorae from spilling farther off the concentration, which seems to be what happened along the remaining western side of the assemblage. The positions of the amphorae support this hypothetical scenario:

1. There is a line of amphorae at the starboard (western) side that has fallen eastwards (rim to the east and toe to the west), instead of westwards (rim to the west and toe to the east); these must have been stored against the starboard side of the bow, inside of where the anchor was attached. When this part collapsed, it seems to have pushed them eastwards against the rest of the amphorae, that had fallen westwards when the ship tilted.

2. The port side of the cargo shifted into the starboard side and this must have caused some of the breakages found *in situ*. Most of the upper-tier amphorae were found at the port side.

3. In the fore end of the concentration, some amphorae were found broken and turned upside down: perhaps they were bounced from their original positions when the ship reached the seabed and broke open.

According to the above observations and stratigraphic analysis (Table 1), 26 amphorae were stowed in the lower tier and 16 at the upper one (42 in all).

If this hypothesis describes, even roughly, the episodes of the ship's gradual collapse, the positions of the anchors and the amphorae can provide clues to the size of the ship's bow. The minimum width of the hold's bottom between the two bowers must have been enough to accommodate the amphorae of the lower tier and certainly no less than double the current distance between the starboard anchor and the keel (2 x 1.19 m = 2.36 m), given that the starboard anchor fell on the seabed, most probably next to ship's bilge, whereas the port anchor was moved toward the keel when the ship tilted westwards.

To test this hypothesis, we tried to stow these 42 amphorae in a virtual space that roughly follows the lines of a ship's bow. A gap of 100 mm was left between the amphorae. Although they had moved from their original positions, it was obvious that there had been

Find No.	Description	Layer/ Orientation			Interpretation	3D Model Used
		Lower	Upper	Uncertain		
P0001	Chian, almost complete, missing one handle. Large hole on its shoulder and body		W		Upper layer, in the middle	Actual
P0141	Mushroom-Rim, almost complete. Large hole on its shoulder and body		E		Starboard side, upper tier	Actual
P0159	Chian, complete		W		Port side, upper tier	Actual
P0252	Chian, almost complete, missing part of the rim		E		Upper tier, in the middle	Actual
P0259	Chian, almost complete, with large hole on body and part of rim broken		W		Port side, upper tier	Actual
P0260	Chian, lower part		W		Uncertain side because it was a free surface find	Average Large
P0264	Chian, almost complete, with one handle broken *in situ*		W		Starboard side, upper tier	Actual
P0272	Chian, almost complete, missing the toe		W		Starboard side, upper tier	Actual
P0275	Almost complete Lycian?, missing one handle, part of neck and rim			W/ U	Starboard side, uncertain tier	Actual
P0277	Chian, complete, small size		S		Starboard side, upper tier, against the hull?	Actual
P0283	Chian, complete, small size			W	Starboard side, upper tier	Actual
P0290	Chian, missing one handle, as well as part of rim and neck			E	Starboard side, against the hull?	Actual
P0291	Chian, broken *in situ*			E	Starboard side, against the hull affected by the anchor collapse	Actual
P0312	Chian, complete			E	Starboard side, lower tier	Actual
P0313	Chian, broken *in situ*	W			In the middle; it collapsed and then P0355 fell on top of it and broke it *in situ*	Average Large
P0314	Lycian? half of lower part			W	Starboard side, against the hull?	Average (P0275)
P0352	Chian, complete			W	Starboard side, against the hull affected by the anchor collapse	Actual
P0353	Chian, lower part	U			Lower tier, in the middle	Average Large
P0355	Chian, lower part		U		Upper tier in the middle; it fell and broke P0313	Average Large
P0356	Chian, complete	W			Port side, lower tier	Actual
P0357	Chian, broken *in situ*	W			Lower tier, in the middle	Average Large
P0360	Chian, lower part	U/W			Starboard side, lower tier	Average Large
P0367	Chian, complete	W			Port side, lower tier	Actual
P0368	Small Chian, missing part of rim and neck and one handle	W			Lower tier, in the middle	Actual
P0372	Chian missing part of rim and neck		W		Port side, lower tier	Actual
P0373	Chian, complete with a hole below its shoulder	E			Port side, against the hull	Actual
P0374	Chian complete	E			Port side, against the hull	Actual
P0377	Chian, lower part	U/W			Port side, lower tier	Average Large
P0378	Chian, small size, partly visible (still *in situ*)	E			Port side, lower tier, against the hull	Average Small
P0382	Chian, lower part	S			Port side, lower tier	Average Small
P0383	Chian, lower part			E	Port side, tier uncertain because it was found off the main concentration	Average Large
P0384	Coan amphora, upper part			N	Starboard side, against the hull?	Average (P0144)
P0385	Chian, broken *in situ*			W	At the foremost end of the hold	Average Large
P0387	Chian, lower part	W			Port side, lower tier	Average Large
P0388	Chian missing part of rim and neck	E			Port side, against the hull, higher that the lower tier	Actual
P0389	Small Chian missing part of rim and neck			N	Port side, against the hull, possibly foremost end of the hold	Actual
P0392	Chian, lower part			NA	Port side, lower tier, close to the fore most end of the hold. It was found upside down	Average Large
P0399	Chian, lower part			E	Starboard side, uncertain tier (it was hypothetical-ly placed in the upper tier)	Average Large
P0401	Mushroom-Rim, lower part			NA	At the fore most end of the hold. It was found upside down	Average (P0144)
P0818	Chian, lower part	U/E			Starboard side, lower tier	Average Large
P0819	Chian, lower part	W			Lower tier, in the middle	Average Large
P0359	Chian, complete	W			Lower tier, in the middle	Average Large

Table 1 (Opposite page). The stowage arrangement of 42 amphorae discussed in the paper, with descriptions of their original and the reconstructed positions (W= westwards, E=eastwards, S=southwards, N=northwards, U=upright, NA = not applicable).

Figure 11. Amphorae at the bow: No. 359 is lying between two lower halves, still standing in an upright position (Photo: Andonis Neophytou, MARELab).

space among them before the collapse. For example, in more than one case, the necks of amphorae lying on their side were found between the lower halves of amphorae still standing in an upright position (Fig. 11), which means that they could not have moved significantly from their original positions. Moreover, despite the confined space, most amphorae had collapsed on the seafloor. In addition, the ship's geometry at this part, with curved surfaces under and at the side of the cargo block, does not allow for dense stowage, as the example of Madrague des Giens has demonstrated. Ample space between the amphorae must have also facilitated stowage under a deck; the upper layer was stowed from the side, not from above – in which case, it was important to leave enough room for manoeuvring between the lower-tier containers. The limited number of containers in the upper tier also corroborates this scenario.

To reconstruct the original location of each individual amphora, the following factors were determined: its stratigraphic unit (upper or lower layer), its orientation and its position as found in relation to the keel (port, starboard, or in the middle) (Table 1). Actual 3D models of the finds were used wherever possible but when only partly preserved ones remained, the parametric model was used to represent the originals. As a result of this analysis six rows of amphorae, transversal to the keel axis, were detected in the lower tier, although the number of containers in each row was not always straightforward: in other words, it was not always clear in which row to place an amphora when its original position had been seriously disturbed. Following the pattern created by the amphora find-spots, six containers were placed in

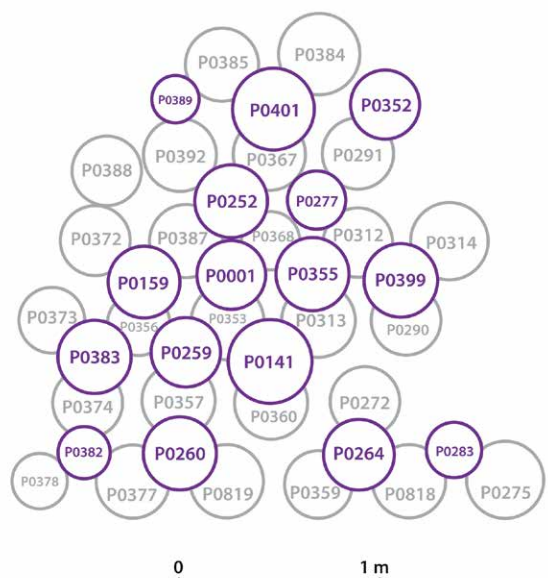


Figure 12. Schematic plan of the suggested stowage reconstruction, at the fore end of the bow. The lower tier is marked with grey circles and the upper tier with purple.

the first row (counting from north to south), four in the second, six in the third row and then five, three and two in the remaining rows (Fig. 12). Such an arrangement can be explained by the irregular shape of the hold's space at the bow but it still leaves several gaps that would have had to be filled to stop the cargo from moving around.

For example, the 16 containers of the upper tier were found mainly at the port side, so their reconstructed

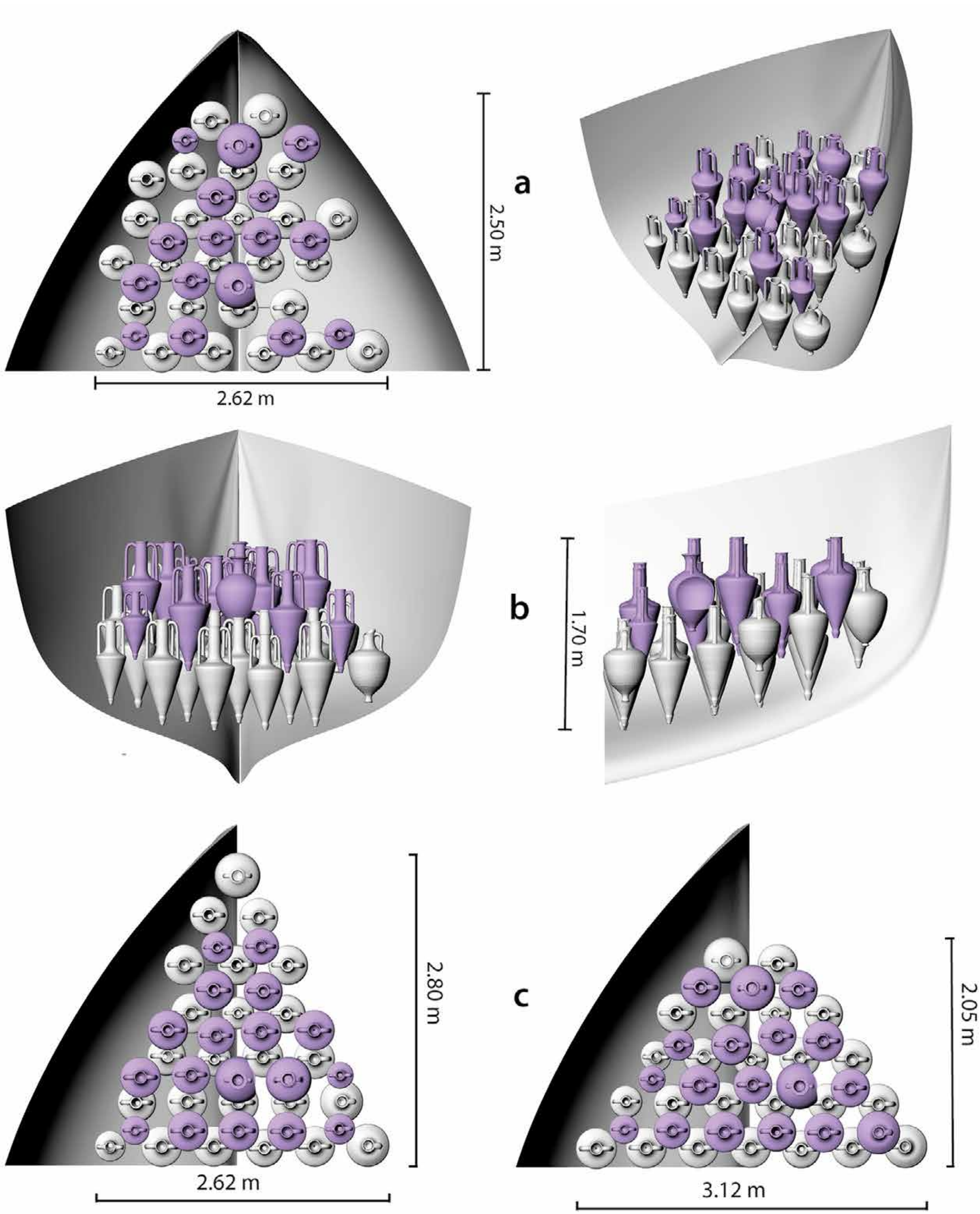


Figure 13. Stowage reconstructions at the bow end: a) and b) views of the suggested stowage reconstruction, with the find spots taken into account; c) two different hypothetical reconstructions where find-spots are not taken into account (3D model and image composition: Irene Katsouri, MARELab).

distribution is uneven, leaving a large gap at the starboard side. If this is not the result of disturbance from the deck collapse, it may represent a true gap, where organic material (nets or rope, now destroyed) was stored. In this hypothetical reconstruction, staggered rows are used instead of the square arrangement, because they work better with irregular distribution. Based on this arrangement, the minimum dimensions of the ship's bow compartment excavated thus far should be as follows: height, 1.70 m; width, 2.62 m; length, 2.50 m (Fig. 13 a-b).

The last phase of this project was to stow the 42 amphorae without taking their specific find-spots into consideration, a procedure that is usually followed for scattered assemblages, where the ship's internal stratigraphy is completely disturbed. The maximum width and length of these conjectural blocks differed in each arrangement (width, 2.62-3.12 m; length, 2.05-2.80 m) (Fig. 13c) but the height remained the same.

Discussion

In conducting this spatial analysis of the Mazotos bow area, several challenges arose that are more typical of disturbed than of well-preserved shipwreck sites. The reconstruction discussed above was based on find-spots that have been affected by diverse processes, impossible to determine with certainty, so the stratigraphic permutation (the detection of the temporal relationship of different units of stratification) remains hypothetical. Nonetheless, the process was very instructive, in several respects:

First, it demonstrated that hypothetical reconstructions that do not include stratigraphic data can provide a rough estimate of the volume, but cannot demonstrate potential particularities of specific ships, especially as far as depth is concerned. The distance between the containers of the lower tier is decisive because it determines how far down the upper tiers can be set into the lower ones. Although in well-preserved shipwrecks, such as the Madrague de Giens or Mazotos, there is a good chance that this distance is preserved at the centre of the hold, it is difficult to detect at the extremities, which suffer most from impact with the seafloor. Still, accurate mapping of the relative positions of the Mazotos finds, even the fragmentarily preserved ones revealed useful clues that indicated gaps of around 100 mm between the containers. For methodological reasons, this was kept for the entire lower tier, although most probably no such strict rule was applied in antiquity. The maximum height of the cargo block reconstructed with the proposed arrangement was 1.7 m but more space should be allowed between the top layer and the deck above, to enable safe loading and manoeuvring. For ships of this period, there is no other archaeological evidence regarding the foredeck, so this is the first indication of the foredeck's place in the hull (the maximum distance of the *Kyrenia II* foredeck from the keel is 1.35 m but this was not determined based on stratigraphic data, Kariolou, pers. comm., 2018).

Second, the compartment under the foredeck was unlikely to have been loaded all the way to the stem, since some space must have been left for non-cargo items that also had to be stored there. The lading processes are also among the unknowns of the hypothetical stowage, especially in the case of the compartment under the deck, not only are we unable to determine the system used when it was necessary to rearrange the cargo or accommodate non-standard containers and other artefacts in the hold, but it is also uncertain if there was a hatch or another opening to facilitate stowage. Although the gaps among the recorded amphorae at the starboard side of the Mazotos ship bow may suggest such use, the reconstructed cargo block can only be considered indicative of the compartment's minimum size. What the stratigraphic and spatial analysis did demonstrate, however, is that random stowage with irregular gaps may have been a common practice in the limited covered space of ancient merchantmen. Such practices cannot be reconstructed with precision but cannot be ignored either, since they contribute to the discussion of specific spatial arrangements (as, for example, non-cargo items storage), which must be taken into account when replicas are designed.

Where and how the anchors were stored was also an issue when attempting to explain the amphora positions. Stratigraphic evidence from Mazotos implies that the anchors were stored outboard, not on the deck, which makes sense for practical reasons: the limited space of the foredeck would have been too small for two anchors, each more than 2.5 m long. Such an arrangement finds parallels in iconographic evidence: two Hellenistic ship graffiti from the House of Dionysus on Delos show merchantmen with the anchors fixed on the hull's outboard sides (Basch, 1987: 373, nos 7 and 9).

Apart from information on the ship itself, spatial analysis of the cargo can also provide useful insights into the ship's possible ports-of-call before it sank off the coast of Cyprus. The homogeneity of the cargo allows us to assume with some confidence that all the Chian amphorae were loaded on the island of Chios. The northern Aegean amphorae of the stern were found stowed among and under Chian ones, so they might also have been loaded on Chios. The provenance of all the non-Chian amphorae of the cargo block analysed above, however, is located south of Chios, on the sea route from the Aegean to the eastern Mediterranean. These include the Coan (P0384), the southern-Aegean Mushroom-Rim (P0141) and the two possibly Lycian amphorae (P0314 and P0275). Since none of them belonged to the lower tier (Fig. 9), it seems plausible to suggest that they could have been bought *en route* to Cyprus, either as cargo or as provisions, and were stowed in the bow compartment, on top of the Chians, as shown in the reconstruction in Figure 13.

Conclusions

The spatial analysis of the Mazotos finds conducted thus far, while partial, has demonstrated how digital mapping and visualization in three dimensions can open new paths for shipwreck archaeology. As excavation progresses to less disturbed areas, more clues will be added to the puzzle of the original ship's spatial arrangement. For example, when the bow compartment has been fully excavated, a more comprehensive reconstruction of its destruction will be possible. In addition, apart from the documentation of the amphora positions, different kinds of evidence can be plotted in three dimensions: this would include marks on the exterior of the amphorae, break patterns, and the stratigraphy of organic finds. The goal is to understand better the natural site-formation processes and combine not only spatial but also temporal information to explain the sequence of collapse episodes that took place in the wrecked ship.

Micro-scale documentation can lead to more advanced archaeological hermeneutics and contribute significantly to the study of ancient ships and trade mechanisms. As measurement and data-gathering become less complicated and the accuracy of data acquisition helps advance documentation methods, more specific and incisive questions can be asked. Thus, despite the numerous unknown factors, reconstructing the lost spaces within ancient shipwrecks is now certainly more feasible than ever before.

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Final Report on the Remains of Four Vessels Found in the Ancient Harbour of Naples, Italy, Dating to the Late 2nd Century BCE and the Late 2nd-Late 3rd Century CE

Giulia Boetto, Chiara Zazzaro**, and Pierre Poveda**

Between 1999 and 2016, preventive archaeological excavations before the construction of lines 1 and 6 of the Naples metro in Piazza Municipio provided new evidence about the coastal landscape by the ancient harbour basin. These investigations led to the discovery of the remains of seven wrecks (Napoli A-C, and E-H) dating to the Hellenistic era and the Roman Empire. This paper presents the study of the architectural characteristics of four wrecks uncovered in 2013-2015 in the passageway connecting the metro stations to the modern tourist harbour (Stazione Marittima) and will suggest hypotheses concerning the function of the vessels.

Keywords: Harbour, Naples, Hellenistic era, Roman Empire, ship, wreck.

The archaeological excavation undertaken in Naples before the construction of the city's metro lines 1 and 6 provided a unique opportunity to explore the ancient Neapolitan coastal landscape. Besides the discovery of impressive ancient harbour infrastructure, these investigations provided evidence of seven vessels dating back to the Hellenistic era and the Roman Empire. The excavation was conducted under the scientific direction of Daniela Giampaola of the archaeological Superintendency of Naples and involved a large number of specialists belonging to different institutions including universities, research centres, and private companies. The project to conserve the waterlogged wood is underway in the form of a collaboration between the Naples archaeological superintendency and the Istituto Superiore per la Conservazione e il Restauro of Rome (ISCR) of the Italian Ministry of Cultural Heritage (MIBACT), in collaboration with the Centre Camille Jullian (Aix Marseille University, CNRS), and the ARC-Nucléart laboratory of Grenoble (France).

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The harbour

The Naples metro-line archaeological excavations have allowed us to understand the development of the coastal landscape between Neapolis, the new city founded in

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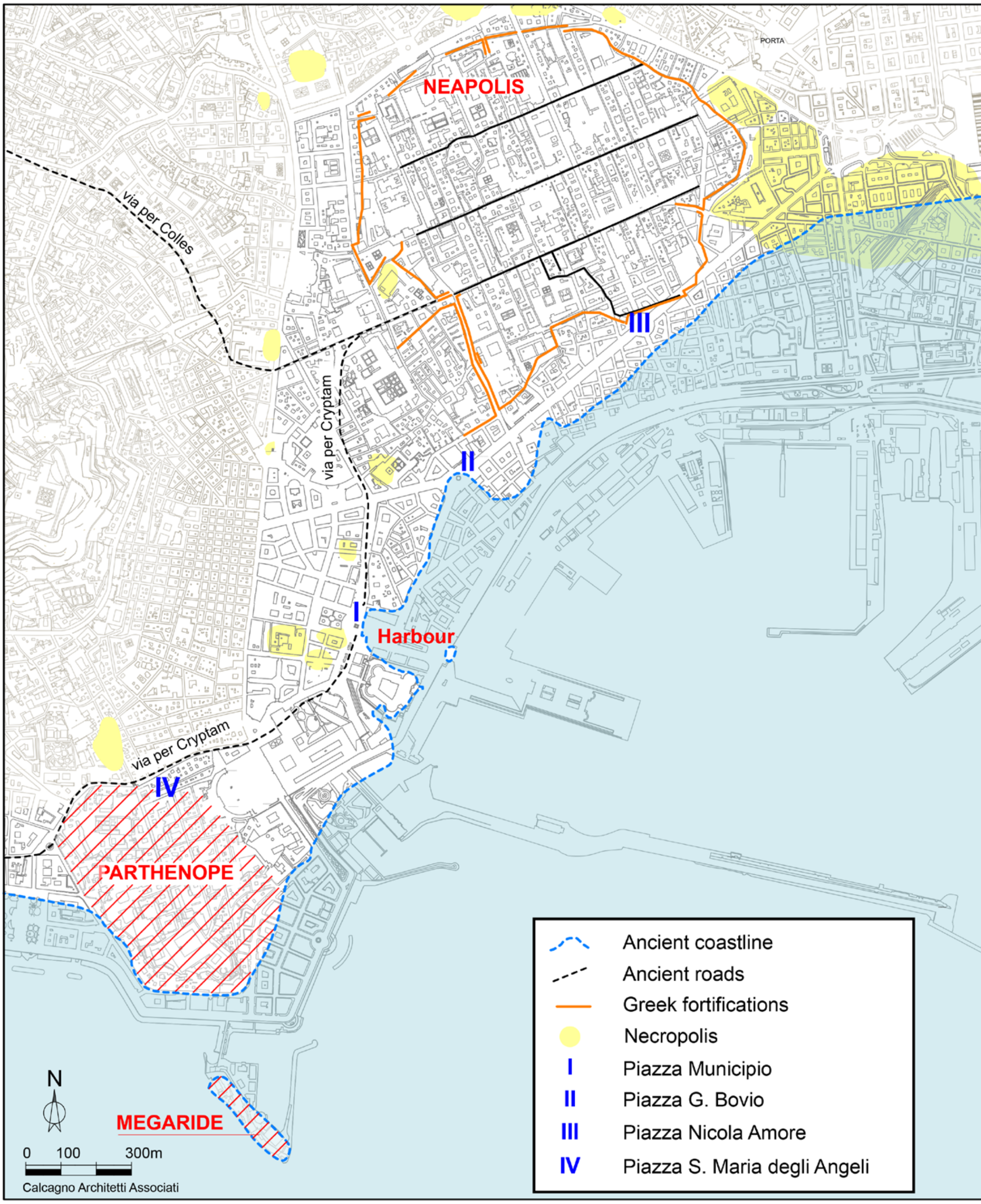

Figure 1. Reconstruction of the coastline between Neapolis and Parthenope (Giampaola, 2017b, fig. 1, Scientific development D. Giampaola, graphic rendering Calcagno Architetti Associati).

the late 6th-early 5th century BCE, and Parthenope, the earlier settlement founded by Greeks from Cumae in the early 7th century BCE on what is today the hill-fort of Pizzofalcone (Giampaola and D'Agostino, 2005) (Fig. 1).

In particular, geological coring and archaeological excavations in the metro stations Piazza Bovio and Piazza Municipio revealed that, in antiquity, a large bay lay between the church of Santa Maria di Porto Salvo to the east and the hill of Castel Nuovo to the west. In Piazza Municipio, the excavation provided evidence of uninterrupted stratigraphic datasets and structures from the 3rd century BCE until modern times (Giampaola and Carsana, 2005; Giampaola *et al.*, 2005: 47-54; Carsana *et al.*, 2009; Giampaola, 2010; 2017a; 2017b: 32-35; Di Donato *et al.*, 2018).

The construction of an artificial harbour started in the 3rd century BCE with huge dredging works, as attested by the discovery of large intersecting pits: traces left by devices used for their excavation were visible on the bottom of these pits. The dredgers removed marine sediment until they reached the layer of the Neapolitan yellow tuff. The aim of this process was to create a proper harbour basin with enough draught for ships and to ensure the harbour remained effective by avoiding siltation. The dredging was accompanied by the construction of some structures – a ramp that was perhaps a slipway, and terraced walls.

In the early 1st century CE, new infrastructures were erected including buildings for *thermae*, jetties, quays, and a road. This sector of the port was used until the early 5th century CE when the harbour basin became a marshland and was filled with sediment (Amato *et al.*, 2009; Carsana *et al.*, 2009; Cinque *et al.*, 2011; Russo Ermolli *et al.*, 2014; Di Donato *et al.*, 2018). As a consequence, the port was displaced to the east, probably close to the current Piazza Bovio (Giampaola, 2017b: 35).

The vessels

The remains of three vessels were discovered between 2003 and 2004 in the line 1 metro station in Piazza Municipio (Fig. 2). Napoli A and C had been abandoned at the end of the 1st century CE, while Napoli B, with its cargo of lime and stones, was wrecked in the late

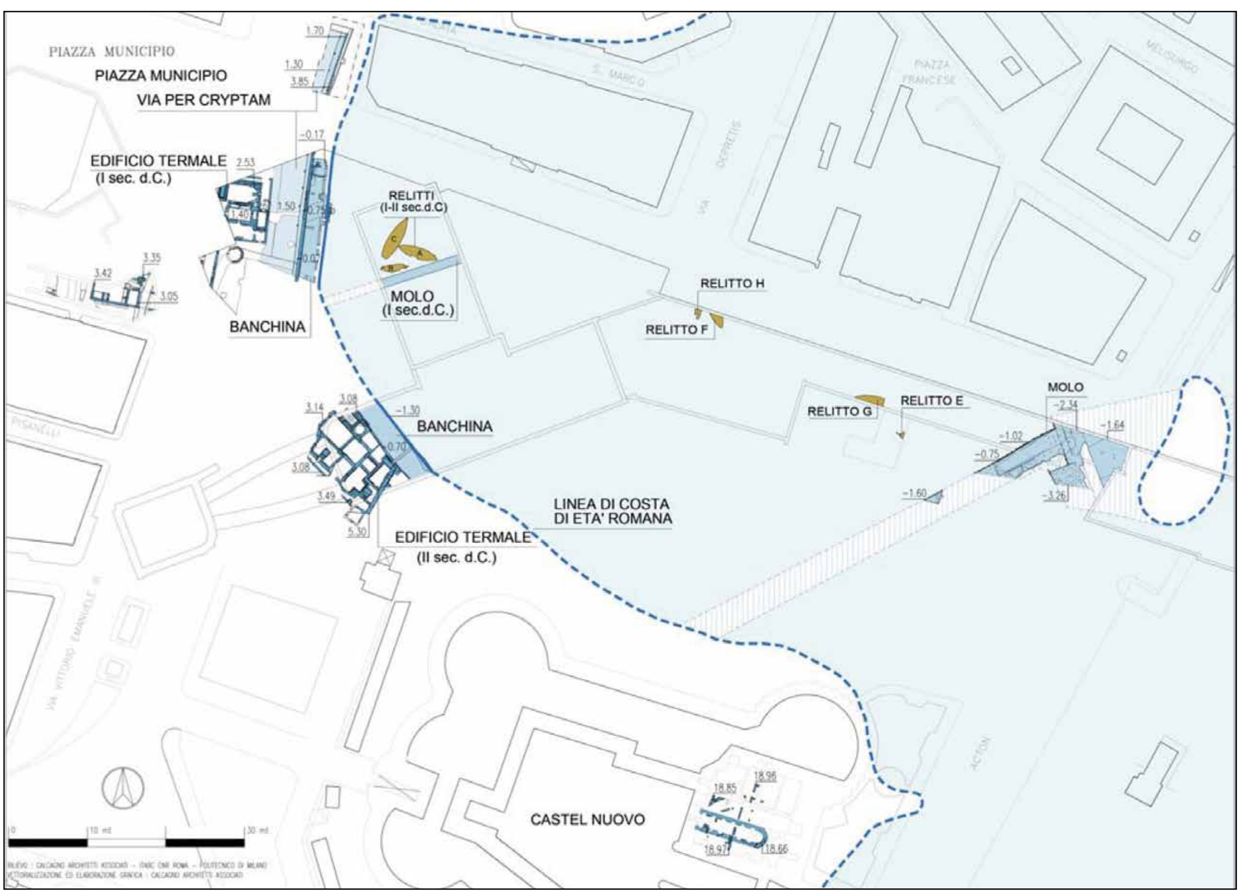

Figure 2. The archaeological excavations in Piazza Municipio, Naples, with the position of port infrastructures, buildings, and wrecks (Giampaola, 2017b; fig. 64, Scientific development V. Carsana, graphic rendering Calcagno Architetti Associati).

2nd to early 3rd century CE. The ships were excavated and recovered in 2004 and are currently preserved in water, in a store belonging to the archaeological superintendency at Piscinola, on the outskirts of Naples (Boetto, 2005; Giampaola *et al.*, 2005; Boetto, 2007; Boetto *et al.*, 2009; 2010). Napoli A and B correspond to one-masted sailing vessels (Boetto, 2005; 2007; Poveda, 2012; Boetto and Poveda, 2018), whereas Napoli C is a transom-bow boat used for harbour service identified as a *horeia*-type vessel (Boetto, 2009; Poveda, 2012; Boetto and Poveda, 2014).

Ten years later a fourth vessel (Napoli E) was uncovered in the passageway (Area 4) connecting the stations on lines 1 and 6 to the modern tourist harbour (Stazione Marittima) (Fig. 2). It was dated to the Hellenistic era and was, at that time, the earliest evidence of an ancient vessel within the harbour basin. At the end of 2014, another wreck was discovered (Napoli F), while two further wrecks (Napoli G and H) and a wooden anchor were uncovered in the following year (Boetto *et al.*, 2019). These four wrecks were dismantled and stored at Piscinola. Devoid of cargo or other datable material, all the wrecks have been dated stratigraphically: Napoli H and E are dated to the 2nd century BCE, and Napoli F and G are dated between the late 2nd and late 3rd century CE.

It is worth noting a large quantity of various materials that had been lost or discarded in the harbour basin that testify to the vitality of the city. Around 30 fragments of oars and small masts, as well as stone anchors, lead stocks, rigging elements (ropes, pulleys, deadeyes, sail rings), and carpentry tools were found. None of these objects was directly connected to the vessels.

The Hellenistic wrecks

Napoli E

Napoli E lay north-west/south-east at a depth of 5.7 m below the present relative sea-level (RSL) (3.6 m below the ancient RSL). This wreck extended beyond the limits of the trench and was poorly preserved. The visible remains had a maximum length of 1.5 m and comprised a keel, 16 strakes, one floor-timber, and fragments of a few other frames (Figs 3-4). The keel, rectangular in section (110-120 mm wide, 180 mm deep), is broken into two parts (L9, L4). The upper corners are carved with a rabbet (50 mm deep, 30 mm wide) to accommodate the garboards. The garboards were assembled to the keel with pegged tenons and copper nails.

The planking comprises seven strakes on the north-eastern side and nine on the southwestern side. Planks, 30-36 mm thick and 90-150 mm wide, are connected with a set of pegged tenons. On average the pegs, which have a diameter of 8.5 mm measured on the inboard, are spaced 110 mm apart, centre-to-centre. The floor-timber, 330 mm moulded and 130 mm sided, has a V shape due to its position at one of the extremities of the ship. Because the shipwrights marked the position of the frames with two parallel lines scribed on the planking, it was possible to estimate the space between the frames at 145-170 mm. The frames were connected to the planking with treenails. The remains of lead sheathing fixed to the hull with small copper nails have been observed on the exterior surface of the keel (Fig. 5) and of the planking. A thick layer of pitch covered the interior of the hull.

Figure 3. Napoli E from the west (Photo courtesy of Superintendency of Naples).

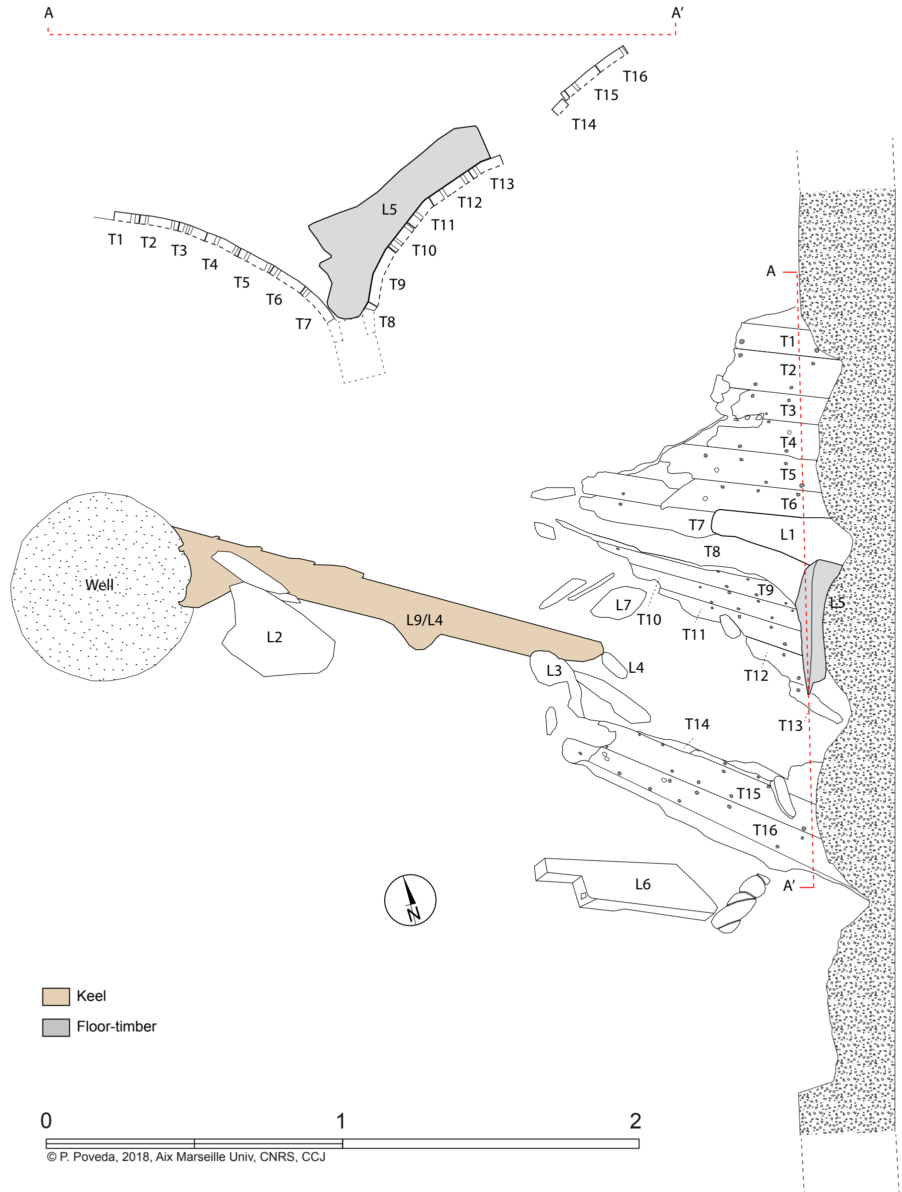

Figure 4. Napoli E. Plan and cross-section of the preserved L5 floor-timber (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

Napoli H

Napoli H was found at a depth of 5.79-5.98 m below the present RSL (3.69-3.88 m below the ancient RSL). The orientation was north-east/south-west (Figs 6-7).

The trench wall cut across the wreck, as with Napoli E, and only one end, 2.74 m long and approximately 2 m wide, is preserved.

The two sides of the wreck were found around 1 m apart because of the loss of the keel. The flush-laid planking consists of six strakes on each side: some planks are joined by oblique scarfs to make a strake. The planks are a maximum of 185 mm wide and 28 mm thick on average and joined with pegged tenons. The pegs (average inboard diameter 9.7 mm) are spaced 125 mm apart on average. Some planks (T4, T12, and T13) present tenons used for repairs that are inserted from inside the hull. The repair tenons are long, thin wooden tongues that are inserted through quadrangular recesses opened on the outer or inner face of the plank to be repaired. They were first attested on the 4th-century-BCE Kyrenia wreck in Cyprus (Steffy, 1985: 83 and 97-98, fig. 9; 1999: 397-398, fig. 4), and were widespread in Roman times.

To the western side, only one floor-timber is still connected, while on the eastern side the assemblages with the planking are broken. This floor-timber has a rectangular cross-section (93 mm sided; 200 mm moulded) and presents a single rectangular-shaped limber hole on its western branch at the level of the plank T3. The frame is fixed to the hull with treenails (14 mm diameter) and copper nails. The position of five other frames could be

Figure 5. Napoli E. Detail of lead sheathing covering the keel fragment L9 (Photo P. Groscaux AMU, CNRS, CCJ, courtesy of Superintendency of Naples).

Figure 6. Napoli H (Photo M. Gentile, courtesy of Superintendency of Naples).

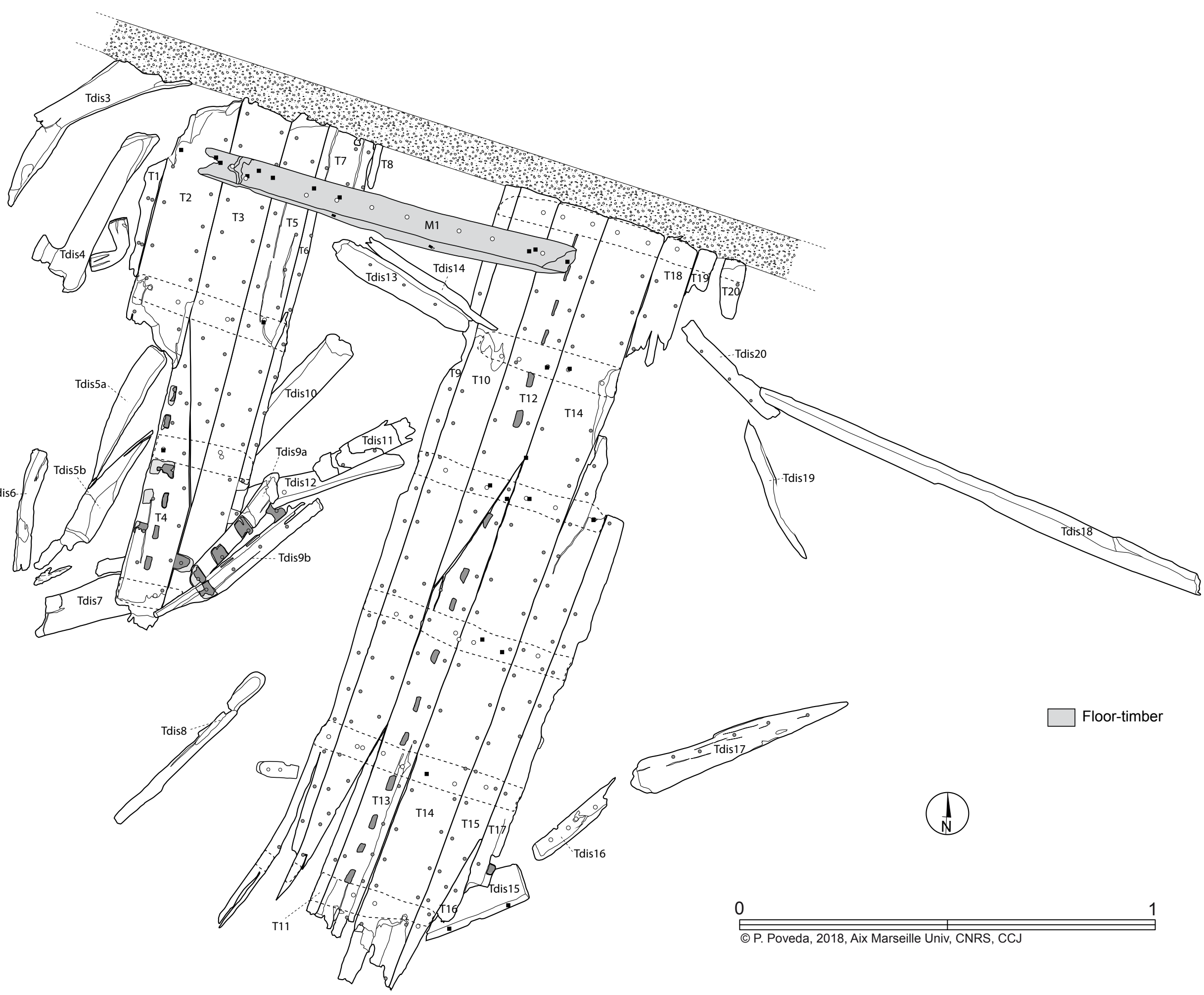

Figure 7. Napoli H. Plan of the wreck (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

deduced by rows of nail and treenail holes still visible on planking. The average frame spacing is 390 mm. A layer of pitch protected the interior of the hull.

The Romano-Imperial wrecks

Napoli F

The Napoli F wreck, oriented north-west/south-east, was discovered at a depth of 3.3 m below present RSL (1.7 m below ancient RSL). One extremity of the vessel lay beyond the limits of the excavation trench, so the visible hull remains measure 5.89 m long, 2.6 m wide, and 670 mm deep (Fig. 8). Just a small portion of the keel and the eastern side of the planking survived, while the western side, on which the hull lay when it sank, is preserved up to the second wale. The wreck also includes 12 frames to which ceiling is attached. A large number of timber fragments (137) belonging to the vessel have been found out of their original positions both in and around the hull (Fig. 9).

The longitudinal axial timbers consist of a portion of the intermediate timber and a fragment of the endpost. This post has not been identified as either the sternpost or the stem. The hook scarf connecting the two pieces is locked with a horizontal wedge or key (110 mm long, 40 mm wide, 18 mm thick) (Fig. 10). An extremely corroded iron bolt (or nail) crosses the scarf vertically. It is likely that this bolt would also have fastened a floor-timber (not preserved) to the keel. The intermediate timber (107 mm wide, 165 mm deep) is worked on its sides with triangular rabbets to take the hood-ends of the strakes, which were locked in place using nails and mortise-and-tenon joints.

The planking is flush-laid and fastened with mortise-and-tenon joints. The western side is composed of 20 strakes, 22 mm thick on average (Fig. 11). The two west-side wales (T33o and T41o) are 170 mm wide and 70 mm thick. The pegs locking the tenons were driven from the outboard (inboard diameter 5 mm; outboard diameter 8 mm on average) at 177 mm intervals, measured centre-to-centre. Mortises (57 mm wide; 38 mm deep; 4 mm thick) are spaced 56 mm apart on average.

Figure 8. Napoli F. Plan of the wreck (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

Figure 9. Napoli F. As found, showing displaced pieces found inboard and outboard the hull (Photo M. Gentile, courtesy of Superintendency of Naples).

Figure 10. Napoli F. Hook scarf between the transitional timber and the endpost, and the corroded iron fastener (bolt or nail) connecting the two pieces (Photo C. Zazzaro, courtesy of Superintendency of Naples).

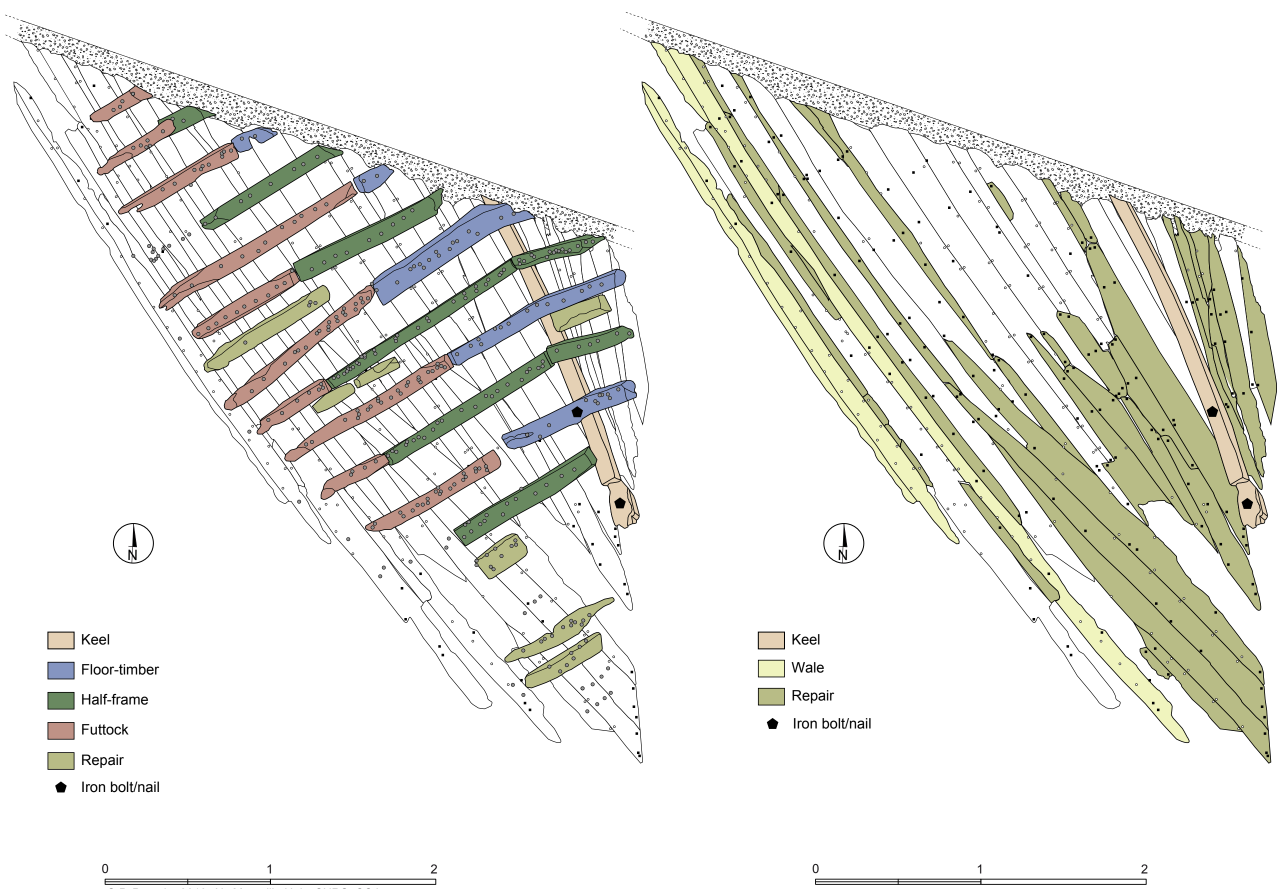

Figure 11. Napoli F. Plans of planking and frames (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

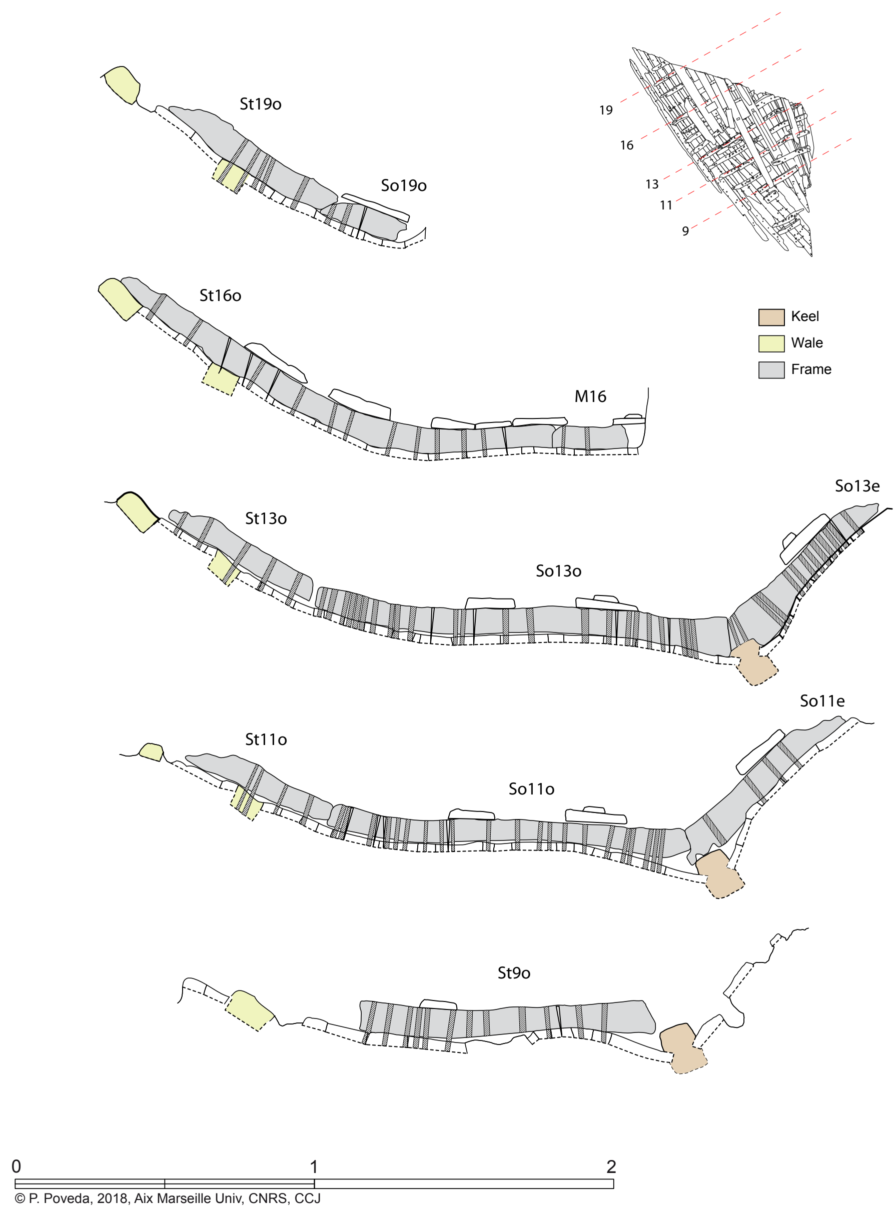

Figure 12. Napoli F. Cross-sections of frames (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

There are numerous planking repairs, mainly toward the end (Fig. 11). They include planks simply nailed to the frames, planks with mortise-and-tenon joints only on the lower edge (the other edge being nailed to the frame), and planks with repair tenons inserted from the inboard.

Three small, rectangular, lead patches were also observed on the outer side of the hull: these were attached to the planking with small nails. The patches on planks T29o and T23o measure, respectively 290 x 55 mm and 280 x 65 mm. The lead patch on the seam between T5e/T8e is longer (400 x 46 mm) and is engraved with a cross-hatched pattern on its outer surface. This characteristic has been observed on lead patches found on the 4th-5th-century wreck at Pakoštane, Croatia (Boetto *et al.* 2012b: 123, fig. 47; Radić Rossi and Boetto, 2018). This type of repair for the planking is relatively common during the Empire and Late Antiquity (Boetto *et al.*, 2012b: 123-127; Radić Rossi and Boetto, 2018).

The transverse timbers consist of 12 frames (Figs 11-12). The rows of nail holes visible on the planking identify the position of three or four other frames, which have not been preserved. The cross-section of frames is rectangular (on average 100 mm sided and 90 mm moulded) with room-and-space of 180-260 mm. Floor-timbers and half-frames alternate systematically. Due to their position at an extremity of the vessel, floor-timbers M10, M12, and M14 are V-shaped.

Floor-timber M14 is carved with a triangular limber hole at its base. Futtocks, preserved only on the west side, extend the floor-timbers. Only one of the floor-timbers

(M10) is connected to the keel by an iron bolt (Figs 11, 13). This type of joint was also observed in the scarf between the transitional timber and the endpost. Lastly, the frames are fastened to the planking by treenails (13 mm average diameter).

Among seven repaired frames, three are connected to the planking only by nails (R1o, R2o and R3e) (Fig. 8). Nails also serve to attach the numerous pointed ends of plank repairs (Fig. 11). The large number of treenails observed on the other four frame repairs, as well as on some other frames, is a clear indication of extensive repairs carried out not only on the planking but also on the frames. The ceiling consists of five stringers on the west side and one on the east side (maximum 195 mm wide, 23 mm thick) (Figs 8, 14). They are fastened to the frames with iron nails. Two small planks are nailed on top of the two stringers C1o and C1e, located near the keel (Figs 8, 14). This feature may have allowed the accommodation of movable transverse planks that have been lost. The stringers alternate with removable ceiling planks, of which only four are preserved in their original position (410 mm long, 143 mm wide, 20 mm thick).

The use of pitch to protect and waterproof the vessel is also attested in this wreck.

Figure 13. Napoli F. Detail of floor-timber M10 with its iron bolt (Photo C. Zazzaro, courtesy Superintendency of Naples).

Figure 14. Napoli F from the south-east: note the two small planks nailed on top of stringers C1o and C1e (Photo M. Gentile, courtesy of Superintendency of Naples).

Figure 15. Napoli G from the east (Photo M. Gentile, courtesy of Superintendency of Naples).

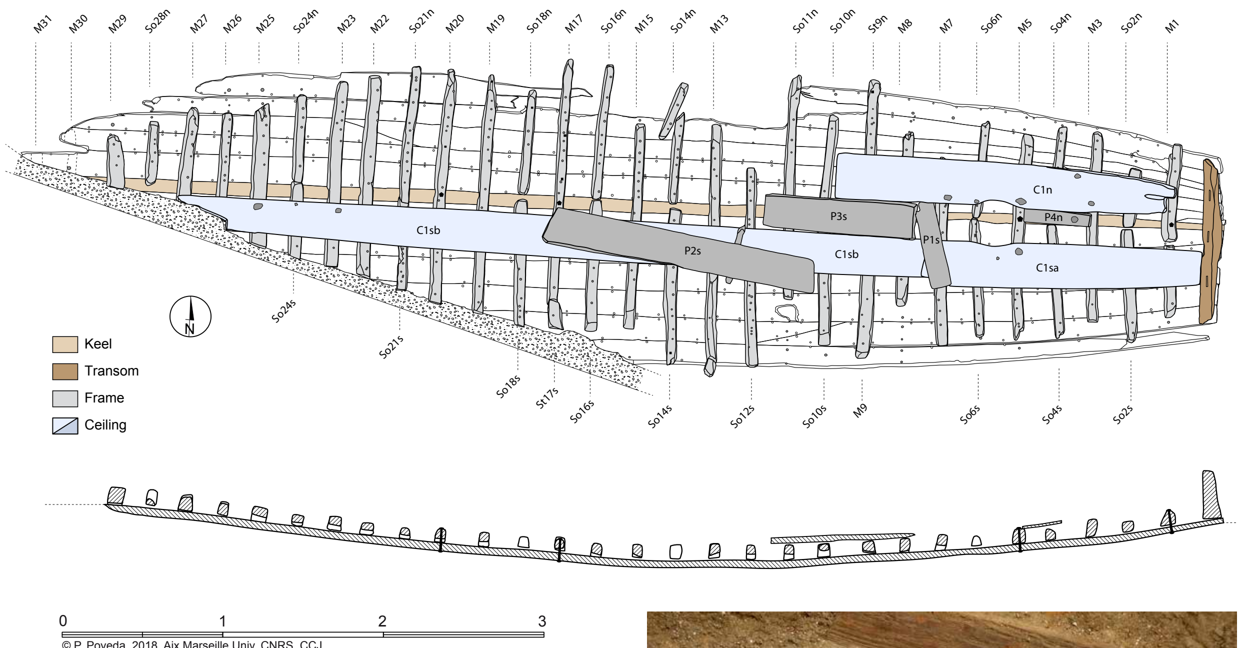

Figure 16. Napoli G. Plan and longitudinal section of the wreck (Survey Politecnico di Milano, Drawing P. Poveda AMU, CNRS, CCJ).

Figure 17. Napoli G. The keel at the level of half-frames So2n and So6s (Photo C. Zazzaro, courtesy of Superintendency of Naples).

Figure 18. Napoli G. The transom from the east (Photo C Zazzaro, courtesy of Superintendency of Naples).

Napoli G

Napoli G, oriented northeast-southwest, was found at a depth of 3.14 m below RSL (1.54 m below ancient RSL). Although the south-west end lay beyond the limit of the excavation trench, the boat is well preserved and measures 7.5 m long, 1.93 m wide, and 420 mm deep (Figs 15, 16). The transom end, located to the east, is exceptionally well preserved. The longitudinal hull-profile is asymmetrical, while the midships section is rounded. Hull remains comprise a keel, transom, 12 strakes, 29 frames, and some planks identified as ceiling. The position of two more frames was identified on the planking toward the western extremity.

The keel is one single piece without chamfered edges. It is wide – 80 mm at its maximum – and it narrows toward the transom (30 mm). It is worth noting that at the level of half-frames SO6s and SO2n, the keel is only 40 mm wide (Figs 16 and 17). This is probably due to the presence of knots or other flaws in the wood, a problem that was corrected by reducing the timber used to build the keel and by widening the garboards at that point.

The triangular transom (1015 mm wide, 305 mm high, 7-10 mm thick), is vertical and is fastened to the planking with iron nails and treenails driven from the outboard (Fig. 18). The piece is not fastened to the narrow keel-end. Only a small, wooden wedge was documented between the transom and the keel, probably to fill a gap. Three mortises (60-65 mm wide, 40-68 mm deep, 50-60 mm thick, spaced 187-212 mm apart) connected

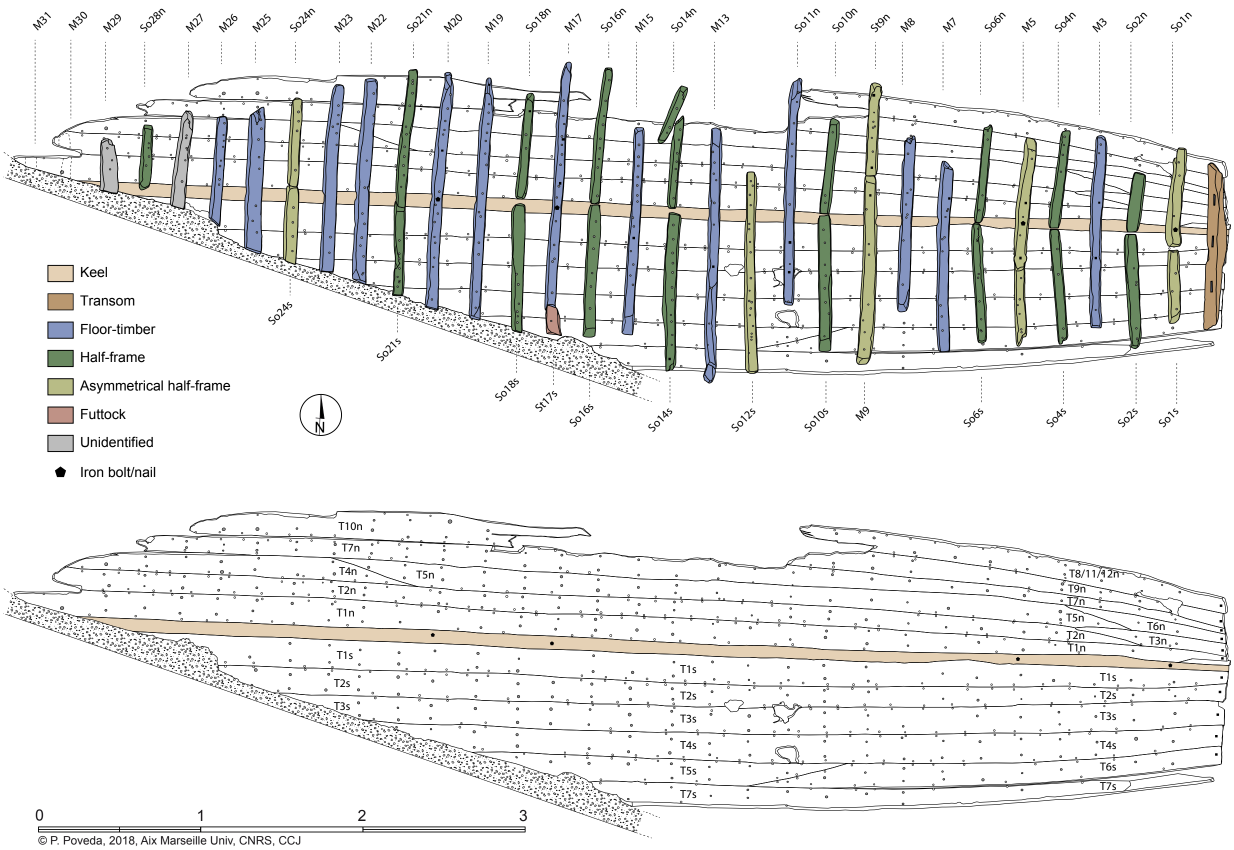

Figure 19. Napoli G. Plans of frames and planking (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

the transom to another element positioned on top. The transom is entirely coated in pitch. Only a small triangular zone is free from pitch. This may point to the presence of an internal support: however, the frames close to the transom do not provide any evidence of fasteners (nails or treenails) that would have fixed such an element.

The flush-laid planking consists of six strakes (maximum 195 mm wide, average 18 mm thick) on both sides with some oblique joints (Fig. 19). No wales are preserved. The planking is assembled with closely set mortise-and-tenon joints. The mortises are on average 46 mm deep and 100 mm apart. Tenons are on average 56 mm wide and 30 mm thick, and the pegs (with an average diameter of 90 mm on the internal surface of the planking) are spaced on average 160 mm apart.

The 29 preserved frames (66 mm sided; 73 mm moulded) did not show the classical alternation between floor-timbers and half-frames (Figs 19 and 20). Asymmetrical half-frames (one branch crossing the keel) and consecutive floor-timbers are attested. Only one futtock (St17s) is present in relationship to floor-timber M17. The average frame spacing measures 170 mm. Limber holes are rectangular (31 mm wide, 26 mm deep) and are positioned along the keel. They are present on practically all the frames, as well as on the asymmetrical half-frames. Cleaning the floor-timber M3 revealed the presence of two triangular limber holes beside the keel, which were completely filled by waterproofing pitch.

The frames are fastened to the planking with treenails (average 13 mm diameter) and iron nails (head diameter 15 mm; shaft diameter 5-8 mm). Fasteners are driven from the outside of the hull. Bolts or big iron nails connect three floor-timbers (M5, M17, and M20) and one asymmetrical half-frame (So1n) to the keel (Fig. 19). The ceiling consists of two parallel stringers and four removable planks (Fig. 15). These planks are 420-937 mm long, 136 mm wide, and 11-25 mm thick (Fig. 16).

Two stringers, 230-285 mm wide and 22-30 mm thick, consist of a single plank to the north (C1n) and two planks to the south (C1sa et C1sb). C1sa overlaps C1sb and they are fastened by a single nail.

Toward the transom, stringers (C1sa and C1n) are cut to form an approximately circular recess, 280 mm wide, and about 290 mm long (Fig. 21). In sailing vessels, such a configuration can be seen on sister-keelsons supporting the mast step and part of the bilge pump system, for example on the late-4th-early-5th-century-CE wreck Port-Vendres 1 found in France (Rival, 1991: 276, pl. 96).

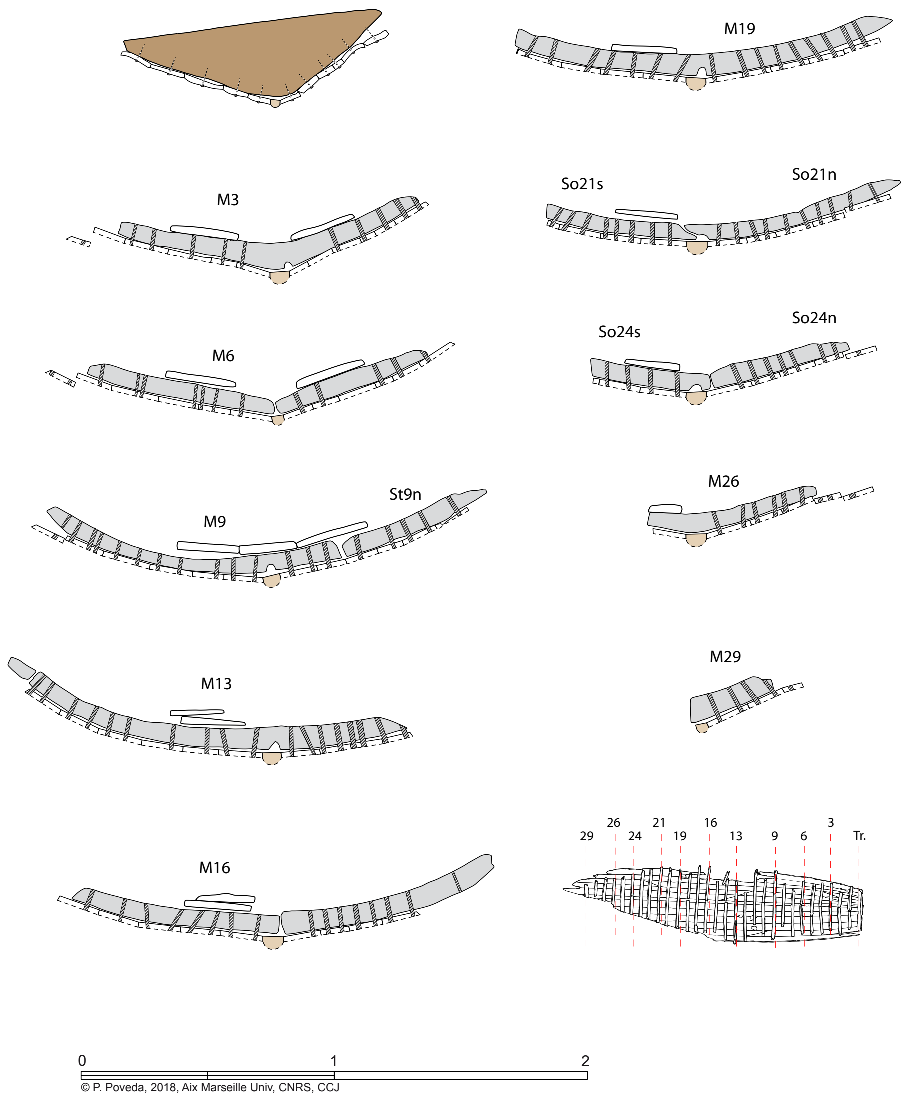

Figure 20. Napoli G. Cross-sections at frames (Survey Politecnico di Milano, drawing P. Poveda AMU, CNRS, CCJ).

However, given the small dimensions of Napoli G, we suggest that this feature did not house a bilge pump but rather could have been used to bale the water out manually. A similar recess is also present on Pisa C wreck (Italy, early 1st century CE), which is a 12 m asymmetrical vessel with a cutwater and with mixed propulsion (oars and sail) (Camilli, 2002; Camilli and Setari, 2005; Camilli *et al.*, 2006).

A single lead patch (340 mm long, 850 mm wide) was nailed externally to repair a diagonal break between planks T1Ss and T2s toward the transom. The remains show numerous tool marks (such as saw and axe). The inner face of T2n plank and of the side of the half-frame So14n show some signs that could represent letters or numerals. However, the pitch-based waterproofing coating, which is very consistent both inside and outside the hull, precluded the correct interpretation of these signs and it possibly covered other marks.

Figure 21. Napoli G. The semi-circular recesses cut in the stringers (Photo C. Zazzaro, courtesy Superintendency of Naples).

Construction principle, building process, architectural and functional type

The construction principle used for the four vessels presented in this paper is based on a shell structural concept for the hull structures, and on a longitudinal strake-oriented concept for their hull-shapes. The building process is shell-first (Pomey, 1988; 1998; 2004; Pomey and Rieth, 2005: 30-31; Pomey *et al.*, 2012; 2013). Closely set, pegged mortise-and-tenon joints firmly connect the planks and ensure the boat structure's internal stiffness, while the frames play a secondary role in the construction.

Since the oldest wrecks (Napoli E and H) are poorly conserved, their architectural and functional type and original shapes are unknown. However, it is important to note the presence of lead sheathing on the Napoli E vessel: this type of hull protection was used from the Hellenistic era to the end of the 1st century CE when it was replaced by pitch and encaustic mixtures (Gianfrotta and Pomey, 1981: 259; for a detailed catalogue of shipwrecks with lead sheathing see Fitzgerald, 1995: 184-195; Pomey and Rieth, 2005: 164). In fact, the vessels dated to the Imperial period from Naples show the exclusive use of pitch for the protection of the hull, while the small lead patches are only occasionally used for planking repairs.

From its structural characteristics, Napoli F can be interpreted as belonging to the western Mediterranean Roman Imperial architectural type defined by Patrice Pomey (Pomey and Rieth, 2005: 166-167) and to identify it as a transport sailing vessel. Nevertheless, the limited preservation of the hull structure does not allow us to be categorical on this point.

Napoli G shows previously unknown features, because of the presence of the transom end, which recalls other asymmetrical boats found in Naples (Napoli C), in 1st-century-CE boats Toulon 1 and 2 (Boetto, 2009), and in Ostia's Isola Sacra 1 (Boetto *et al.*, 2012a; 2014; 2017), where the transom corresponds to the bow. These vessels belong to the family of *horeia*-type vessels, a type of craft known from written and iconographic sources. Depending on their dimensions and propulsion, these vessels were used as harbour lighters or for fishing (Boetto, 2009). However, Napoli G is distinguished from the other known examples of *horeia*-type vessels by some of its features, including the shape of the transom, which is triangular without chamfered edges to accommodate the strakes, the absence of internal supports, and the presence of a bilge recess near the transom end. As the recovery of the bilge water is normally located in the lower part of the ship near the stern, it is possible that the transom would, therefore, correspond to the stern in Napoli G and not to the bow as in the other transom vessels. The reconstruction of the original shape will possibly provide additional data for the functional interpretation of this craft.

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The Mandirac 1 Shipwreck, Narbonne, France

Marie-Pierre Jézégou **, Patrick Andersch Goodfellow**, Jonathan Letuppe***, and Corinne Sanchez***

Archaeological excavations carried out in the Narbonne marshes have uncovered a harbour channel, nearly 2 km long, built in the second half of the 1st century CE, which functioned without interruption until Late Antiquity. During repairs to the channel, the remains of a harbour barge were used to fill a breach. This vessel has been dated by its residual cargo to the early 5th century CE. The mast step in the forward third of the hull supported either a cargo boom, a towing mast, or possibly a spritsail mast. Thus, this boat must have operated exclusively within the harbour channel.

Keywords: Narbonne harbour, shipwreck, shell-first, Late Antiquity.

One of the most important western Mediterranean ports in antiquity, Narbonne was located at the mouth of the Aude Valley and at the crossroads of major land routes – the Via Domitia and Via Aquitania. The Aude completed the link between the Mediterranean and the Atlantic, providing a route for tin from the British Isles, as well as for products travelling in the opposite direction (Diod. Sic. V: 38).

Archaeological excavations in the Narbonne marshes since 2006 have uncovered a harbour channel nearly 2 km long that was built in the late 1st century CE, extended, and maintained in use without interruption until Late Antiquity, providing access to the city by river (Sanchez and Jézégou, 2015; Faïsse *et al.*, 2018; Mathé *et al.*, 2018).[1] Its two parallel banks, 15-17 m wide, which channelled the River Aude as it emptied into the lagoon the Romans called Rubresus, were also improved for human activity. Between them flowed a 50 m-wide channel.

During Late Antiquity, an undetermined climatic event damaged the left bank, which required immediate repair. The height of the bank between the river and the lagoon was raised using large stone blocks taken from Narbonne (Sanchez and Jézégou, 2015: 511).

A ship damaged during this same event was reused as a caisson. It was filled with stones and the dyke was reconstructed on top of it. This find was designated Mandirac 1. The ship's remains were used as the foundation of the dyke and were completely encapsulated within it (Fig. 1). Ships have been reused within port structures at least since Roman Antiquity – an example is the Caligula ship at Portus (Testaguzza, 1970: 115-119; Ford, 2013: 202).

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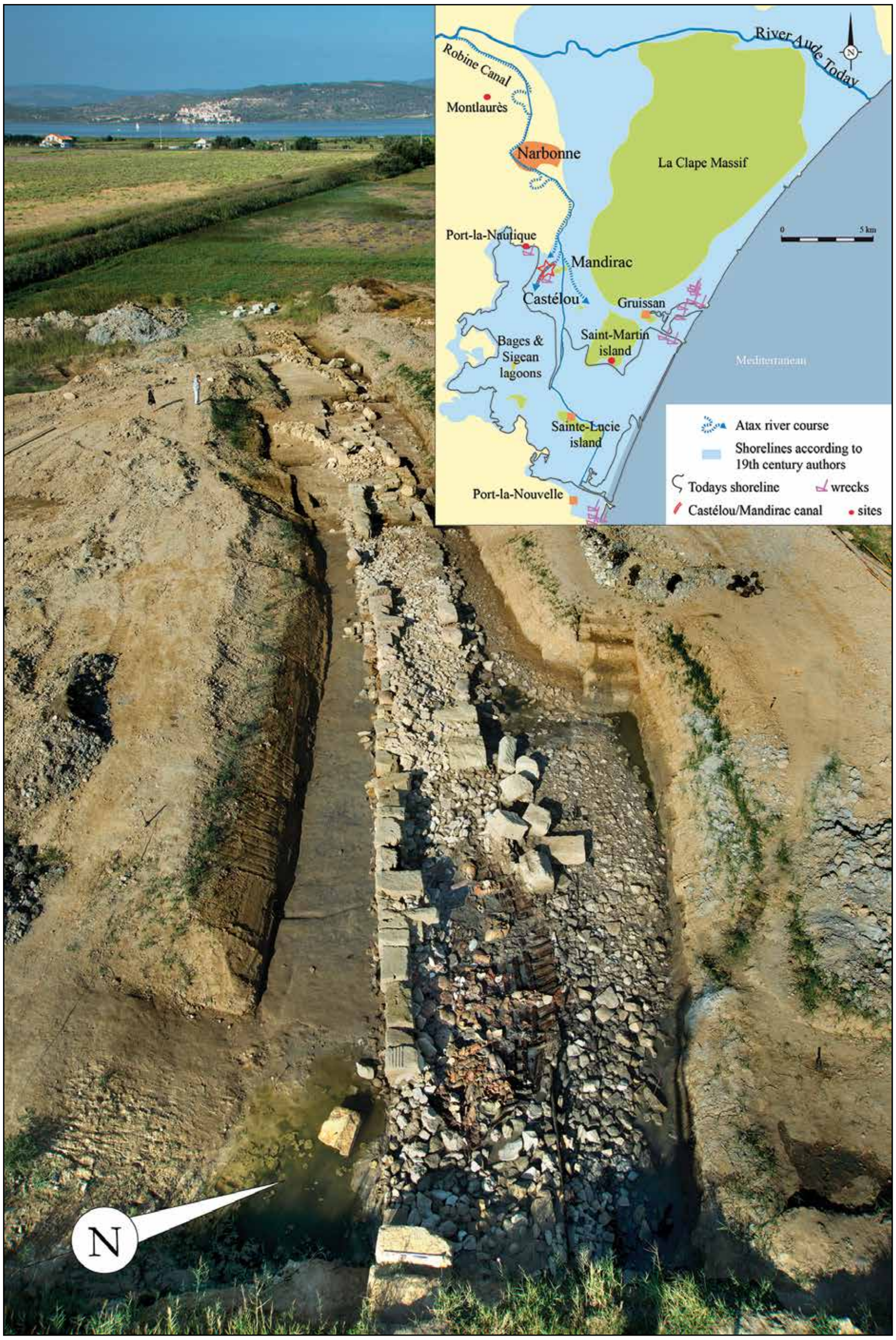


Figure 1. The shipwreck used to fill a breach in the dyke (Copyright Christine Durand, CNRS, UMR 7299-CCJ).

The vessel has been dated by its cargo, comprising mainly Lusitanian and North African amphorae, Almagro 50 and 51, and Keay 25.2 (African, 3rd century CE) from the late 4th-early 5th century CE (Sanchez and Jézégou, 2015: 511). There were also several Dressel 23 amphorae from Baetica.

This vessel can be added to the 50 or so shipwrecks from the long transition period (mid-2nd-11th century CE) marking the shift from shell-first to frame-first construction (Pomey *et al.*, 2012: 236-237, 286-289). In the first system, the strakes represent the major structural element and determine the shape of the hull. In the second, the frames take over this role. This transition is not chronologically linear since there are 5th- and 6th-century shipwrecks with more advanced features than some from the 7th-9th centuries. Nor is it geographically continuous; similar evidence can be found in both the western and eastern Mediterranean from the 6th and 7th centuries, depending on the geo-historical context. And the use of one building method or the other is not linked to a particular type of vessel.

The preserved part of the Mandirac 1 vessel measures 9.4 m long, 3.8 m wide, and is 0.8 m deep along the starboard side. All the structural remains were found still articulated except for two boards, probably ceiling planks, found inside the ship in the space between frames 7 and 8. The remains consist of the keel with its forefoot to the west and sternfoot to the east, 28 strakes amidships, 13 to starboard and 15 to port (including one low wale), 29 frames (some reinforced) and 14 ceiling plank fragments (9 to starboard, 5 to port), including 11 fixed and 3 loose (Fig. 2 a-b).

The remains amidships tilt up at 30 degrees on its southern, port side. While this side of the hull is preserved to a higher level, it has slumped around the turn of the bilge, at strakes 7N and 7S. The boat lies flat along its length and elevation differences in the hull are mostly due to the forefoot and sternfoot. It has a long bow, but it is difficult to draw any conclusions about the shape of the stern. Amidships the bottom is flat, with rounded bilges. The transverse sections are narrower fore than aft.

In 2014 and 2015, the structural elements – starboard ceiling, frames, and planks – were excavated and some

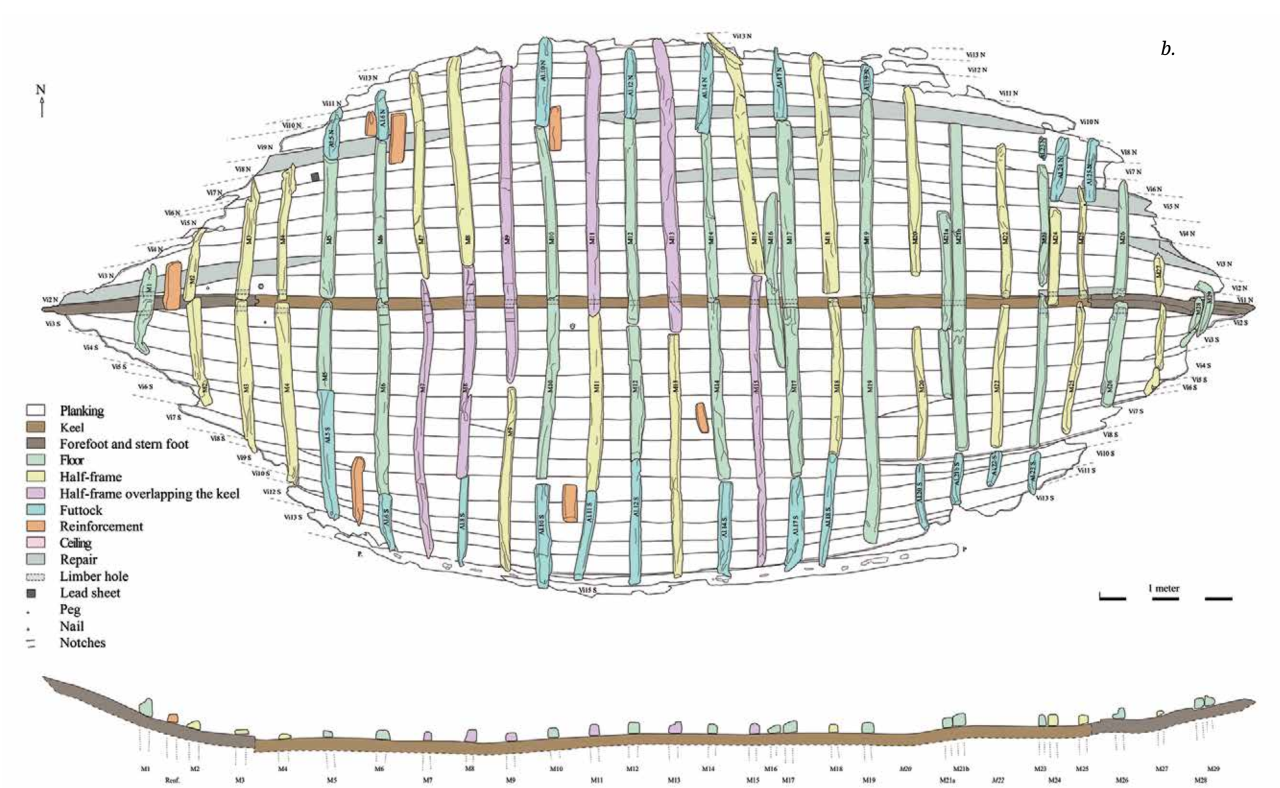


Figure 2. a) The ship with amphorae removed (Copyright Séverine Sanz-Lalliberté, CNRS, UMR 5140-ASM); b) The shipwreck after the ceiling was removed (Copyright Patrick Andersch Goodfellow, CNRS, UMR 5140-ASM).

were removed.[2] Transverse sections were drawn for each frame at 1:10 scale to reconstruct the buttock lines and hull shape. A complete topographic relief plan was backed up by orthophotography. A photogrammetric record was made at each stage of the disassembly. Each piece removed was recorded photogrammetrically, drawn at full scale, and recorded digitally. Samples were taken for wood species analysis and dendrochronology studies, pending results.[3]

The longitudinal assemblage

Three elements comprise the longitudinal assemblage: the keel, a sternfoot, and a forefoot (Fig. 2b). They are joined with keyed hook scarfs without bolts (Fig. 3a-b). Keys were pushed in from port and are slightly trapezoidal. On this form of scarf, the ends are cut to a blunt 'nib' which slots into a matching shoulder in the mating piece. It is related to Dubois type 3 (Dubois, 1976: 171; Steffy, 1994: 292). On the forefoot, we note the presence of a dowel inserted into the hook at the locking key, keel side only (Fig. 3c). The dowel has no fastening function; it does not reach the top of the keel and is not visible on the inside of the forefoot. Rather, it reinforces the hook to prevent it from buckling under the pressure of the key that keeps the unit in place (Rival, 1991: 165). The dowel lends strength because its grain is perpendicular to the grain of the main part. This practice is very common and has been observed on many shipwrecks dated from the 2nd century BCE to the 4th century CE (Poveda *et al.*, 2016: 17).

The length of the scarf is 220 mm and the keel depth is 110 mm, so the ratio is 2:1. (The ideal total length of a scarf, however, is 1:3-1:3.5 times the depth of the timber. Less than this and the surfaces of the shear planes are likely to be too small to absorb the forces at work on them.[4])

The joints are not protected with metal sheathing but there are abundant traces of pitch on adjoining pieces, particularly at the bow. The ends of the forefoot and the sternfoot cover the ends of the keel, suggesting the following building order: first, the horizontal part of the keel was placed. Then, a negative of the assemblies was cut and the scarfs scribed on the forefoot and the sternfoot. Finally, forefoot and sternfoot were fitted to the keel.

The keel measures 6.3 m long, 80-90 mm wide, 160 mm deep, and is rockered. Its forefoot varies from 70 mm wide at its preserved end to 90 mm where it joins the keel. The sternfoot is uniformly 80 mm wide and extends beyond the preserved end of the garboards. It is 110 mm deep at its endpoint.

Near the eastern end of the sternfoot, there is a 60 mm-deep step on which we identified the trace of an iron nail, offset to starboard. This cut continues for 330 mm to the preserved end of the foot to the east.

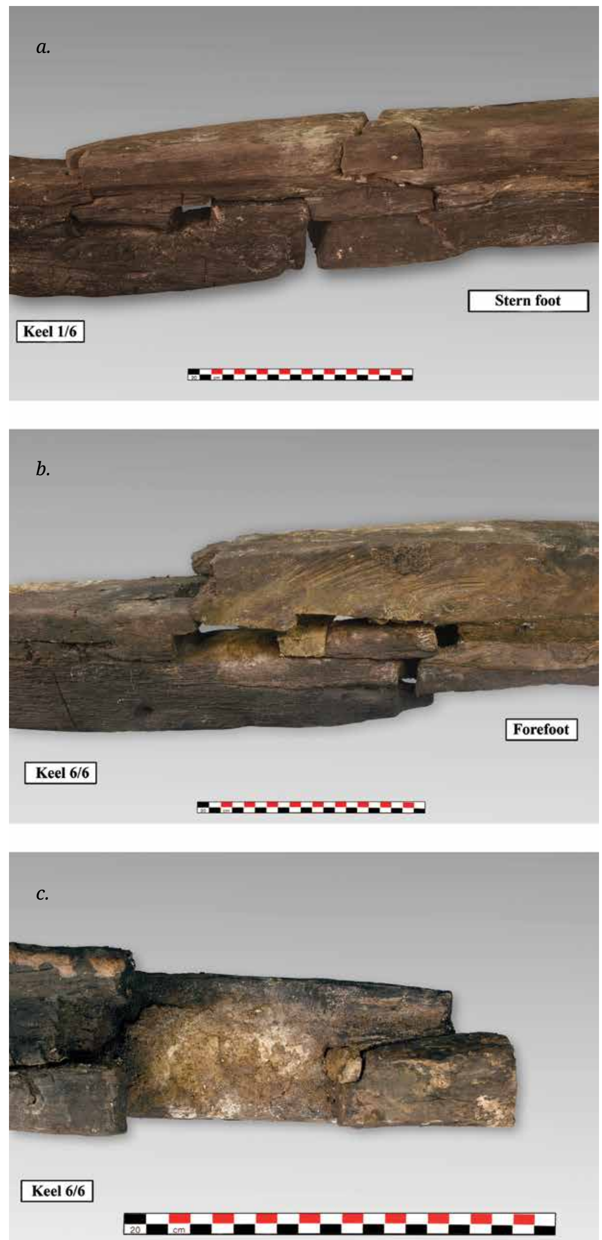


Figure 3. a-b) The keel-sternfoot, and keel-forefoot scarfs; c) a dowel reinforces the forefoot scarf on the keel (Copyright Stéphane Cavillon, DRASSM).

2 Labex ARCHIMEDE, program 'Investissement d'Avenir' ANR-11-LABX-0032-01.

3 Ongoing analyses by Christine Locatelli et Didier Pousset, Laboratoire d'Expertise du Bois et de datation par Dendrochronologie (Besançon).

4 Information provided by André Aversa, shipwright in Sète (France).

Since the eastern end of the keel has been lost, it is impossible to determine how it was attached to the sternpost (although there is room for a possible deadwood piece resting against the missing sternpost). There is a scribed mark on the northern face of the sternfoot. It takes the form of two vertical lines that cut across the grain of the wood. It is clearly different from the neighbouring cracks and resembles a Roman numeral II (Fig. 4). Scribed marks have been found on other wrecks (Tran, 2014: 165-170).

Figure 4. A scribed mark on the sternfoot (Copyright Julie Labussière).

The hull planking

There is a single layer of carvel hull planking with 13 starboard strakes and 15 port strakes, including the wale. The garboards are single planks 8 m long, with a maximum width of 183 mm. On the port side, the second strake is a single plank 9 m long. The other strakes of the Mandirac 1 shipwreck have planks joined with oblique 500-850 mm-long flat scarfs. The scarf layout to the starboard side does not appear to be random. The scarfs on strakes 5N and 7N are toward the stern, between frames 21 and 19, and frames 22 and 21, respectively. Strake 6N is scarfed toward the bow between frames 10 and 8 (Fig. 5).

On the port side, the scarfs could not be drawn as accurately, but they were observed on strakes 3S and 5S toward the stern and on strakes 6S and 8S toward the bow. Thus, it seems that the shipwrights took the trouble to alternate the position of the planking scarfs to obtain complete strakes running from stem to stern. In addition, the scarfs on adjacent strakes are never aligned on a given side of the hull; however, they are mirrored on the two hull sides. For example, both the starboard and port fifth strakes are scarfed between frames 21 and 19. The placement of scarfs on the sixth strakes, between frames 10 and 8 to starboard and frames 9 and 8 to port, also approximate this pattern.

Each garboard has treenails that are not structural. Nor do they indicate reused materials as we observed on

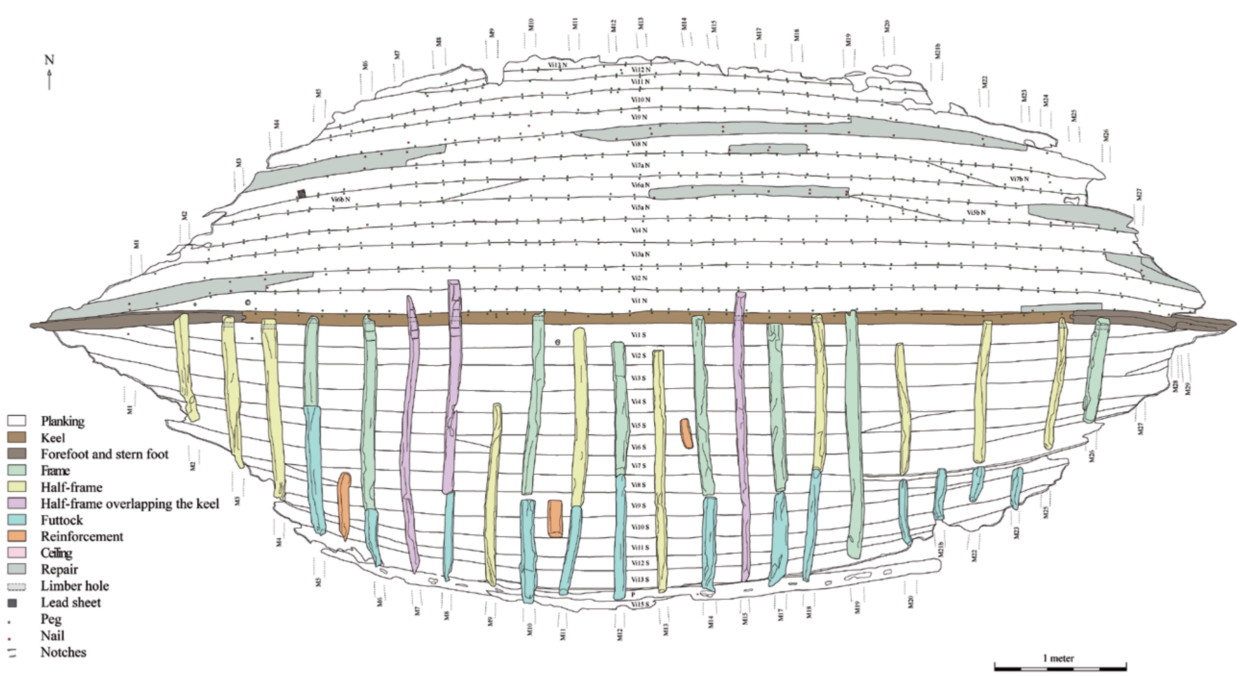


Figure 5. The shipwreck after removal of both the ceiling and the starboard frames (Copyright Patrick Andersch Goodfellow, CNRS, UMR 5140-ASM).

Figure 6. Treenails in the garboard planks used to plug holes (Copyright Julie Labussière).

Figure 7. Two adjacent strakes on the starboard side with the mortises opened to reveal the tenons (Copyright Marie-Pierre Jézégou).

other hull elements. Rather, these treenails were used to fill holes where knots had been removed from the wood (Fig. 6). Some strakes have circular, non-perforating holes on their upper surfaces; these also correspond to the removal of a knot, after which the aperture was plugged with pitch.

Planking fasteners

The strakes are laid edge-to-edge and fastened to each other and to the keel with pegged tenons in closely spaced mortises cut into the edges of the planks. The interval between peg centres is 110-190 mm, typically 150-190 mm over most of the shipwreck, especially between frames 3 and 25. The tenons are roughly staggered in a quincunx pattern. The scarfs between planks are also fastened with tenons perpendicular to the scarf and mostly pegged. They are not reinforced with nails with one exception – the end of the scarf of strake 7b (under frame 22) was connected to strake 6 with a transverse nail in the edge after strake 7b was in place. This means that strake 7b was installed before strake 7a, which extends it to the stern (Fig. 5).

When we opened the mortises of two adjacent strakes to observe the tenons, we noticed an important asymmetry. The tenons placed in the mortises of the lower strake, which was already in place, were cut to fit perfectly, while mortises cut in the strake above exceeded the dimensions of the tenons (Fig. 7). This allowed more flexibility in positioning the strake being fitted.

Garboard-keel and garboard-foot fasteners

The garboards are fastened to the keel with the same pegged mortise-and-tenon system, but a different method seems to have been used to attach the garboards to the forefoot and sternfoot. Numerous traces of ferrous oxidation along the forefoot rabbet suggest iron nails were driven obliquely from the exterior, through the starboard garboard. At the stern, the same technique has been used to fasten port strake 2S, which, better preserved to starboard, ends in the sternfoot rabbet above the garboard.

The wale

On the port side, strake 14 consists of a thicker plank between frames 5 and 21b and is interpreted as a wale. The plank is 4.75 m long, up to 135 mm wide, and up to 79 mm thick, and is fastened to strakes 13 and 15. Along its upper edge, between frames 8 and 18, the wale has four large, rectangular mortises about 1 m apart, which

Figure 8. Large rectangular mortises near M14 (Copyright Julie Labussière).

are different from the planking mortises (Fig. 8). They are offset from the pegged mortises and are cut into the outer part of the edge. Some of these mortises still contain a tenon with visible sections varying from 35 × 20 mm to 40 × 25 mm. One tenon is sticking out of its mortise against frame 17. Pending further study of the wale, we can hypothesize that it might have been intended for adding a wash strake. The preserved port wale fragment is fastened to the previous strake (13S) and the following one (15S) using the usual mortise-and-tenon method, but without pegs fastening the tenons.

Portside strake 15S is the vessel's top strake. It is very badly preserved but, where preserved, there are no more mortises on the upper edge.

The frames

The vessel's framing comprises 30 elements – 15 floor-timbers, 8 pairs of half-frames in place, an isolated half-frame, 6 half-frames overlapping the keel and 23 futtocks. The first floor-timbers at each end, M1 at the bow and M29 at the stern, are canted. Except for those at the ends, most of the floor-timbers are preserved over their entire length and are extended by 23 futtocks: 13 to port and 10 to starboard (Fig. 2b).

The spacing tends to be regular, usually about 320 mm. There are limber holes in the frames to allow bilge water to circulate freely at the bottom of the hold.

The floor-timbers

The floor-timbers have either a square or a rectangular section. The sided dimension ranges 70-120 mm, but most measure 100 mm. The moulded dimension ranges 70-130 mm, with most at 100 mm. The floor-timbers cover the entire floor from one turn of the bilge to the other. Floor-timber 19, the longest, runs from starboard strake 10N to port strake 13S. Most of the others cover the area between strakes 8N and 8S, demonstrating a certain attempt at symmetry and solidity between the two sides (for example, floor 14, Fig. 2b).

The half-frames

The shapes and dimensions of the half-frames resemble those of the floor-timbers. Pairs of half-frames meet on top of the keel, except for a single pair in which the timbers are separated by 400 mm. This interval suggests a space reserved for a bilge pump, but no trace of such a pump has been found.

The half-frames overlapping the keel are extended by asymmetrical timbers on the opposite side. There is exactly the same number of half-frames overlapping the keel to port and to starboard (Fig. 2b).

The futtocks

Futtocks also extend the floor-timbers, starting at the level of the turn of the bilge. The shapes and dimensions of the futtocks resemble those of the floor-timbers. Their original lengths remain unknown because they are all broken. They are not fastened to the frames and display major differences in their relationship to the frames. While some futtocks and frames are joined with a diagonal scarf but are not fastened, others are separated by a few centimetres.

Frame and planking fasteners

Frames were fastened to planking with truncated, conical treenails driven mostly from outboard. Two or, less frequently, three treenails were used per strake, spaced 50-100 mm apart and aligned (Fig. 9). No frames are fastened to the keel, not even the floor-timbers.

Internal longitudinal structure and mast step

The internal longitudinal structure comprises 11 ceiling planks fastened in place and three fragments of loose ceiling (Fig. 2a), but most had already been recovered when the boat was reused in the dyke. The ceiling planking is nailed to the frames. The only evidence of a possible mast step was observed at the forward end of the boat, on frames 6-9. It takes the form of notches on each of the frames on either side of the keel (Fig. 10). These notches enabled two longitudinal elements, doubling pieces or mast step partners, to be set into frames 6 and 9. These would have supported a very short mast step timber riding on a crosspiece linking two sister-keelsons. This system is characteristic of western Roman Imperial naval construction (Pomey *et al.*, 2012: 300). It was found on Port-Vendres 1 (Chevalier and Santamaria, 1972: 18-21; Liou, 1974: 425-426) and Pakoštane (Boetto *et al.*, 2012: 121), which are contemporaries of the Mandirac 1 vessel, and also on earlier shipwrecks such as Saint-Gervais 3,

Figure 9. Frame planking fastening on the starboard side. The pink rings are nails; the yellow ones are treenails (Copyright: Julie Labussière).

Figure 10. Notches on either side of the keel on frames 6-8 (Copyright Julie Labussière).

Laurons 2, La Bourse, La Luque B and on later shipwrecks such as Saint-Gervais 2 (Pomey *et al.*, 2012). On Mandirac 1 this assembly is very short, spanning just four frames. Its length was likely no more than about 1 m. It is not positioned precisely at a third of the total length from the bow, as was the custom on square-sailed seagoing vessels with a square sail in antiquity. Nor is it located all the way forward, as it would be for a spritsail. The more probable interpretation is that it supported a cargo boom or a tow post. Towing masts are normally situated in the forward third of the vessel for efficient towing parallel to the banks of the canal (Beaudouin, 1985: 11-12; Rieth, 1998: 106-107). The best comparison is Fiumicino 1, which features a small forward keelson that served as a towing-post step fitted directly onto the floor-timbers (Boetto, 2008: 45). This interpretation, derived from its riverine use, was also seen in the County Hall vessel. Both were sea-river vessels (Pomey *et al.*, 2012: 301).

Indications of reuse and repairs

Reuse

Careful examination of the frames reveals that, in some cases, the number of treenails greatly exceeds the number visible on the *in situ* planking. This is particularly true of frames 13, 17, 18, 19 and 21b, and on starboard futtock M10 (Fig. 11). These treenails are only visible on frames and futtocks and not on the strakes, and so cannot be signs of repair as was observed on the Pakoštane shipwreck (Boetto *et al.*, 2012: 120). On M17, we can see that one treenail overlaps another (Fig. 12). This means

Figure 11. Frames 13-18: the yellow rings show the large number of treenails on some frames (Copyright Julie Labussière).

Figure 12. One treenail overlaps another on frame 17 (Copyright Julie Labussière).

Figure 13. Ceiling plank Va2 with a treenail cut flush in the space between two frames. Nearby, a nail was used to fasten the ceiling to a frame (Copyright Stéphanie Wicha).

Figure 14. Pitch on the lower surface of ceiling plank Va1 (Copyright Stéphanie Wicha).

that one was put in after the other and testifies to the reuse of elements removed from another structure, probably a boat.

Signs of reuse are visible on the ceiling planks, too. Strakes from another boat were reused here. Again, some of the treenails are not aligned with any frame, thus serving no purpose, which is evidence of prior use elsewhere (Fig. 13). Likewise, tenons recorded in the edges of the ceiling planks serve no purpose because they are almost never found in alignment. There are also many unpegged and broken tenons in the mortises. More evidence of the reuse of former hull strakes can be seen in the abundance of pitch on the lower surface of certain ceiling planks. This would have been the outer face of these pieces when they were elements of hull planking (Fig. 14). Examples of timbers removed from one ship and used in building another are well known, as in the Kinneret boat (Steffy, 1987: 327; Wachsmann, 1995: 74).

Repairs

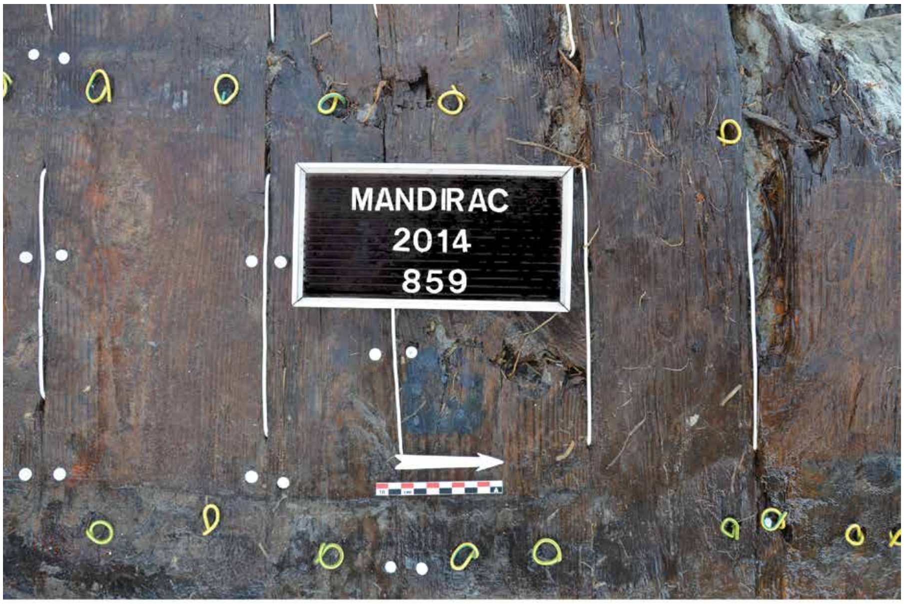
The starboard side was completely removed for study. Several planks were repaired and some replaced. Most of the repairs were at points of fragility, such as the turn of the bilge or at the ends of the vessel. To starboard, at the keel-to-forefoot scarf, where the garboard seam had rotted or split away, a graving piece was inserted (Fig. 5). Another 1.55 m-long graving piece was inserted on strake 6N between frames 13 and 19. Meanwhile, the seams between strakes 8N and 7N between frames 15 and 18 needed a 630 mm-long graving piece. A 3.4 m-long replacement plank was inserted between strakes 8N and 9N, which were roughly trimmed to receive it. Strakes

Figure 15. Repaired strakes fastened to the frames with nails highlighted in pink (Copyright Julie Labussière).

2N and 8N were repaired at the bow, as were strakes 3N and 5N at the stern. Strake 3N was repaired twice (Fig. 5). In each case, the original plank was cut to receive the ends of the repair planks, and the edges of the replacement planks were coated with pitch. At the repair points, the strakes were no longer fastened to each other with pegged tenons. Except when re-cut, the adjacent planks retained the tenons from the original joints, pegged into their mortises. The replacement planks had to be forced into the space vacated by the original pieces and were simply nailed to the frames (Fig. 15).

In 1994, J.R. Steffy wrote of the Kyrenia shipwreck plank repairs: 'Since the frames were already in place, it would only have been necessary to nail the replacement strake to them to complete the repair; that is what latter-day shipwrights would have done' (Steffy, 1994: 56). The shipwrights who repaired the Mandirac 1 nailed the replacement strakes. On the Kyrenia vessel, the new planks were attached to the original planks using tenons inserted in mortises cut from the inside of the new planks, called 'patch tenons'. Since Steffy's 1994 publication, more repairs on ancient ships have been published. A corpus of some 30 shipwrecks covering a period of more than 1000 years was compiled to compare the use of these two methods of replacing planking – patch tenons inserted in mortises cut on the internal or the external surface of the new strake (or on both surfaces) and direct nailing (Jézégou and Chaussade, forthcoming). On vessels for which frame-first construction could be identified, the replacement strakes were only attached to the frames with nails. Similar wrecks are known including Dor 2001/1 (Kahanov and Mor, 2014: 48); Tantura E (Israeli and Kahanov, 2014: 55, 58); and the more recent Serçe Limanı (Matthews and Steffy, 2003: 107). Butt joints set over the frames join the replacement planks to the original planks in the same strake, as in the original construction. One exception is noted: the original strakes on the Serçe Limanı wreck were joined with both butt joints and oblique scarfs (Matthews and Steffy, 2003: 107). Ships with shell-first construction offer more diverse ways of fastening replacement strakes. Some use only patch tenons inserted in mortises cut from the inboard or the outboard of the new planks, locked with pegs or not; others use patch tenons and nails in parallel, but not on the same planks (Jézégou and Chaussade, forthcoming).

The use of patch tenons can be found on later vessels, such as Jules-Verne 1-2, dating from the 4th century CE, in repairs to the ship's side (Pomey, 1995: 460). Patch tenons were also detected on the Port-Vendres 1 that sank in the early 5th century CE (Rival, 1991: 267-296).



a.

b.

Figure 16. a) On strake 7, a small lead patch is fastened with iron nails. (Copyright Julie Labussière); b) nails and a peg fasten a lead patch (Copyright J. Letuppe, Eveha).

On the other hand, nailing replacement planks directly onto the frames appears from the 1st century CE. On Jules-Verne 5, the remains of a dredging boat dated to the 1st century, the planking repairs on the strakes at the turn of the bilge are rudimentary, being simply nailed to the frames. When strakes affecting the structure of the vessel had to be partially removed for repair, the new planking was carefully installed using pegged patch tenons inserted from mortises cut from the inboard side (Pomey, 1995: 467). On Jules-Verne 3, the remains of a dredging boat dating from the early 2nd century, the replacement strakes at the turn of the bilge are simply nailed to the frames (Pomey, 1995: 465). On the Fiumicino 1 shipwreck, a *navis caudicaria* dated to the late 4th-early 5th century, repairs are more complex. Here, most of the replacement strakes are simply nailed to the frames except for the garboards, which are fastened to the keel with iron nails obliquely driven into tetrahedral notches. Giulia Boetto (2010: 142). suggests that this is an old technique used in river craft, adapted to seagoing vessels.

This probably non-exhaustive inventory shows no trend toward simplification by nailing replacement planking to the frames during repairs. Except for frame-based vessels for which strake-replacements could only be made by direct nailing, the use of this simple method seems to have been reserved for small boats, service crafts (Jules-Verne 5, Jules-Verne 3, Napoli C, and the Mandirac wrecks), or small river-sea boats (Fiumicino 1), after the 1st century CE. As yet, direct nailing has not been observed before this date, but then repairs have not always been noted, particularly when investigated under water. However, even on these small vessels, when repairs affected the structure, the carpenters turned to the patch tenon system.

On Mandirac 1, two sheets of lead measuring 55 mm on each side were used to fill a gap. One was fastened to the inner surface of strake 7N, toward the stem, with square nails with a cross-section of 5 mm (Fig. 16a), as is frequently observed on shipwrecks from Late Antiquity (Boetto *et al.*, 2012: 123-125) or earlier (Daveau and Boetto, 2012: 135). On the outboard face of strake 9, at futtock M14, five nails and one peg were found driven from the outboard (Fig. 16b). They had been used to attach a lead patch (which was not preserved), to stop a crack (Jézégou and Chaussade, forthcoming). This second repair could have been made either during construction or later, once the vessel was in the water, since it was above the turn of the bilge.

Interpretation

The construction of Mandirac 1 perfectly embodies the tradition of a 'longitudinal shell-first conception' in which the hull shape is determined by the strakes (Pomey and Rieth, 2005: 30-31). The hull planking plays the primary structural role, and the framing is of secondary importance. The pegged mortise-and-tenon fasteners used to assemble the strakes constitute a network that ensures the longitudinal cohesion of the structure.

This network of tenons on the Mandirac 1 is dense with highly regular spacing of 150-190 mm. Our current observations suggest that this spacing is comparable to that found in wrecks dated between the mid-2nd century and the beginning of the 4th century CE, such as Saint-Gervais 3, Laurons 2, La Bourse, and La Luque B (Pomey *et al.*, 2012: 297). On shipwrecks from the 4th and 5th centuries CE, mortises and tenons are more widely spaced, at around 300 mm (Pomey *et al.*, 2012: 297). On Mandirac 1, unpegged mortise-and-tenon joints were used only for fastening the wale.

No frames are fastened to the keel or the futtocks. On shipwrecks earlier than the 5th century CE, the sporadic fastening that we find does not necessarily mean that these frames were 'active', and might represent frame repairs.

In Greco-Roman naval construction, boatbuilders usually placed the half-frames so that they met over the keel, alternating with floor-timbers. Later, from the 2nd century CE, some cargo vessels in the Roman western Mediterranean had half-frames crossing the keel, alternating with floor-timbers. All of these are flat-bottomed craft with rounded bilges (Pomey *et al.*, 2012: 298). The Mandirac 1 framing includes a mix of half-frames overlapping the keel, half-frames meeting on the keel, and floor-timbers. The overlapping half-frames increase the structure's transverse strength. Of the six such frames found on Mandirac 1, three are related to the presumed mast step, which they apparently supported.

The internal axial longitudinal elements, the mast step and keelson, are also of fundamental structural importance. From the 2nd century CE, we begin to see in the western Mediterranean a system comprising two central sister-keelsons, connected by transverse braces to which the mast step is fitted (Pomey *et al.*, 2012: 300). On the Mandirac 1 shipwreck, there is neither keelson nor notches that might have served to attach one. In contrast, there are traces of a system using two short, central sister-keelsons. Our preliminary study of Mandirac 1 indicates that its builders sought both seaworthiness and economy of construction. With regards to seaworthiness, care has been taken to ensure symmetry between the vessel's sides, and in the pattern of framing timbers, and, in particular, floor-timbers that cover the whole floor to the turn of the bilge. The shipwrights also set out to avoid using too many scarfs, which would have risked weakening the hull planking. Most of the strakes were made of a single plank and when scarfs are used, they are never aligned on adjacent strakes. Likewise, tenons in adjacent seams are not aligned but staggered in a quincunx pattern.

The numerous reused pieces and partial repairs to certain planks indicate economical, utilitarian construction and maintenance. The many repairs suggest a service craft requiring successive renovations and, perhaps, a rather long working life.

The position of the presumed mast step in the forward third of the vessel, rather than precisely at the forward-third line, would have made it difficult to use the kind of square sail usual in seagoing craft. It points to a towed service craft, a lighter intended for offloading cargo ships at the port-access channel and used to transfer cargo to the city. In fact, this body of water is so narrow (50 m) that proceeding under sail would have been difficult.

Conclusion

The Mandirac 1 vessel was built using a strong arrangement of pegged mortise-and-tenon joints that accord with the concept used for its shape and structure, and with a full shell-first construction process. The hull is reconstructed as 12.8 m long, with a charge of 8-9 tonnes, and a draught of 1 m.

Numerous repairs are visible, including several hull planks that have been replaced. Ongoing dendrochronological analyses may clarify the date of these events – such as reused elements, original parts of the construction, and final repairs – to help estimate the vessel's lifespan. Port vessels, sailing within a protected area, may have had a longer lifespan than written sources suggest was usual for maritime vessels. A *misthoprasia* contract refers to a lease agreement among four people who paid for the construction of a boat over 17 years before acquiring it fully for 50 further years (Arnaud, 2011: 72). Questions of the maintenance and longevity of ancient vessels are seldom raised because they are difficult to estimate. Underwater archaeology rarely allows for systematic dismantling. The Mandirac boat, however, was employed in a sheltered environment that would have allowed for prolonged use without excessive risk.

A thorough study of this shipwreck is essential for our understanding of river and lagoon transport and of the construction of harbour craft. While the development of nautical archaeology over the past half-century has given us a good grasp of ships that navigated in the open sea and the coastal zone, service craft remain relatively unfamiliar: they are usually discovered during large-scale urban development projects, such as Toulon (Boetto, 2014: 56-61), Antibes (Daveau and Boetto, 2012: 127-138), Marseille (Pomey, 1995: 459-484), Pisa (Camili, 2004: 53-75), Naples (Boetto, 2005: 63-76 ; Boetto *et al.*, this volume), and Istanbul (Koçabas, 2014: 78-85). The Mandirac 1 vessel seems to have particular characteristics that deserve further study. These characteristics, which reflect the adaptation of the craft to its setting, its function and its use, are equally shaped by the ancient Mediterranean tradition that preceded it.

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A late-12th-century Byzantine Shipwreck in the port of Rhodes

A preliminary report

George Koutsouflakis and Eric Rieth***

In November of 2013, the Hellenic Ephorate of Underwater Antiquities undertook the partial excavation of a Byzantine shipwreck of the late 12th century lying in the modern commercial harbour of Rhodes at a water depth of 13-14 m. The ship apparently sunk after a fire at the very entrance of the medieval harbour and was carrying a cargo of Günsenin 3-type amphorae. Limited to the stern area, the excavation revealed extensive parts of the keel, keelson, frames, planking, and ceiling planks. The data recorded suggest an extremely large vessel, with a possible overall length of 35 m.

Keywords: Byzantine, ship structure, amphora, Rhodes, merchant vessel.

Archaeological investigations of ancient and medieval port facilities can present rich opportunities for interdisciplinary approaches and offer unique windows on to past maritime cultures. An often-overlooked advantage of such research is its potential for tracing and studying the remains of hulls in closed, controlled environments, whether terrestrial or under water. Ports used over long periods and undergoing alluvial aggradation almost inevitably turn into extensive wreck-cemeteries.

The recent research at Yenikapı in Istanbul, conducted as a rescue excavation in the context of a large-scale public work, led to the discovery and excavation of a total of 37 surprisingly well-preserved Byzantine ships, covering a chronological range from the 4th-11th centuries CE (Kocabaş, 2008; 2010; 2012; 2014; 2015). Now, after the systematic study and preliminary publication of some of the wrecks, one might suppose that shipbuilding technology of the Aegean and the Black Seas from that period can hardly hold any new major secrets (Özsait-Kocabaş and Kocabaş, 2008; Pomey *et al.*, 2012: 279-291).

Projects of a scale comparable to that of Yenikapı have never been undertaken in Greece. There are, however, port installations of long-standing historical importance that are still in use in modern times and where conditions favour the preservation of ancient and medieval hulls. The commercial port of the island of Rhodes, in the south-eastern Aegean, falls into this category.

In 2008, a team from the Hellenic Ephorate of Underwater Antiquities (EUA), carrying out a routine survey, identified a half-buried ship there (Figs 1-2). This ship, buried for centuries in sludge deposits, had been partially uncovered by the churning of the huge propellers of cruise ships passing daily and anchoring over its location.

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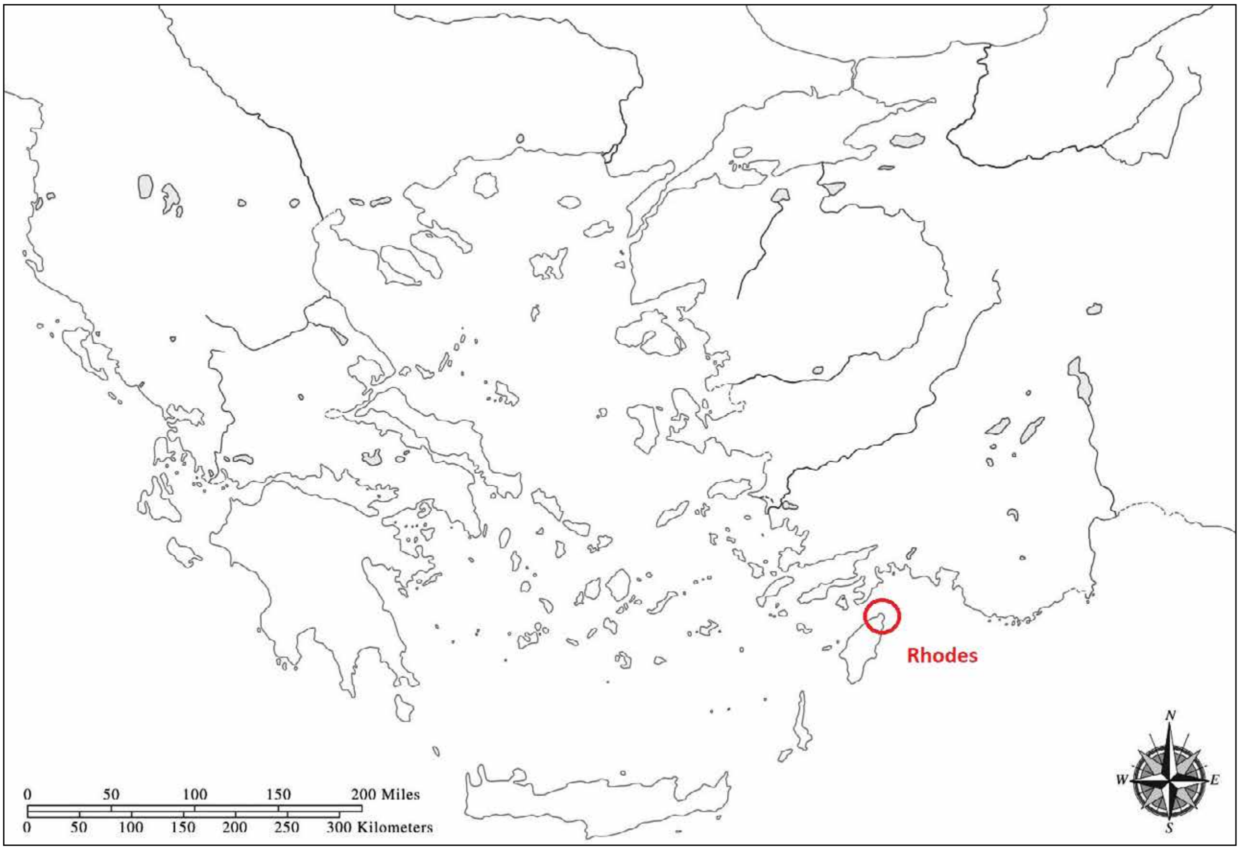

Figure 1. General map of the Aegean, with the island of Rhodes circled (map source: http://iam.classics.unc.edu).

Figure 2. The main pier in the commercial harbour showing the location of Rhodes Wreck No. 4 (Photo Vasilis Mentogiannis, EUA).

Figure 3. Rhodes Wreck No. 4 as located in 2008 (Photo Vasilis Mentogiannis, EUA).

In November 2013, in collaboration with the Technological Educational Institute (TEI) of Athens and with the assistance of the University of the Peloponnese, the EUA partially excavated this historic wreck.

The discovery of Rhodes Wreck No. 4

Rhodes Wreck No. 4 was discovered in April 2008, about 50 m west of the northern part of the main dock of the commercial harbour (Fig. 2), at a water depth of 12-13 m. Unlike two other shipwrecks documented in the same area (Koutsouflakis, 2017: 479-483), Wreck No. 4 was almost entirely buried in the muddy deposits, its presence indicated only by the tips of its frames, which protruded at regular intervals (Fig. 3). These frames were visible along a curved line extending 8.5 m in length, indicating that the underlying structure belonged to one end of a hull. Exposed and half-buried timbers were also abundant in the adjacent areas, some of them of considerable size. A direct association between these members and the newly traced shipwreck was not clear, however, since parts of several other hulls were also lying scattered in the immediate vicinity.

The discovery took place during the last days of the 2008 survey, and team members were already engaged in other tasks, so time for detailed documentation was short. A trial trench was opened between two adjacent frames, to get a first impression of the condition of the wood. Though the exposed extremities of the frames were badly afflicted by *teredo navalis* (Fig. 4), all buried sections were preserved in unusually good condition, with the initial measurements pointing to a ship of large dimensions and particularly robust construction. Two

Figure 4. Side view of a frame in the northern end of the vessel (Photo VasilisMentogiannis, EUA, 2008).

successive frames unearthed at the point at which they curve toward the keel revealed scantlings of 200 mm moulded and a maximum sided measurement of 400 mm. The interval between them measured 230 mm, giving a room to space ratio of almost 1:1. Finally, the uppermost surviving strake of the planking was 120 mm thick, much larger than the average plank thickness of ships of the ancient world (Casson, 1971: 214-216).

Beyond its massive structure, several finds collected during 2008 further indicated that the newly discovered shipwreck was exceptional. A pouch found embedded between the frames was made from a goat pelt and contained white cheese that probably belonged to the ship's provisions (Koutsouflakis, 2017: 484). Several amphora necks and handles from a distinct assemblage were assigned to the Günsenin 3 amphora type, suggesting an approximate date in the 12th-13th centuries CE. This dating was to a certain extent confirmed some months later by the radiocarbon dating of a segment of a frame, which showed a calibrated date between 1020 and 1155 CE (95.4%).[1]

Excavation of Rhodes Wreck No. 4

Despite the 2008 preliminary campaign's highly promising results and a series of subsequent reports on the critical condition of the shipwreck and the constant dangers posed to its integrity, funding for excavation was not available. The crucial next step was made possible only five years later in the framework of the European programme Thales/NSRF 2007-2013, which funded a TEI of Athens project entitled MERMAID – Saving Wood Shipwrecks in the Mediterranean Marine Ecosystems: Research, Development and Application of Innovative Methods of In Situ Protection. This project involved the cooperation of a large number of institutions and individual experts and provided the financial support for a field season between 29/10/2013 and 1/12/2013. Research had to be carried out in winter because the port of Rhodes receives heavy traffic during summer months.

The project's principal investigators unanimously agreed that the shipwreck had to be saved from destruction, but there were no illusions concerning the difficulties involved. Clearly, the hull would not survive long once exposed. On an island with an economy dependant primarily on tourism, local authorities were not willing to close down the port's main quay, which accommodated up to 3000 visitors a day. This, and a lack of previous experience in handling and conserving waterlogged wood on a large scale, plus the absence of basic infrastructure and adequate funding, precluded the option of raising the hull.

Although the purpose of the project was to partly excavate the wreck, document the main characteristics of the ship's construction and offer a 'sustainable' solution for *in situ* preservation that would meet UNESCO requirements, the long-term future of the site looked anything but auspicious. Preservation *in situ*, by whatever method, would buy only a short extension of time.

Ominously, we discovered in 2013 that in the five intervening years since the 2008 campaign the underwater landscape of the wreck-site had undergone dramatic changes due to periodic movements of mud in this commercial harbour. The 2008 level of the seafloor in the area of Rhodes Wreck No. 4 had become heavily silted, with new deposits up to 1.5 m thick. To relocate the vessel, and to access the site at the 2008 level, 120 metric tonnes of mud had to be removed and deposited elsewhere, an operation that caused the loss of eight valuable days.

In contrast to 2008, the section of the hull rediscovered in 2013 and designated for excavation turned out to be the vessel's opposite, southern end, which was covered by a layer of deposits 0.7-1.5 m thick (Fig. 5). Although some of the pottery collected from this overburden could be chronologically related to the underlying shipwreck, the presence of a lot of modern waste showed that almost all the stratified deposit above the ship was disturbed and contaminated.

For the purposes of controlled excavation, a rope-grid was installed on the site, defining a total of 30 squares, each measuring 2 x 2 m. Ultimately, the excavation was extended to a total area of about 90 m^2 and revealed the vessel's two sides converging at its southern end (Fig. 6). Excavation focused mainly on the interior of the hull, while also probing an area of about 1 m wide along the vessel's exterior.

As the excavation proceeded, it became clear that the hull belonged to a commercial ship loaded with a cargo of amphorae. Most of the ship's surviving wooden upper structure was carbonized, revealing the initial cause of the shipwreck – fire. Traces of both extensive and superficial burning were abundant on most of the ship's timbers and almost every portable artefact raised. The bulk of the amphora cargo was found collapsed in the hold, forming a dense, compressed layer of ceramic sherds, 1 m thick (Fig. 7). Not a single amphora was found intact. Indeed, the entire cargo showed traces of long exposure to very high temperatures, which had caused it to shatter into small fragments. The presence of this cargo layer inside the ship blocked access to the ship's underlying hull structures, which we were seeking to document.

Once it was realized that the cargo was homogenous, consisting of a single, well-known type of amphora, several issues had to be considered. Recording, removing,

1 The C14 analysis was conducted by G. Maniatis at the laboratory of archaeometry of the National Centre of Scientific Research Demokritos, Athens in 2008.

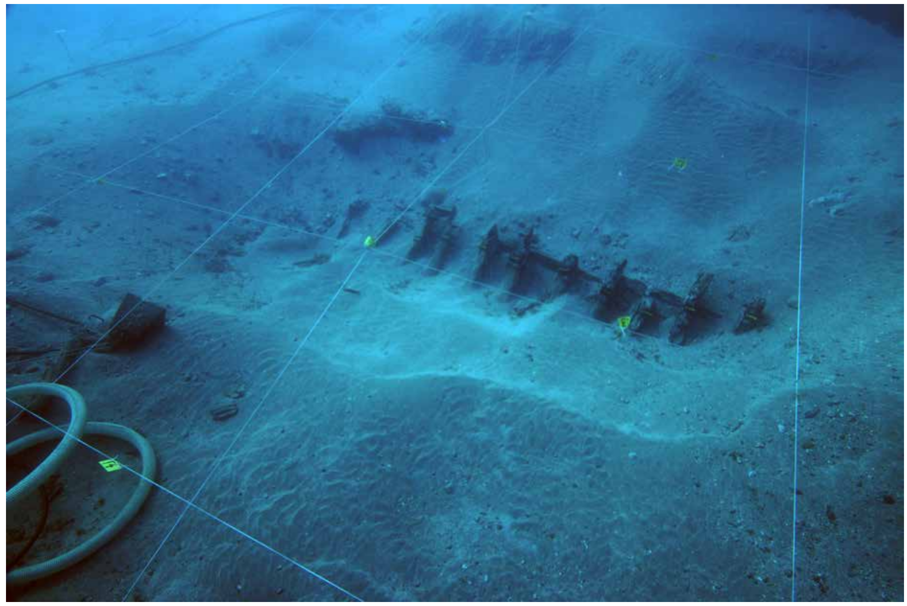

Figure 5. Frames of the eastern side of the wreck discovered after the removal of 1.5 m of sediment (Photo George Koutsouflakis, EUA, 2013).

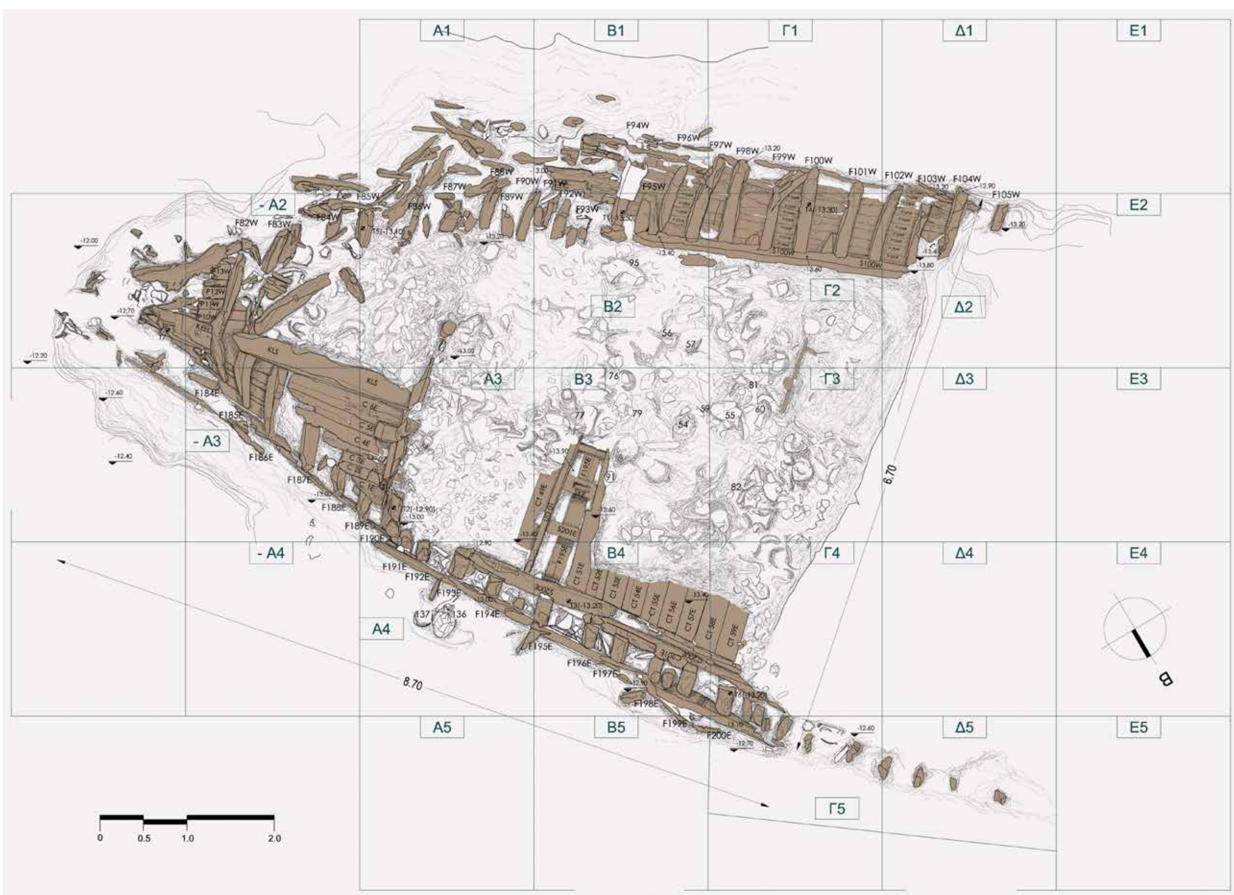

Figure 6. General photogrammetric plan view of Rhodes Wreck No. 4 (Drawing Foteini Vlachaki, EUA, 2013).

and analysing massive amounts of identical shattered amphorae would add little to our knowledge, but would cost valuable time and effort. Much of the cargo stratum, therefore, was rapidly removed in bulk and placed in heaps beside the hull, with subsequent excavation focusing only on the portions of the ship's remains that could provide critical data for its construction.

The hull of the vessel was located at depths ranging from -12.5 m to -14 m, oriented NW-SE, with a deviation from the N-S axis of about 40°. For convenience of

Figure 7. Cargo of shattered amphorae in the hold of the wreck (Photo Vasilis Mentogiannis, EUA, 2013).

reference, the longitudinal axis of the shipwreck was conventionally considered to be N-S.

The excavation proceeded in depth around the S/SE end of the hull (squares -B3, -A2, -A3, A3), along the interior of the southern side of the hull (squares B3, B4 and Γ4) and the western side of the hull (squares B1, Γ1, Δ1, B2, Γ2, Δ2).

Sections of about 25 frames of the western side were revealed along with 30 frames of the eastern side, the inner side of the planking on the western side, sections of a transverse bulkhead that subdivided the end of the ship from the hold area, parts of the keel and keelson on the south side at the end of the vessel, and parts of the transverse timbers that lined the hold on the eastern side. The uncovered parts of the vessel extended to a length of about 8.7 m on the longitudinal axis of the vessel and 6.7 m on the cross axis.

As previously mentioned, a large portion of the ship's southern end was affected by fire. In contrast, no substantial traces of burning had been observed on the northern end of the vessel, previously documented in 2008. The different state of the two ends of the hull perhaps reveals something of the way the fire spread on the vessel or how the ship went down.

The patterns of burning on the southern part of the vessel were uneven. The ship's various timbers showed different degrees of charring, while several timbers remained completely unscathed. The western side of the hull was generally less affected, with charring limited to only the surviving ends of the frames. Lower parts of the hull were intact or displayed only superficial traces of burning. In contrast, the hull's eastern side was affected to a far greater extent, which probably explains why it did not survive to the same height. Even there, however, the fire did not generally extend to parts of the hull below the lowest deck.

The eastern side was the most damaged part of the ship. Here, paradoxically, underlying structures of the bilge displayed traces of carbonization, while adjacent members of the superstructure remained unburned. All these details reported during documentation have helped us to understand that the ship heeled to one side while the fire was still burning. This inclination on the axes of both length and width caused the fire to be quenched first at the northern end and the western side of the vessel, while exposing lower sections of the hull that would normally have been below the waterline. We must take into account, however, that a fire's spread may also have been affected by other factors (wind direction, air circulation inside the vessel, the presence of especially flammable materials etc.).

The cargo

As mentioned above, the bulk of the ship's cargo was found *in situ* within the hull, in the form of a dense deposit of severely fragmentary amphorae (Figs 6-7). This stratum was detected at a greater depth than the surviving portions of the two sides of the vessel – a clear indication that the cargo had collapsed under its own weight directly onto the surface of the hold. All artefacts examined within this layer bore extensive traces of exposure to high temperature: the load probably collapsed and disintegrated as a result of thermal fracturing.

The stratum of fragmentary amphorae was not uniform across the interior of the vessel. South of the transverse bulkhead that isolated the aft-most compartment of the vessel from the main hold (Fig. 6, squares A2-A3), the density of artefacts was much lower. It is hypothesized that this area had not been loaded with cargo and that the crushed material found there had fallen from the hold after the collapse of the upper part of the bulkhead. This conclusion appears to be confirmed by both the inclination of the amphorae layer and the nature of other finds within the confined rear compartment, such as kitchen utensils, tableware, and foodstuffs – all of which suggest that this space had served as a galley or pantry. A similar layout has been attested in the stern of the 7th-century Yassı Ada shipwreck (van Doorninck, 1982: 89).

The amphorae

The main cargo of the shipwreck consists of amphorae identified as one of the many variants of the Günsenin 3 type (Günsenin, 1989: 271-274; 1990: 28-30). In other classifications, the type is also referred to as Group 5 (Bakirtzis, 2003: 80, pl. 20); Saraçhane, type 61 (Hayes, 1992: 76); Mbyz, type 15 (Vroom, 2005: 97-99); Sazanov, Romanchuk, Sedikova, Class 48 (Sazanov *et al.*, 1995); and Sazanov, Type 53 (Sazanov, 1997: 98). No intact specimen was found, but the study of hundreds of diagnostic sherds has shown that all amphorae of the Wreck No. 4 cargo belonged to the same variant of this general type. Dense, combed decoration extends from about mid-shoulder down to a level at about one-third of the amphora's height, then descends further, alternating with an almost imperceptible ribbing, toward the base (Fig. 8). The amphora body exhibits a slight inward curvature at one-third of its height, which tends to give it a somewhat pear-shaped form. This inward curvature creates a kind of 'waist' and recalls a similar feature in the amphorae of the typological classification Group 4 Bakirtzis, from which they are probably descended (Bakirtzis, 2003: 78-80, pl. 19: 2.6). The bases are curved, while the handles, particularly bulky and ellipsoidal in cross-section, emerge at the lower part of the shoulders, rise above the rim, and curve sharply downward to join the long neck just below the rudimentary lip. The neck exhibits a pronounced narrowing at mid-height; the walls are especially thick (up to 12 mm, in some cases); and the clay is coarse, buff-orange in colour, containing a high percentage of non-plastic elements. The average height of the amphorae from Rhodes Wreck No. 4 is estimated at 600-640 mm, while the maximum diameter ranges 220-250 mm.

According to the existing evidence, these amphorae began to appear at the end of the 11th century (Bakirtzis, 2003: 80), with their main period of circulation being the 12th and early 13th centuries (Hayes, 1992: 76). They continued to appear in fewer numbers until the end of the 14th century (Sazanov, 1997: 98). The nature of their contents is not well known. Inside several preserved amphora-bases from Rhodes Wreck No. 4, a solidified, oily, brownish-black substance was observed. Although not yet analysed, it is likely to be some type of resin. It is unclear, however, whether this substance was an added aromatic/preservative in the wine, or was derived from

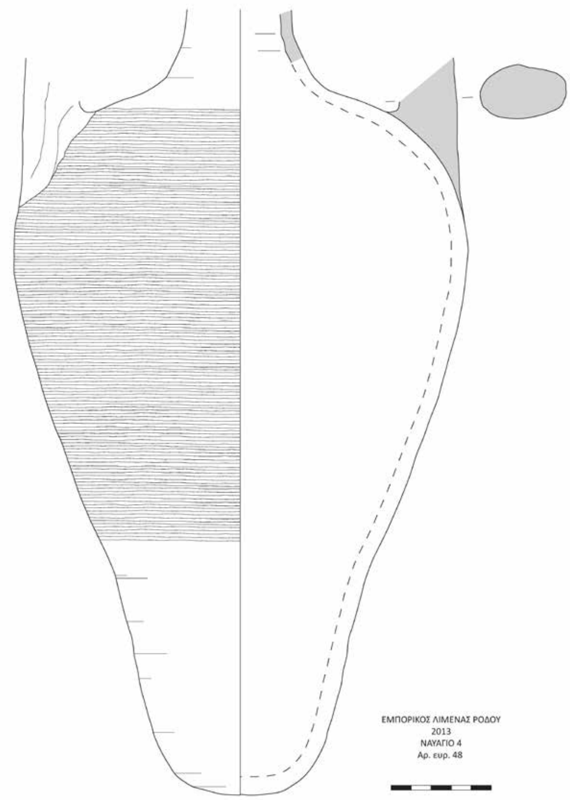

Figure 8. Drawing of Günsenin 3-type amphora from the cargo (Drawing Maria Xanthopoulou, UP).

Figure 9. Wooden amphora lids from the cargo (Photo George Koutsouflakis, EUA).

the amphora's original internal lining, which had flowed into the base. Recent chemical studies of organic residues in amphorae of the same class from Chalkis and Boeotian Thebes have shown that their contents were a fermented product (possibly red wine), but at the same time have identified traces of vegetable oils (Pecci *et al.*, forthcoming).

The origin of Günsenin 3-type amphorae is not known with any certainty. Nevertheless, it was the most common Byzantine amphora type in the Aegean during its floruit and its spatial distribution points to an Aegean origin (Koutsouflakis, forthcoming). At present, the existence of a production site has been confirmed in Chalkis (Kontogiannis *et al.*, forthcoming), but this type's extreme variability in shape, size, and capacity, as well as the large numbers in which it occurs, makes the existence of other production centres quite possible.

A large number of amphora lids, scattered loosely throughout the cargo layer, were also collected. The lids are truncated cones made of pine bark (Fig. 9). Diameters are 37-43 mm. They were obviously seated in the upper part of the amphora neck, and the jar was sealed with some additional malleable or semi-liquid substance, traces of which survive on some of the lids and rims of the amphorae. Similar forms of wooden stoppers have been found in the 9th-century shipwreck in Bozburun, Turkey (Gorham, 2002: 368; Hocker, 2005: 104) and the 11th-century shipwreck in Serçe Limanı (Ward, 2004: 496).

The decorated tableware

Glazed tablewares represent only a very small percentage of the findings raised from Rhodes Wreck No. 4, and if this material is presented here in some detail, it is only because it offers a unique opportunity to narrow the chronological span of the rest of the assemblage, determined so far only by the period of circulation of the Günsenin 3-type amphorae and the radiocarbon chronology of the ship's timbers.

Like the amphora cargo, tableware on board suffered from the fire, with only a small part of the retrieved sherds retaining diagnostic features. In most of the samples, the fire had melted their glaze entirely, erased their engravings and even deformed their shapes almost beyond recognition. Only a handful of fragmentary samples retained enough of their original shape and decoration to allow full typological evaluation. They mostly appeared in the area of the isolated aft compartment, although several sherds were also found in the area of the main cargo. Most of the identifiable sherds belong to plates and ring-based shallow bowls, while several heat-distorted handles indicate the presence of some pitchers. Quantities of individual shapes cannot be determined with any certainty, due to the poor state of preservation of the recovered material. Nevertheless, it is plausible that all tableware should be attributed as galley wares, rather than a secondary consignment that accompanied the main amphora cargo.

All samples presented here belong to the well-defined Fine Style or Incised Sgraffito Wares (Morgan, 1942: 117, 146-147) also known under the generic names Aegean Ware or, most recently, Middle Byzantine Production (MBP) (Waksman *et al.*, 2015).

Two of the most characteristic examples belong to bowls decorated with a central bird framed by floral sprays within a medallion and bordered by a narrow ring of hatched design (Fig. 10). The rendering of the central motif used a combination of the techniques of incised sgraffito, normally dated in the last third of the 12th century, and Champlevé ware, the full blooming of which took place at the very end of that century, or shortly after. The Champlevé technique, however, witnessed an earlier spread in the second half of the 12th century, limited mainly to the rendering of birds in central or peripheral medallions (Sanders, 2003: 389, fig. 23.2.11). A plate from Corinth exhibiting a similar bird has been dated by its stratigraphic relationship to coins of Manuel I Komnenos (1143-1180) to between the years 1170-1200 (Papanikola-Bakirtzi, 1999: 45, nr 30). Several other medallions decorated with birds of the same style, rendered in an imbricated background, are attributed to the Developed Style Sgrafitto Ware, generally dated to the second half of the 12th century (Sanders, 2003: 392-393).

In another example, a partially preserved bird is engraved freely on an empty background, encircled in a simple plait motif (Fig. 11). The bird's body and plumage are rendered by a combination of incised sgraffito and cut-slip technique, a decorative fashion that generally succeeded the earlier Fine Style Incised Sgraffito, with the two wares overlapping chronologically in the last decades of the 12th century. Similar bird decoration, also dated to the late 12th century, is known from Corinth (Morgan, 1942: pl. LI, i), and the Kavalliani shipwreck (Koutsouflakis and Tsompanidis, 2018: 44, fig. 9).

Several other fragments have zones of concentric, peripheral bands, hatched with dense parallel crescents in shallow relief (Fig. 12), a motif also known from the Kavalliani shipwreck material (Koutsouflakis and Tsompanidis, 2018: 42, fig. 5), and from terrestrial assemblages that might extend chronologically to the first decades of the 13th century. Some other fragments, however, bear motifs that should be dated slightly earlier. Floral sprays on an imbricated background (Fig. 13), or peripheral zones of pseudo-Cufic decoration fit well with earlier decorative styles of the third quarter of the 12th century.

In sum, the tableware pottery recovered from Rhodes Wreck No. 4 varies in style, origin, and date. They may constitute a collection of fine ceramics acquired piecemeal, degraded, and eventually incorporated into the ship galley's locker. The latest items suggest a date for

Figure 10. Fragmented and deformed glazed bowl from the stern compartment (Photo Petros Vesyrtzis).

Figure 11. Fragment of bowl decorated with incised sgraffito (Photo PetrosVesyrtzis).

the shipwreck at the end of the 12th or perhaps the very beginning of the 13th century.

Figure 12. Fragments of bowls decorated with zones of short parallel crescents (Photo Petros Vesyrtzis).

Figure 13. Fragment of a shallow bowl, decorated with floral sprays on imbricated background (Photo Petros Vesyrtzis).

The ship's structure

It is important to note that the structural study of Wreck No. 4 was carried out *in situ*, without disassembling constructional elements, except in a very limited number of cases (mainly involving transverse ceiling planks). This disassembly, although only partial and specifically based on certain archaeological questions, has been fundamental in providing answers regarding the hull's structural design. In the same way, the disassembly, even partial, of some planks has proven essential for the study of the planking structure, as well as for making certain observations – for example, regarding the absence or the presence of edge joinery, in particular coaks or dowels.

Our constructional observations on Wreck No. 4 remained primarily external. Consequently, the results of the architectural study of this ship are preliminary and of provisional character (Rieth *et al.*, 2015).

Sectors studied

In a triangular sector (3.26 m long and 3.83 m maximum width) at the southern end of the wreck, only the ship's eastern half was excavated (an area approximately 1.8 m wide) and studied in detail (Fig. 6: squares A3, -A3, -A2).

On the eastern side of the wreck, only the ends of the frames, the upper edges of several planks, and one section of ceiling planks were excavated (10.9 m in length) and

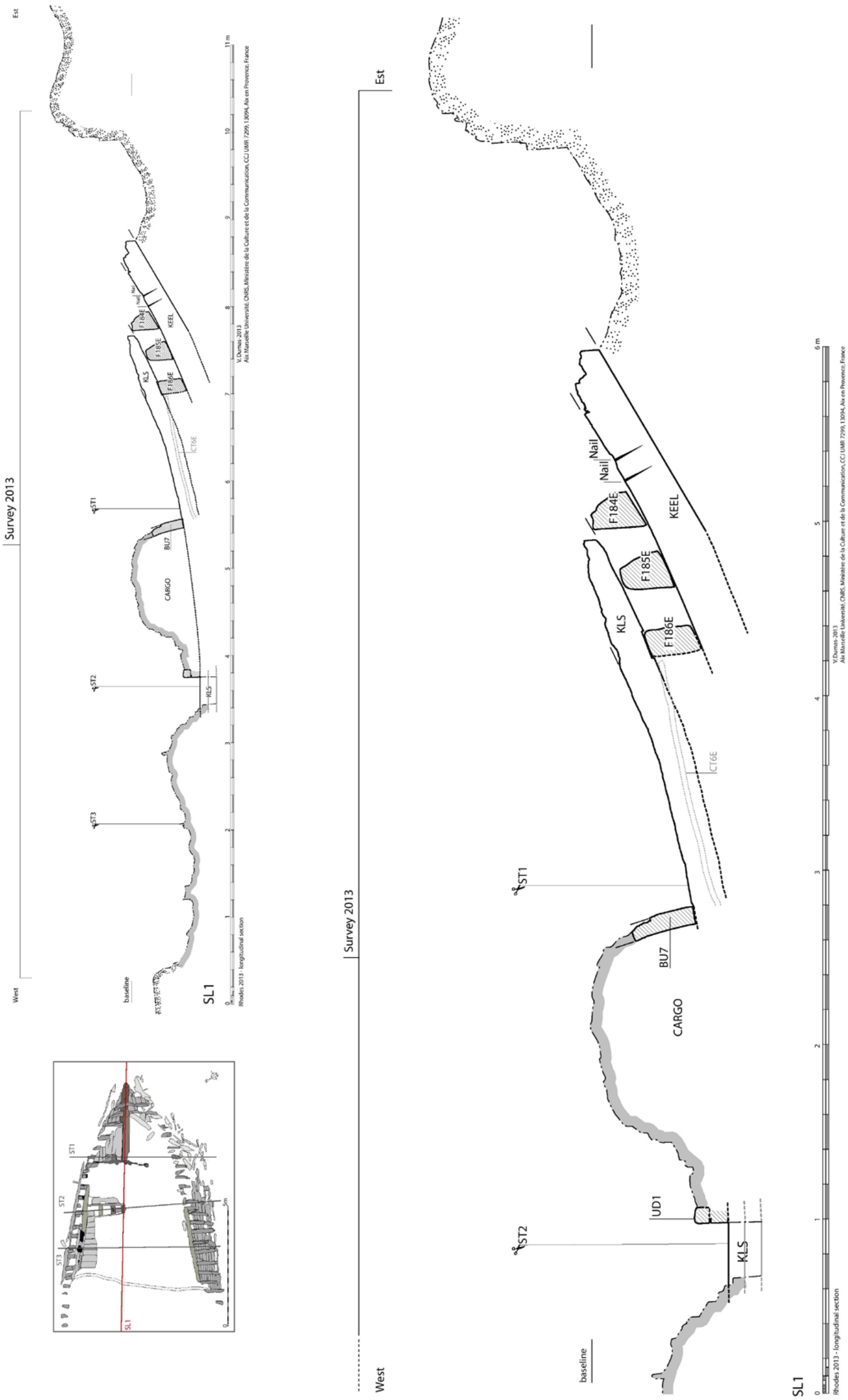

Figure 14. Longitudinal section SL1 (west-east) of the southern end of the wreck. (Drawing Vincent Dumas, CCJ, AMU-CNRS).

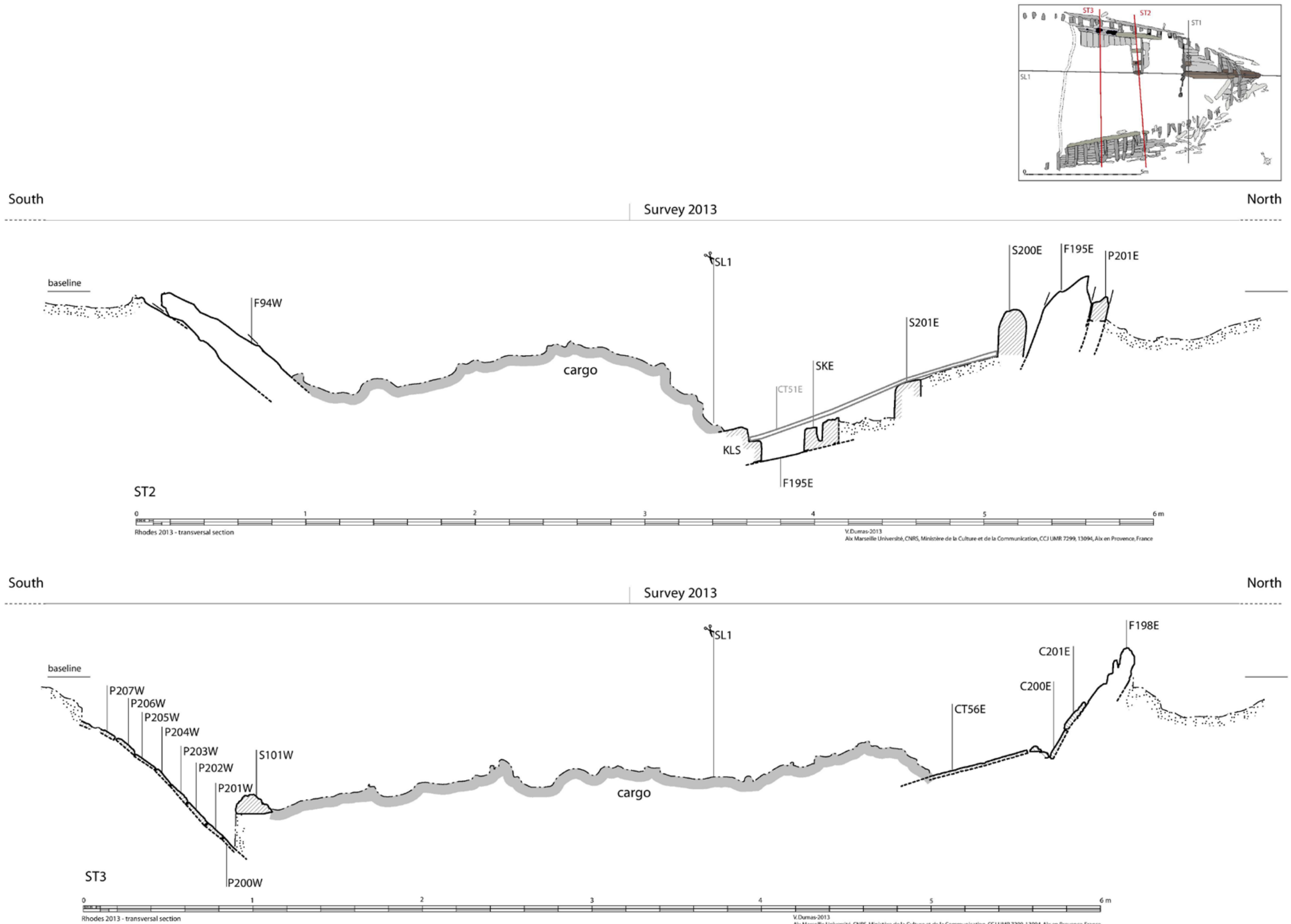

Figure 15. Transverse sections ST1, ST2, ST3 (south-north) of the southern part of the wreck. (Drawing Vincent Dumas, CCJ, AMU-CNRS).

studied in detail (3.40 m in length, between frames F200E and F194E) (Fig. 6, squares A4, B4, Γ4). In addition, a limited probe trench (700 mm wide, 1.2 m deep) was dug in the area north of the transverse bulkhead, following frame F195E and extending as far as the keelson (square B3 in Fig. 6) (Fig. 7).

On the wreck's western side, part of the futtocks (F104W to F90W) and planking (interior face only) was excavated from the upper ends of the frames to the stringer S100W (squares B1, B2, Γ1, Γ2, Δ1, Δ2 in Fig. 6)

Position of the wreck

The recorded longitudinal section SL1 reveals that the wreck is lying relatively flat (Fig. 14). On the contrary, in its transverse view, the wreck slopes from east to west, the value of which is difficult to estimate with precision but which can be defined, at this early stage in the excavation, as 15-20° (Fig. 15). This tilted position of the wreck has two main ramifications. Firstly, the architectural-remains are in different states of preservation: the western half of the wreck appears to have been more deeply buried in sediment and, consequently, is better preserved than the eastern part. Secondly, it seems likely that the wreck is now distorted in its transverse view, and that the two sides are no longer symmetrical.

Figure 16. Southern butt of the keel with a presumed flat scarf (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

Figure 17. Moulded eastern side of the keelson's southern end (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

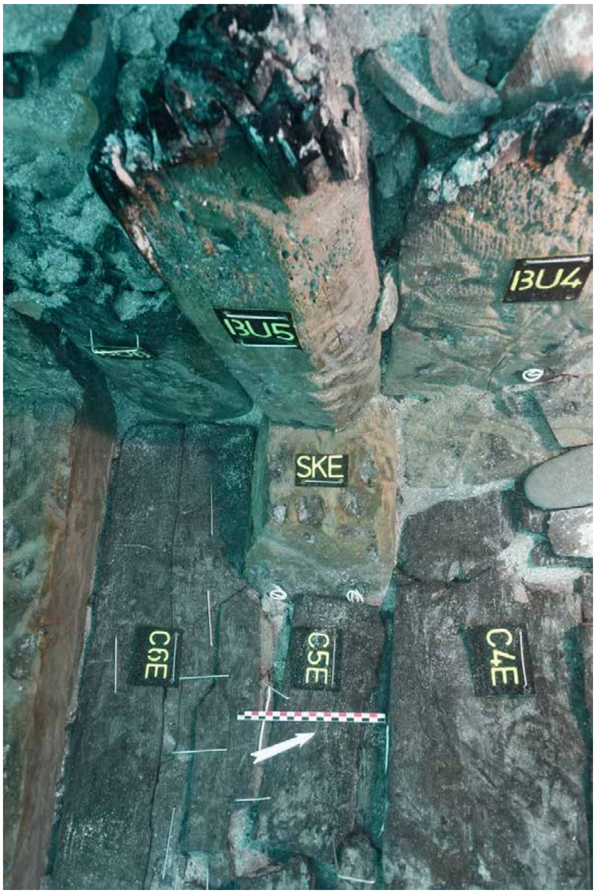

Figure 18. End of the eastern sister keelson (SKE) under the vertical element BU5 (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

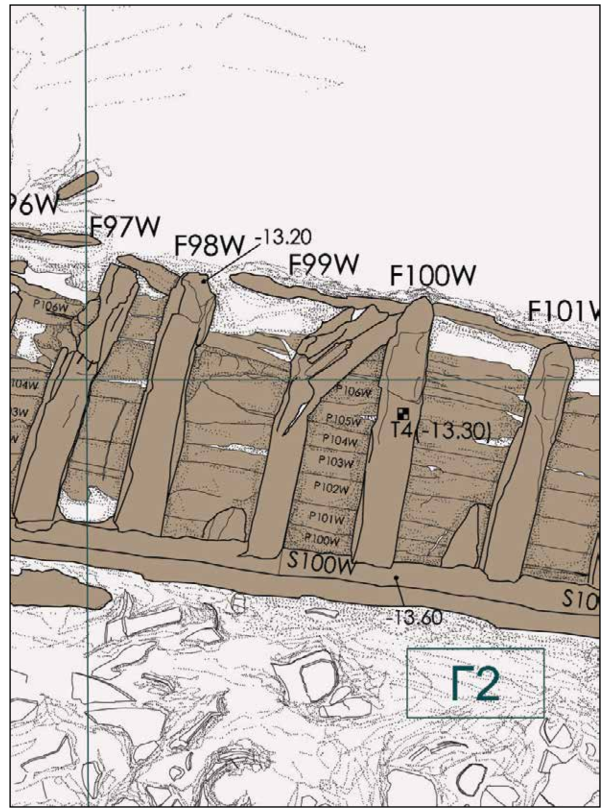

Figure 19. Detail of the photogrammetric view of the wreck along the west side, between futtocks F97W and F101W (Drawing Foteini Vlachaki, EUA).

Figure 20. Room and space between futtock F100W (left) and F101W (right); the two futtocks are notched in stringer S100W (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

Longitudinal structure

Three principal characteristics are to be noted. First, the basic longitudinal structure is composed of a keel (290 mm wide; height unknown) with a rabbet on each side for insertion of the garboard-strake. The southern butt of the keel, which is very badly preserved, seems to end in a scarf intended for the assembly of the stem or sternpost (Fig. 16). The keel is reinforced above by a keelson (average width: 250-280 mm; average height: 210 mm), the under-surface of which appears notched to accommodate the floor-timbers (Fig. 17).

Second, the keel and keelson present a curved profile, which seems to begin at the level of the undetermined transverse piece UD1 (square B3 in Fig. 6) (Fig. 14). In all logic, the curves of the keel and keelson must have been parallel and symmetrical: certainly, they appear to have a significant slope which, in the present state of the preservation of the remains, extends nearly 5 m in length and reached a height (above the lowest presumed underside of the keel) of 1.45 m.

Third, in addition to the main keelson, the hull's longitudinal structure includes two sister-keelsons (190 mm wide; 200 mm high) laid parallel to and 200 mm from the main keelson. Their southern ends finish outside the transverse bulkhead (Fig. 18: SKE).

Frames

There are four principal observations to note concerning the frames. First, the general organization of the frames is based on the principle of laterally joining floor-timbers to futtocks, with futtocks placed on one side of the frame or the other according to their position in the vessel (Figs 19-21). In the eastern half of the wreck, it is not possible to identify precisely if the futtock is placed against the fore or aft moulded face. Following the traditional architectural rules in frame-first construction, the first futtock would be placed on the aft (southern) moulded face of the floor-timber. In the western half of the wreck, it is difficult to determine precisely how

Figure 21. Sided view of frame and futtock overlap on futtock F101W (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

Figure 22. Carvel-planks P10W to P13W, at the level of frame F82W (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

high the framing elements have been preserved – to the first, or second futtock. In the most probable scenario, in which the frames are preserved to the level of the second futtock, it would seem that the traditional framing pattern has generally been respected.

Second, this general frame-timber organization gives a room of 130-150 mm and a space of 280-290 mm. As disassembly was not possible, the actual rhythm could not be determined with certainty. On the wreck's western side, where this is easier to see, the space appears twice the width of the room (Fig. 20). If this rhythm can be confirmed, it would indicate a relatively light arrangement of frames, which would correspond to traditional Mediterranean shipbuilding practices.

Third, as the frames could not be disassembled it could not be ascertained if the timbers are joined with hook scarfs or not. Hook scarfs, called *écart à cadeau* or écart à croc in French post medieval documents, are characteristic of traditional Mediterranean shipbuilding practices. One of the oldest-known examples of this design feature is seen on Culip VI found in Catalonia, Spain, dated to the end of the 13th century (Rieth, 1998). The zone where frames meet can be weak and it is unclear if the Rhodes Wreck No. 4 frame scarfs were fastened with nails or treenails (Fig. 21). This zone is often reinforced by a stringer – here, stringer S100W and undoubtedly also stringer S200E (Fig. 6: squares A4-B4) (Figs 19-20). While primarily reinforcing the frame assembly, the stringers also strengthened the internal longitudinal structure by complementing the main keelson and sister-keelsons.

Fourth, the three rising floor-timbers (F184E, F185E, F186E) at the southern end of the wreck, on the curved part of the keel, have undersides notched over the keel and bevelled (Fig. 16) on both their upper and lower faces (Fig. 22). This bevelling matches the slope of the keel and keelson and kept the floor-timbers perpendicular (not oblique) to the hull's longitudinal axis.

Planking

Carvel (edge-to-edge) planking was observed in two areas: at the wreck's southern end, south of the transverse bulkhead, as well as on the west side, between frames F104W and F94W.

On the west, ten carvel-strakes were preserved (P100W-P110W, Figs 19-21). No external evidence of connections between them was identified during meticulous observation of their inner faces. That does not preclude, of course, the existence of possible joinery on their edges in the form of small dowels (coaks), as in the case of a significant number of the Byzantine vessels of earlier date found at Yenikapı (Kocabaș 2008; 2015; Pulak *et al.*, 2015; Ingram, 2018). These remains of merchant vessels and warships can be interpreted as evidence of various regional shipbuilding traditions, in an historical context of technological transition between the shell-first and frame-first shipbuilding methods (Pomey *et al.*, 2012; 2013).

In the southern part of the wreck, the strakes studied are associated with three frames (F186E, F185E-F83W, F184E-F82W). The four carvel-strake fragments (P10W-P13W) have no evidence of joinery on their edges (Fig. 22). This absence of joinery can be interpreted as an 'architectural fingerprint' of a frame-first construction. As the four eastern carvel-strakes (P10E-P13E) attest, the planking was nailed, probably from the outboard, to the frames, where iron concretions now mark the position of the nails.

An important characteristic of the planking is the progressive reduction in the width of the carvel-strakes, following the hull's changing shape toward the pointed,

Figure 23. Longitudinal ceiling planks C1E-C6E and timbers of the transverse bulkhead (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

Figure 24. Transverse bulkhead (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

Figure 25. Transverse ceiling planks in the area of the hold (Photo Philippe Groscaux, CCJ, AMU-CNRS, 2013).

southern end of the wreck. The butts of two of the western strakes (the garboard P10W; and the second strake, the riboard, P11W) have pointed ends that are seated in the keel rabbet.

Ceiling

The ceiling is made up of two distinct units: longitudinal ceiling behind the southern face of the bulkhead, toward the southern end of the keel, and a transverse ceiling extending from the northern face of the bulkhead toward the north end of the wreck.

The longitudinal ceiling, studied in the eastern half of the wreck, is composed of six planks of varying width, which are badly preserved (Figs 18, 23). The butts of the ceiling planks appear to rest against the bottom of the bulkhead's southern face, except for C5E, which butts against the southern end of the eastern sister keelson (SKE). Only rare points of nailing have been identified. A wooden element of triangular cross-section (UD4) may constitute a kind of filling-piece covering the ends of ceiling planks C4E and C3E (Fig. 24).

One of the remaining questions is the function of the narrow, inclined, planked section, located between the transverse bulkhead and the southern end of the hull. No clearly identifiable pieces of cargo, sailor's kit, or ship's fittings were found in this area. Was this space an equipment locker, an area reserved for cooking, or a cabin to accommodate the crew?

The transverse ceiling was primarily observed in the upper part of the east side, between frames F200E and F194E. This section is composed of 11 ceiling planks, some of which are no longer attached (Fig. 25). Apart from one plank (CT49E, southern, which is comparatively broader, with notched edges), the other ceiling planks were laid out parallel, edge-to-edge, with an average width of 250 mm. These planks, perpendicular to the wreck's longitudinal axis, do not appear to be fixed in place. They would have been easily removable, allowing access to the spaces below, either to clean them or to empty water accumulated there. In fact, after part of this floating ceiling was lifted off, a remarkably well-preserved wooden scoop was discovered underneath (Koutsouflakis, 2017: 496, fig. 24).

The butts of the ceiling planks are supported in two longitudinal half-lap notches: one on the east side of the keelson (KLS) and the other in a longitudinal piece cut in form of a reversed-T comprising two half-lap notches. In the western notch are laid the butts of the ceiling planks, while in the eastern one rests the lower edge of the lateral ceiling plank C200E. Moreover, the ceiling planks are supported on two members of the internal longitudinal structure: the eastern secondary keelson SKS and the stringer S201E. This transverse ceiling planking was apparently intended to receive the cargo, as it is associated with the hold of the ship.

Transverse bulkhead

The transverse bulkhead, preserved to a height of 720 mm, was excavated over a length of almost 1.9 m (between the keelson and the end of the eastern section of floor-timber F190E) (Fig. 23). This bulkhead is composed of a series of vertical elements made up either of boards or stouter, pillar-like wooden pieces (Figs 23-24). Here again, without disassembling the longitudinal ceiling, it was not possible to observe how the base of the bulkhead's vertical elements rested on the bottom of the hull – either directly on the planking's interior face, or on a transverse reinforcement (a sort of bulkhead frame) adjacent to the southern face of the floor-timber F190E. It was observed, however, that the foot of a vertical pillar BU5 is seated on the top of the end of the eastern sister keelson SKE (Fig. 18). In addition, the bottom of the board U1 is laid mainly against the southern moulded face of floor-timber F190E. Probably the same is true for all the boards of the transverse bulkhead.

The transverse bulkhead appears to have played a functional rather than a structural role, as it sections off the narrow, inclined southern end from the ship's cargo hold. One of the best comparative examples is that of the wreck Tantura E, Israel, radiocarbon dated to the 7th-9th centuries (Israeli and Kahanov, 2014). That wreck's construction, following the frame-first principle, exhibits architectural similarities with ships of the Byzantine world, while five ceiling planks display letters of the Greek alphabet carved in their wood. According to Israeli and Kahanov, the transverse bulkhead, of which two vertical elements were preserved, was used to separate the hold and an aft space reserved for the crew (essentially a cabin), or as an aft equipment locker for ship's fittings. Three main characteristics of the Tantura E wreck are similarly found in Rhodes Wreck No. 4. First, the end of the curved keel has a half-lap scarf for the assembly of a piece identified as the sternpost. Secondly, the lower part of the hull reserved for the cargo is equipped with a transverse ceiling. And thirdly, the aft end of the vessel is equipped with a longitudinal ceiling. By comparison with the Tantura E, the southern end of Rhodes Wreck No. 4 can thus be identified as the ship's stern.

Three other Byzantine vessels found at Yenikapı also have transverse bulkheads: YK 11 (7th century), YK 29 (7th-9th century) and YK 31 (9th century). Five additional Yenikapı vessels, YK 3, YK 12, YK 14, YK 20, YK 21, all dated to the 9-10th centuries, likewise present possible archaeological evidence of a bulkhead – grooves cut into the inner face of the frames (Ingram, 2018: 127-129).

Lastly, it can also be noted that transverse bulkheads, in addition to their utilitarian function in subdividing the internal space of a ship, could also play a role in the evaluation of a ship's tonnage, as indicated in the recent study of a Byzantine manuscript of the 13th century, the *Codex Palatinus Graecus 367*. This document, which dates to roughly the same time as Rhodes Wreck No. 4, contains drawings of a merchant ship with a series of holds separated by transverse bulkheads over the full length of the hull. Each of these compartments could be a factor in estimates of tonnage (Harpster and Coureas, 2008).

Timber identification

To determine the type of timber used in building Rhodes Wreck No. 4, five samples of wood were removed for analysis from the keel, keelson, frames F199E and F100W, and transverse bulkhead BU10.[2] They were found to all belong to the *Pinaceae* family and *Pinus* genus, and according to the microscopic structure they are assignable to one of two species of pine – East Mediterranean pine (*Pinus brutia Ten.*; commonly known as Brutia, Turkish, and Calabrian pine) and Aleppo pine (*Pinus halepensis Mill.*) – but are more likely to belong to the former. The geographical distribution of East Mediterranean pine is, as its common name suggests, generally limited to the eastern half of the Mediterranean and today the Brutia species flourishes in central Italy, mainland Greece,

2 The timber identification was conducted by Prof. A. Pournou at the Department of Conservation of Antiquities and Works of Art of the Technological and Educational Institute (TEI) of Athens in 2015.

Anatolia, Crete, Cyprus, and northern Syria (Crivellaro and Schweingruber, 2013: 583).

Conclusions

In summary, Rhodes Wreck No. 4 belongs to an exceptionally large cargo ship of the end of the Middle Byzantine Period, probably the last quarter of the 12th century, which, loaded with a cargo of Günsenin 3-type amphorae, sank at the entrance of the main harbour of Rhodes. Based on the archaeological data, the cause of its sinking was a fire. It is not known, however, whether this fire was due to a naval accident or to some kind of assault. The date of the wreck, in the late 12th-early 13th century CE, is defined by the C14 analysis of the vessel's timbers, the circulation period of its amphorae, as currently understood and, most importantly, the typological assessment of fineware found on board.

Conclusions on ship construction presented here should be considered provisional. Judging from the archaeological data collected during the excavation, the basic principle behind the building of Rhodes Wreck No. 4 was, in all probability, frame-first. Taking into account the ship's date, it reflects the known naval architectural practices of shipyards of the period, both in the western and the eastern Mediterranean. However, given the limitations of the 2013 campaign, which had to be approached much like a rescue excavation, and the fact that certain significant sections of the remains could not be disassembled, in-depth questions concerning the ship's construction methods, such as its construction sequence, could not be addressed, even hypothetically.

One of the distinctive characteristics of the vessel is its large size. Indeed, previously excavated Byzantine wrecks, all dating prior to Rhodes Wreck No. 4, include fishing boats, merchant ships, or warships that generally do not exceed 15 m in length. The archaeological archetype for this eastern Mediterranean class of coasting merchant ship is the 11th-century Byzantine Serçe Limanı (Steffy, 2004), with an overall length of 15.6 m, moulded breadth of 5 m, hold-depth at midships of 1.6 m, and a maximum capacity of about 35 tonnes. Rhodes Wreck No. 4 was a much larger merchant ship with a length probably in the range of 30-35 m. The architectural solutions required for building such a large merchant vessel may have differed from those used in the construction of smaller ships, thus making further investigation of these remains an important priority.

The entire 12th century, according to the range of dates provided by previously studied Byzantine shipwrecks in the Aegean (Koutsouflakis, forthcoming), seems to have witnessed an unprecedented boom in seaborne freight traffic at both a regional and an inter-regional level. This boom was triggered by a general growth of population, a consequent expansion in the size of most urban centres and the availability of new tracts of land for intensive agricultural exploitation, favoured by the internal policy of the Komnenian administration (Hendy, 1985: 85-90, 106-107; Harvey, 1989: ch. 4; Magdalino, 1993: 140-142; Laiou and Morrisson, 2007: 92-93, 101-105, 130-133; Brandejs, 2013: 16-18). Control over the largest part of Asia Minor was gradually lost and the economic interests of the Byzantine Empire shifted toward mainland Greece. At the same time, the 12th century saw an ever-growing economic infiltration of foreign powers, mainly the Republic of Venice, which, under the continuous concession of the Byzantine court, came to play a leading role in the economic life of the central and regional markets (Jacoby, 1994; 2017: 643-646).

Rhodes Wreck No. 4 probably began its journey at one of the major ports of mainland Greece, perhaps Chalkis, Corinth, or even Athens, since all of these cities enjoyed strong ties with their agricultural hinterlands and featured pottery workshops that catered to the needs of seaborne trade. Contrary to the itineraries of other, previously discovered carriers of the same era with similar cargo, which appear to have crossed the northern Aegean on their way to Thessaloniki and Constantinople (Koutsouflakis, forthcoming), this ship seems to have departed for the markets of the southern Aegean and possibly those further east, in the direction of Cyprus and the Levant.

The size of Wreck No. 4 and the uniformity of its cargo indicate the existence of a flourishing economy at the time of its last voyage, while several other Byzantine wrecks, spread along the coasts of Lycia, Cilicia, Syria, and Palestine, reveal that the east-to-west sea lanes were open (Philotheou and Michailidou, 1986; Parker, 1992: nos 1136, 1191; Doğer and Özdas, 2016).

In addition to the historic value of Rhodes Wreck No. 4, its discovery is equally important for the history of shipbuilding, as it attests a period that, until now, has been a 'blank slate' since no other hull remains of this date have been excavated, thus far. Shipwrecks at Yenikapı Istanbul, are dated no later than the 11th century, by which time the Theodosian harbour had become dysfunctional and was abandoned. Evidence for the 11th century is further strengthened by the fully excavated shipwreck at Serçe Limanı in Turkey – indeed, not far from Rhodes (Steffy, 2004). Despite the abundance of shipwrecks of the Komnenian Period (1081-1185), none has provided evidence of Byzantine hull construction. Even the Çamaltı Burnu wreck, dated to the first half of the 13th century, had fragmentary remains that provided minimal information about its construction (Günsenin, 2005: 122-123).

For all of these reasons, Rhodes Wreck No. 4 appears to be a site of major archaeological interest both for Rhodes itself and for medieval seafaring in the eastern Mediterranean, one which certainly deserves to be the focus of an ambitious international programme of excavation that would uncover its remaining secrets.

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The Construction of the *Ma'agan Mikhael II* Ship

Deborah Cvikel and Avner Hillman***

The Ma'agan Mikhael ship, dated to 400 BCE, was built shell-first, with keel and endposts assembled first, and then the planks connected edge-to-edge by mortise-and-tenon joints to form the shell, and finally, the frames fastened to the planking by double-clenched copper nails. Because of the significance of the archaeological find, the remains were completely excavated, retrieved from the seabed, and conserved, and are now on display at the Hecht Museum at the University of Haifa. The construction of a sailing replica took two years (2014–2016), using the techniques of the ancient shipwrights. This was a challenging task that provided essential information on ancient shipbuilding techniques.

Keywords: Ma'agan Mikhael ship, replica, shell-first.

The Ma'agan Mikhael shipwreck was discovered in 1985, 70 m from the shoreline of Kibbutz Ma'agan Mikhael, 30 km south of Haifa, on Israel's Mediterranean coast. It was found at a water depth of 1.5 m and buried under a 1.5-m-thick layer of sand. Three seasons of underwater excavations were carried out at the site during autumn 1988 (49 days) and spring and autumn 1989 (52 and 94 days respectively) by the Leon Recanati Institute for Maritime Studies at the University of Haifa, with the late Dr Elisha Linder as project head, and Jay Rosloff of Texas A&M University leading the excavation team. The surviving timbers, which occupied a space 11.15 m long, 3.11 m wide and 1.5 m deep, comprised a considerable fraction of the original hull. The surviving hull components were the keel, false keel, and central stringer, parts of 14 full frames, sections of strakes – 12 on the starboard side and 7 on the port side – the mast step, knees in the stem and stern, and various internal components. These timbers were of Turkish pine (*Pinus brutia*), except for the tenons, pegs, and false keel, which were of oak (*Quercus* spp.) (Kahanov, 2003: 53-113; Kahanov, 2011: 162-163; Kahanov and Pomey, 2004: 6-13).

The hull had a wineglass-shaped cross-section, and was built by the shell-first method – the keel and endposts were assembled, the hull planks were joined edge-to-edge by pegged mortise-and-tenon joints, creating the outer shell, and the frames were then fixed to the hull with double-clenched copper nails. It also had sewing at the bow and stern, which was a Greek shipbuilding tradition well attested in both Aegean and Phocaean contexts. In addition to the hull remains, the excavators retrieved: 12.5 tonnes of stone, mostly blue schist with some gabbro (basalt), laid on a bed of dunnage; some 70 items of pottery; a one-armed wooden anchor; a whetstone; several sizes of ropes of various plant fibres; decorative wooden artefacts; food remains; a lead ingot; and a basket of carpenter's tools, which included bow drills, rulers and a square,

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Figure 1. The re-assembled Ma'agan Mikhael ship at the Hecht Museum (Photo Alexander Efremov).

wooden nails, and ready-to-use tenons (Kahanov, 2011: 162-163; Kahanov and Pomey, 2004).

The ship has been dated to about 400 BCE by C14 analysis and the typology of the ceramic finds (Artzy and Lyon, 2003). The origin of the timber has been identified as the western coast of Asia Minor (Hillman and Liphschitz, 2004). The source of the blue schist was the island of Euboea, near Athens, and the gabbro was from Cyprus (Shimron and Avigad, 2003), while the origin of most of the pottery vessels was Cyprus or the Levant, although some items were East Greek from Asia Minor (Artzy and Lyon, 2003). The finds made it possible to reconstruct some facets of daily life on board, although not to definitively identify the origin of the ship or its ports-of-call since tools and objects were traded from place to place.

After the ship and its contents were completely excavated, it was dismantled under water and the timber sections retrieved from the seabed and studied in the laboratory of the Leon Recanati Institute. The hull timbers were conserved at the laboratory, and the hull was re-assembled at the University of Haifa, where it is now on display in the Hecht Museum (Fig. 1) (Kahanov, 2011: 163-167; Segal *et al.*, 2009; Votruba, 2004). The late Professor Yaacov Kahanov of the Leon Recanati Institute for Maritime Studies directed the conservation, research, and reconstruction of the ship.

Why build a sailing replica?

A replica can be defined as a correct three-dimensional reconstruction of a previously existing vessel in both form and material structure (Gillmer, 1990: 207). Building a sailing replica in the framework of experimental archaeology can provide valuable information concerning the shipbuilding techniques and methods, wood resources used, manpower needed, and time devoted to the construction. Once the ship is completed, sailing abilities, handling, and rigging can be tested (Coates *et al.*, 1995: 293; Goodburn, 1993: 200-201).

Only three replicas of shipwrecks nearly contemporary with the Ma'agan Mikhael have been constructed. *Kyrenia II* is a replica of the 3rd-century-BCE Kyrenia shipwreck. It was built in 1981 at the Psarros shipyard in Piraeus, Greece (Katzev and Katzev, 1989; Steffy, 1989; Steffy, 1994: 42-59). This replica is now on display in the Thalassa Museum, Ayia Napa, Cyprus. *Kyrenia Liberty* was built in Cyprus according to the hull lines of the Kyrenia shipwreck, but constructed frame-first without planking edge-fasteners, using modern methods and technologies. This vessel is operational and is sailed regularly. *Gyptis*, a replica of the sewn Jules-Verne 9 shipwreck dated to the turn of the 6th century BCE, was built in a shipyard in Marseilles, France, and launched in 2013 (Pomey, 2017; Pomey and Poveda, 2018; Pomey and Boetto, 2019: 24–26).

From the moment the Ma'agan Mikhael ship was discovered and its significance understood, the aim was to produce a sailing replica. The motivation was basically the research aspect – to discover the practical secrets of the construction of the ancient ship, to understand its sailing abilities and behaviour at sea, and to learn about life on board (Ben Zeev *et al.*, 2009: 1; Kahanov, 2011: 169). The original inspiration for the project came from the late Dr Elisha Linder, who was succeeded by the late Professor Yaacov Kahanov.

The methodological approach toward a reconstruction of the original hull lines of the Ma'agan Mikhael ship was 'minimum reconstruction' (Crumlin-Pedersen and McGrail, 2006: 56-57). The original hull lines were reconstructed based on the remains of the ship's timbers, using computer-aided design and scale models. Missing information about the ship was gleaned from the iconography of the period, such as ceramics, graffiti, and clay models of the 6th and 5th centuries BCE, and from reconstructions of contemporary shipwrecks, such as Kyrenia and Jules-Verne 7.

Building the *Ma'agan Mikhael II*

As reconstructed on paper, the original vessel was a single-masted sailing merchantman, about 14.4 m overall length, with a beam of 4.24 m over frames, and 2.6 m depth amidships. It had 18 strakes, including three wales. Fully loaded with a cargo capacity of 15.9 tonnes, it displaced 22.9 tonnes, at a draught of 1.4 m (Ben Zeev *et al.,* 2009).

The project became viable at the beginning of 2014 after a generous private donation. Several additional donors and volunteers moved the project forward, and the keel-laying ceremony took place in July 2014. As suggested by Crumlin-Pedersen and McGrail (2006: 53), the team comprised an independent, interdisciplinary group of experienced nautical archaeologists, experienced carpenters, naval and civilian ship architects, and other craftsmen and experienced sailors, all united and driven by the desire to build a full-scale sailing replica of the Ma'agan Mikhael ship. The ship was built at the Nautical Officers School at Akko, Israel and students of the University of Haifa, cadets from the Nautical Officers School, Sea Scouts, volunteers, and people from the community were involved in formal and informal activities connected with the construction of the replica, gaining first-hand experience of different aspects of ancient shipbuilding techniques.

The archaeological evidence served as the primary source of information. All the components were recorded down to the smallest detail, such as wood grain, knots, nails, and the like. Wood from the same tree species as in the original ship was used. Forty-two trunks of Turkish pine (*Pinus brutia),* supplied by the Jewish National Fund (KKL) from planted forests in the Galilee, were used for the keel, frames, endposts, mast step, knees, stringers, and planking. Planks were cut from straight trunks, and frames were cut from trunks and branches that grew naturally in the shapes required to match the curves of individual frames. Two oak trunks (*Quercus* spp), obtained from commercial timber merchants, supplied the false keel, treenails, and tenons. Natural oak timber for the ship's anchor was obtained from a privately owned stand, with permission from the authorities, as required by law. Two cypress (*Cupressus* sp.) trunks were used for the mast and spare mast, and the yard was made of pine.

In building the replica, the carpenters used chisels, mallets, hand saws, planes, and measuring, scribing, and marking tools similar to those used by the ancient shipwrights. Some ancient tools, such as the bow drill and adze, were reproduced by the replica team to test and experience working methods as similar as possible to those of the 5th-century-BCE shipwrights. However, where a feature was repeated without any complications, modern electrical tools such as a band saw, drills, and even a mortise-cutting machine were used. Planking was cut to the required thickness in a commercial sawmill.

Several aspects of the project are of fundamental and practical interest and are described below.

The keel and endposts

The 8.26 m-long keel was made of a single piece of timber and had a rectangular cross-section (Kahanov, 2003: 54). It was the first hull component the carpenters worked on. However, the keel had to be re-made because it did not precisely match the archaeological find: the reproduction was cut straight, whereas the original was slightly rockered (45 mm amidships). This mismatch of only a few centimetres prevented the endposts from fitting correctly. In addition, probably as a result of lack of experience, the keel was not fixed in position, and it warped. A second, rockered keel was fashioned to replace it.

In order to find two large pine branches for the endposts, templates were made, one with an angle of 49° for the stem, and the other with an angle of 57° for the sternpost. The endposts were worked and affixed to the ends of the keel using scarfs, each locked with a single tenon. The false keel was made of three oak timbers connected by simple tongue-like scarfs without pegs and affixed to the bottom of the keel and endposts by mortise-and-tenon joints.

The planking

All the planks were installed in the same direction of growth of the tree, with the concave side of the rings (the core of the tree) facing the inside of the hull, as the original timbers had been (Hillman and Liphschitz, 2004: 151). The full-scale archaeological drawings were copied onto the two-dimensional planks (Fig. 2). Length, width,

Figure 2. Y. Kahanov and carpenter Avihay Ismann copying an archaeological drawing onto a plank (Photo A. Efremov).

Figure 3. Bending the hull planks: a) the timber boiler in operation, with the Old City of Akko in the background (Photo A. Efremov); b) the hot plank is taken to the hull (Photo A. Hillman); and c) installing a plank using temporary tenons and clamps (Photo A. Efremov).

thickness, and scarfs were kept as close as possible to the original. The planks were 45 mm thick – except for strake 2, which was 60 mm thick – and were shaped in three dimensions: strakes 2, 3, and 4 were bent and twisted by about 70º-80º: nearly vertical at the endposts, and almost horizontal amidships. The strakes above the garboard were each made of two planks, connected by scarfs, and laid so that the direction of growth was from stern to bow, as in the original ship (Hillman and Liphschitz, 2004: 154). The planks were connected to the keel and to each other by mortise-and-tenon joints, spaced 130 mm centre-to-centre, requiring 70-80 joints per strake.

The main concern was how to control the cross-section of the hull – how the hull planks were shaped in three dimensions, and how the symmetry between the two sides of the hull was maintained. Several measures were taken in order to keep the replica's cross-section as close as possible to that of the original ship, as described below.

The hull planks were manufactured based on the archaeological data and were as similar as possible to the originals. A procedure for bending the hull planks was adopted as follows: after soaking in fresh water for about three days, the plank was heated in a 9.5 m-long steam pipe for several hours. Then the hot plank was taken to the hull and bent into shape using temporary tenons, several types of lever, and clamps (Fig. 3). The plank was then left to dry in position for about four days, and was then adjusted precisely (to within 2 mm) to fit the adjacent plank. When this was achieved, a full set of oak tenons was installed, each made to fit a matching pair of mortises in adjacent planks. When they all fitted well, the tenons were locked in their mortises by oak pegs. Finally, the outboard surface of the plank was smoothed with a plane.

The mortises cut in adjacent planks were of equal lengths in both strakes, the only exception being strake 2. Because of the angle at which it was set, the mortises cut in this strake were shorter than those in the adjacent strakes (the garboard and strake 3). Moreover, whereas in the original ship the wider, tapered ends of most pegs were located inside the hull (Kahanov, 2003: 86–88), the peg holes of the replica were drilled from the outboard, using an electric drill, and the 8 mm-diameter pegs were driven in from outside.

Throughout the construction of the hull, the angle of deadrise was constantly checked and monitored; angles were taken from the archaeological evidence and from the re-assembled hull. The garboards were connected to the keel without rabbets but fitted into rabbets in the endposts (Kahanov, 2003: 55–56, 73–75). It became clear that these endpost rabbets were an essential carpentry feature – the angle of the mortises decreased toward the ends of the keel, and it was impossible to make a mortise at an angle of less than 28° to the side of the keel. The angles of mortises cut in the keel varied from about 45° amidships, to almost vertical at the endposts, requiring a varying thickness of the garboard along the edge abutting the keel. After a full-scale experiment, the ends of the garboards were shaped in a steam box. However, this gave rise to the feeling that the bending forces were excessive. The installation of the wales was a challenge since they were thicker (90 mm) than the regular hull planking.

The timbers were seasoned for various periods, from a few weeks to more than a year. Timbers were monitored before, during, and after preparation and installation to determine the effects of variations in ambient temperature, humidity, and heat treatment on moisture content and the workability of the wood.

As work progressed and with experience, the time for construction of a strake became shorter: from 121 working days for the starboard garboard to 15 days for strake 18 on the port side. The average time for the production of a strake, from its initial cutting to shape to final installation, was 42 working days.

Mortise-and-tenon joints

In his lecture at the 14th ISBSA conference in Gdansk in 2015, Professor Kahanov raised the issue of documenting mortise-and-tenon joints in shipwrecks. Mortise-and-tenon dimensions recorded in shipwrecks are generally reported as average or typical dimensions, and this misses some of the complexity in understanding the method and practice of building the hull. When two planks are in the same plane, mortises and tenons can be long, for example near the ends – in the Ma'agan Mikhael ship up to 110 mm. When planks are at an angle to one another, mainly near midships, mortises and tenons must be significantly shorter, down to 50 mm. Thus analyses of mortise-and-tenon joints in future studies should refer to their positions in the hull to give fuller information. In building the replica, each mortise cut in a plank was measured and given a number which corresponded to its specific tenon (Fig. 4). This procedure ensured as close a match as possible between the seams.

Sewing

The hull of the Ma'agan Mikhael ship was sewn only at the bow and stern. After the planking was installed, knees were put in place and nailed to the keel and endposts. The adjacent planks were sewn to the knees and the keel, and also to the endposts, at least up to strake 4. The sewing pattern of the Ma'agan Mikhael ship is evidence of a unique Greek technological tradition of sewn shipbuilding that existed in the Mediterranean in the 6th-5th centuries BCE (Kahanov, 2003: 64–71; Kahanov, 2004; Kahanov and Pomey, 2004: 11–13). This technique was used in the replica. One volunteer – a highly skilled retired chief engineer – was introduced to the sewing with only a very basic explanation, and was given liberty to research and apply it to the hull. He made a 1:1 scale model and then used the same techniques on the hull. One of the interesting points is that he prepared the cutting of the tetrahedral recesses by drawing three marks for each recess on the inner surface of the knees and hull planks (Fig. 5). The marks for the recesses he produced are similar to those of the Jules-Verne 9 shipwreck from Marseilles (Kahanov, 2004: 54–55; Kahanov and Pomey, 2004: 15–16; Pomey, 2001: 425–427; Pomey and Boetto, 2019: 26).

Once the three marks were drawn, the recesses were cut by chisels of various sizes, which created a tetrahedral recess. The sewing holes were made using a 6 mm

Figure 4. Detail of the third starboard wale showing corresponding numbers of the mortise-and-tenon joints (Photo A. Efremov).

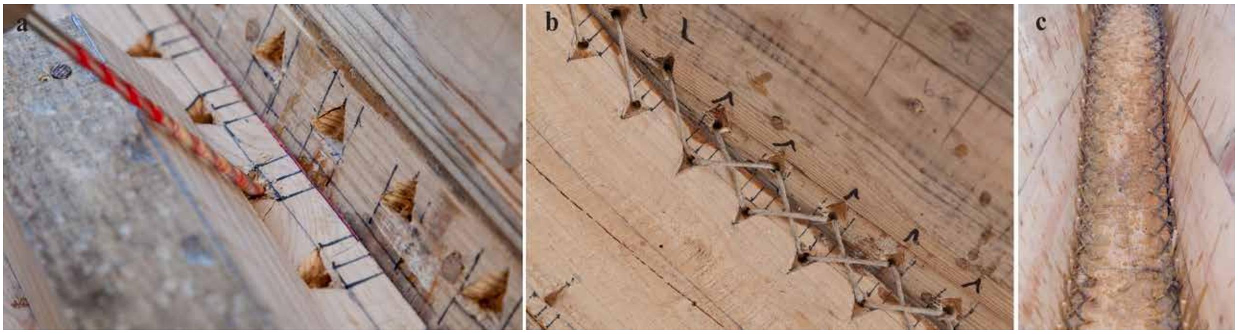

Figure 5. Sewing of the hull: a) drilling the sewing holes from inside the hull at an angle of 45° to the surface of the knee; b) the cord threaded through the sewing holes; and c) the bow knee (Photo A. Efremov).

drill from inside the hull at an angle of 45° to the surface of the knee (Fig. 5a), and the drilled holes typically met about 10 mm in from the outer surface of the plank, preventing exposure of the cords. The cords passed twice through the holes, once for each diagonal, as was done in the original ship. About 40 m of 3 mm-diameter flax cord was used for the sewing (Fig. 5b). After the cords were threaded, the sewing holes were sealed with pine plugs (Fig. 5c). Thanks to the experience gained while practising on the 1:1 scale model, no significant difficulties were encountered while sewing the bow and stern of the replica hull.

Figure 6. The frames, a view from bow to stern (Photo A. Efremov).

Frames

Parts of 14 full frames survived in the Ma'agan Mikhael ship, comprising floor-timbers and futtocks, which were hook-scarfed together in the same vertical plane, and two top-timbers (Kahanov, 2003: 88). However, since the replica was longer than the archaeological find, three additional frames were added: two at the bow and one at the stern, making 17 frames in all. About 70 naturally curved branches were chosen in the forest to fit templates corresponding to the shapes of the floor-timbers, futtocks, and top-timbers. As the archaeological data had not survived above a short section of strake 12, the futtocks were left as high (long) as the natural timber allowed. When extended above the gunwale, the futtocks and top-timbers served for the rails, or as a basis for bitts for hawsers or mooring lines.

Floor-timbers and futtocks were installed from strakes 6 and 7. As in the Ma'agan Mikhael ship, the frames of the replica were not nailed to the keel. Each futtock was fastened to the floor-timber by a hook scarf locked by three to five square-cross-section, oak treenails driven from the top surface into round holes. Copper nails used to connect the frames to the hull planks were hammered through the scarfs and secured them in the same way as in the original ship (Kahanov, 2003: 91-92). The top-timbers started at about strake 9 and continued upward. They were nailed to the hull planks using double-clenched copper nails in a herringbone pattern (across the grain) to prevent the wood from splitting (Fig. 6).

Copper nails

The copper nails connecting the frames to the planks were 145-270 mm long, with an average square cross-section of 5.6 mm (Kahanov *et al.*, 1999: 279, 282). When building the replica, it became evident that producing and driving the copper nails was more complex than initially assumed. The shank had to be hard enough, but its end sufficiently flexible to allow double clenching. Based on the composition of the original nails, and taking into account the fact that they were intensively hammered, a wrought high-conductivity C11000 copper containing 99.96 wt% Cu with excellent cold-working ability was chosen to simulate the material of the original nails. The replica nails were made using traditional methods by a coppersmith in the replica shipshed in Akko. A special furnace, heated by compressed gas, with temperature control up to 1000°C, was built for this purpose. The coppersmith's steel tools included tongs, an anvil, and a set of hammers. The dimensions of the nails – length, head, and cross-section of the shank – were as close as possible to the original. The coppersmith hammered and

Figure 7. The copper nails: a) coppersmith Igor Shteiman with a newly made nail; and b) double clenching a nail over the inside surface of a frame (Photo A. Efremov).

Figure 8. Coating the hull: a) beeswax and pine resin (Photo A. Efremov); b) the boiling mixture (Photo A. Efremov); and c) Zeev Blass painting the underside of the hull with the black mixture (Photo John Tresman).

annealed the copper blank into shape. The total time needed to manufacture each nail, including its head, was 20-30 minutes (Cvikel *et al.*, 2017). As in the original ship, the frames were fastened to the planks by drilling a pilot hole through the plank and the frame from outside the hull, followed by hammering a nail through both timbers (Fig. 7) that was double clenched on the inside surface of the frame in a herringbone pattern, in the direction of the keel.

Protecting the hull

No caulking remains were evident in the shipwreck. Apparently, the wood absorbed the seawater and expanded so the seams became sealed, and thus the hull became watertight. However, the hull timbers were found to be coated with a composition of pine resin mixed with esparto wax or beeswax (Glastrup and Padfield, 2004). As esparto wax was not available, beeswax was used in combination with pine resin at a 1:1 ratio, and all the hull components of the replica were coated with this mixture (Figs 8a and 8b). Under the waterline, charcoal powder was added to this mixture giving the underside of the hull its dark colour (Fig. 8c). In addition, where the seams were found to be more than 2 mm wide, a traditional caulking material (*Desmostachya bipinnata*) was also used. The hull proved to be practically watertight after absorbing water.

Decks

No archaeological data exist regarding decking, although the four stanchions found imply its existence (Kahanov, 2003: 104, 126, note 29). An analysis was made based on iconography (Ben Zeev *et al.*, 2009), the replicas of the Kyrenia (Katzev and Katzev, 1989: 171-172; Steffy, 1994: 52), and Jules-Verne 7 and 9 (Pomey, 2003; Pomey, 2017; Pomey and Poveda, 2018), and consideration was given to hull strength. Partial decks were installed fore and aft: the foredeck is used for handling the anchor and manoeuvring, and the poop for the helmsman: both are used for mooring and for the crew while sailing. The decks were slightly cambered to enable easy draining, and they were connected by walkways along both sides of the hull, leaving a rectangular opening to the hold (Fig. 9). There was no evidence for walkways on the original Ma'agan

Figure 9. A view from stern to bow during construction showing the slightly cambered decks and the walkways connecting them. In the rectangular opening in the hold the crossbeams and mast step can be seen. The extended futtocks and top-timbers serve for the rails and as a base for bitts for hawsers or mooring lines (Photo A. Efremov).

Figure 10. The reconstructed mast step assembly during construction. Pipes of the bilge pump are seen in the foreground (Photo J. Tresman).

Figure 11. The 10.6 m-long mast being carried to the ship by cadets from the Nautical Officers School led by skipper Yochai Palzur (Photo A. Efremov).

Figure 12. The quarter-rudders: a) a schema (Drawing Ofer Zahavi); b) the port rudder and its attachment to the hull; and c) a closer view of the port rudder (Photo Nimrod Gluckman).

Mikhael ship, but the 7th–5th century BCE Amathus Model 2 (Ben Zeev *et al.*, 2009: 12–14) has this feature, which would have been necessary for passage between the bow and stern.

Masting and rigging

Apart from the mast step and some toggles, no archaeological evidence of the mast, yard, sail, or rigging has survived (Kahanov, 2003: 99–106). These were reconstructed based on iconography (*e.g.* Basch, 1987; Ben Zeev *et al.*, 2009) and replicas of nearly contemporary ships such as the *Kyrenia II* (Katzev and Katzev, 1989: 172, 173–174), *Kyrenia Liberty*, and the Jules-Verne 9 wreck (Pomey, 2003; Pomey, 2017; Pomey and Poveda, 2018) (Fig. 10). The 10.6 m-long mast was made of cypress (*Cupressus* sp.), tapering from 200 mm diameter at its base to 140 mm at its top (Fig. 11). The yard was made of three round cross-section, overlapping, pine timbers lashed together. The central piece was 120 mm in diameter and 6.7 m long, while the two side-timbers were each 95 mm in diameter and 5 m long.

The reconstruction of the ship suggests that the original had one square sail. A 6 × 10 m sail was fabricated from synthetic fabric (Dacron), with a sisal bolt-rope to protect it from tearing. Dacron was chosen as a durable practice-sail, given our lack of experience in handling a square sail, and sisal rope was chosen because it is made of natural fibre and is easily available. The sail has two sheets used for trimming it to the wind, and ten brails are used for reefing and furling. To control the yard, two braces are used; one halyard and two lifts are led from deck level to the masthead.

Steering system

As no evidence of the steering system was found in the shipwreck, it was decided to rely on the iconography of the period in order to design and build it. Thus, the ship is steered by two quarter-rudders, one on each side of the stern. Each 3.65 m-long rudder was made of commercial pine timbers (Fig. 12a). The rudders were mounted on a crossbeam 1.9 m long, 200 mm wide, and 110 mm thick, inserted into recesses cut between wales 1 and 2 on both sides of the stern. The crossbeam was fastened to frame 1 using copper nails. This allowed a firm mounting point for the rudder shaft. The upper end of the shaft was lashed to the ship's rail about 1 m from the stern to allow the rudder to rotate and to leave enough space for steering. A quick-release lashing of the shaft to the crossbeam allows the crew to switch rapidly between quarter-rudders while manoeuvring and docking (Figs 12b and 12c).

Figure 13. The completed replica ship in November 2016 (Photo A. Efremov).

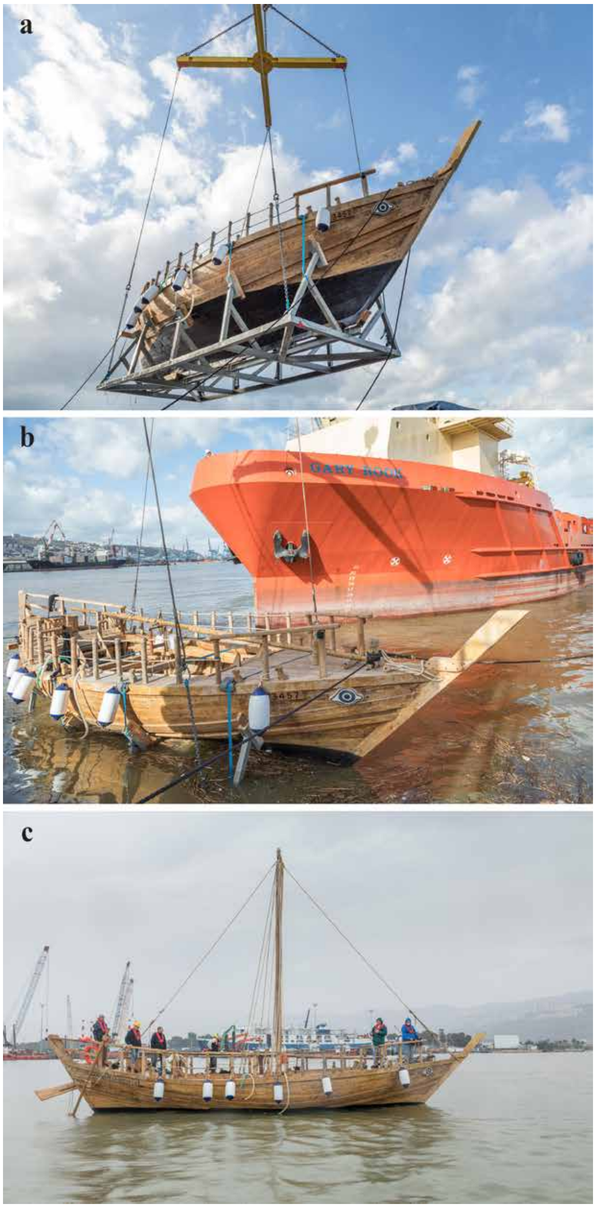

Figure 14. The replica, December 16, 2016: a) between sky and sea; b) lowered into the sea at Israel Shipyards; and c) towed to a temporary mooring at the Kishon Marina, Haifa (Photo A. Efremov).

Completion of the construction

Construction was completed in November 2016 (Fig. 13). The final dimensions of the replica are 16.6 m overall length, with a beam of 4.3 m over frames. The ship has been rigged with a mast carrying a single square sail. The replica was lowered into the water in the Israel Shipyards dry dock on 16 December 2016 and towed to its temporary mooring at the Kishon Marina in Haifa (Fig. 14). The official launch ceremony took place on 17 March 2017, and the ship was named *Ma'agan Mikhael II*. After the ship arrived at the Kishon in December 2016, its hydrostatic characteristics were tested and found to comply with present-day requirements for stability and seaworthiness. This allowed the ship to receive its sailing permit from the Ministry of Transport, and the replica team to carry out a series of sailings in Haifa Bay and along the Israeli coast. The goal of these sailings was to acquaint the crew with the ship, handling the square sail and quarter-rudders, and manoeuvring and anchoring (Fig. 15).

Shell-first or frame-based?

The main questions arising throughout the project concerned the general concept, detailed design, the construction process and its sequence, and the integrity of the hull. J. Richard Steffy, referring to the Kyrenia ship (1994: 48), wrote:

> There were nine bottom strakes on each side [...] probably the shipwright put in some of the frames as soon as the bottom planking was completed, although he could have erected all of the planking before installing any frames. No permanent frames could have been installed before six strakes were in place on each side and probably not before all nine bottom strakes were completed.

The analysis made by Steffy describes the questions and difficulties in this aspect: shell-first or frame-based and, more specifically, exactly when frames were introduced into the hull. Seán McGrail (1997: 77) argued that:

> Strictly speaking, these definitions apply only to the extreme cases of 'pure shell' when the entire planked hull is built before any framing is added, and 'pure skeleton' when the shape of the entire hull is determined by a full framework which is erected before any planking is added. Examples of both forms of building are known. However, the real world is more complex, and there are so-called 'intermediate' or 'alternating' forms used by builders who may be either 'plank-oriented' or 'frame-oriented'.

The problems and challenges faced by the ancient shipwrights arose when reproducing the components of the hull and fitting them together. The builders of the Ma'agan Mikhael replica followed the shell-first principles and method in an attempt to replicate the archaeological data. However, there were some major problems and questions: the ancient secrets of building a 'shell-first' hull with mortise-and-tenon joints are not known, because the technology, know-how, and tradition have been lost. Replicating the archaeological find turned out to be more difficult than building a new hull without

Figure 15. Ma'agan Mikhael II under sail (Photo A. Efremov).

archaeological constraints. The carpenters of the replica did not have the freedom that the original Greek shipwrights enjoyed in making decisions as to the dimensions and shapes of components, or other aspects of construction.

The archaeological information of the planking was complete up to strake 3 on both sides. From strake 4 and upwards the information decreased as the remains became shorter and shorter, which forced the builders to make decisions in extrapolating the missing parts. One well-known traditional technique for defining the form of the hull is the use of battens, but battens need frames. Practically, it was found that above about strake 6 matching planking to frames gave the best result in replicating the archaeological data. Therefore, from strakes 6 and 7 floor-timbers and futtocks were installed. Thus, up to strakes 6 and 7, the hull was built shell-first, and the floor-timbers were shaped to match the installed strakes. From strakes 6 and 7 the dimensions of the planks were dictated by the frames – as far as they survived, and also by battens corresponding to missing frames and the reconstructed hull lines. Planking fastening was continued using mortise-and-tenon joints.

When building the replica, drilling the holes for the wooden tenon pegs from strake 6 and upward left traces on the outer faces of the frames. This is contrary to the evidence from the original Ma'agan Mikhael ship, where these traces were not apparent on the frames. Hence evidence from the construction of the replica supports the conclusion that the frames of the Ma'agan Mikhael ship were installed after the shell was completed. This is yet another proof that the Ma'agan Mikhael ship was built solely shell-first.

Conclusions

The significance of the Ma'agan Mikhael replica project is in the practical construction of an ancient ship. Although shipbuilding in antiquity has been researched and studied for 70 years, the only way to gain an in-depth understanding of ancient ship construction is by actually doing it. Although the archaeological evidence was well understood, putting it into practice was difficult, and the steep learning curve demanded meticulous work, trial and error, and patience.

Building the sailing replica of the Ma'agan Mikhael ship is the final stage in this generation-long research project. This was the first project of its kind to be carried out in Israel and is among the very few which have been implemented anywhere. Based on the archaeological data, an attempt has been made to trace lost knowledge – the ancient technology and shipbuilding tradition. However, the construction of the hull is only a part of the project, since the archaeological study will be completed only by sailing, navigating, and practical research of the ship's capabilities at sea.

Acknowledgements

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HARBOURS

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Patara's Harbour

New evidence and indications with an overview of the sequence of harbour-related defence systems

Erkan Dündar and Mustafa Koçak***

The sheltered natural bay was crucial to the settlement at Patara, in Lycia, as it became an important harbour city. Alluvial infilling of the harbour and the sacking of the town in 1362 led to Patara's abandonment. Recent studies show the harbour became a *limen kleistos* in the late 4th century BCE when it was enclosed by a seawall, and there is evidence of military shipsheds of the same date on the western shore of the inner harbour. The promontory to the west of the inner harbour had a medieval *castrum*, while Tepecik settlement was the site of the earliest harbour-related defensive structures.

Keywords: Patara, Lycia, harbour, fortification, limen kleistos, shipsheds.

Patara, one of the important harbour cities of southwestern Anatolia, was the gateway to the sea from the Xanthos valley in western Lycia, the location of major cities such as Xanthos, Pinara, and Tlos. The earliest finds from Patara date from the 3rd millennium BCE and were unearthed on Tepecik hill (30 m), a natural rock ridge north of the city centre, to the east of the inner harbour (for EBA II ceramics, see Işık, 2000: 6, fig. 5). The data concerning the most recent settlement was obtained from the medieval city lying to the south of the inner harbour (Işık, 2011: 99-101).

The naturally sheltered bay, used as a harbour, was doubtless the most significant factor regarding the foundation of Patara as a settlement, and the loss of the harbour was undoubtedly a leading factor in the abandonment of the town (Figs 1 and 2). The city had no hinterland that could supply agricultural products.[1] With settlement dating back to the early 3rd millennium BCE, the natural bay was used as a harbour or a safe mooring but later, as a result of the accumulation of silt brought by the Xanthos river, *c.*5 km west of the bay, the harbour gradually filled in, becoming a swamp from late in the 14th century CE, with the port and city largely abandoned by the mid 15th century CE (Öner, 1999; Duggan, 2010; İşkan and Koçak, 2014).

Patara had a strategic location on the eastern Mediterranean maritime routes, with sea routes to the east and the west, north and the south intersecting here. The geopolitical location of the city left traces in written sources (Diod. Sic. 19.64.5-8; 20.93.3-4). Being suitable for a naval base, the harbour of Patara witnessed many struggles between the prominent powers of the Mediterranean including the Hecatomnids, Antigonids, Ptolemaic, and Seleucid kingdoms, especially from the 4th century BCE. Although the

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1 Today, the situation is different: the silting of the Xanthos delta created a fertile farmland now covered with greenhouses.

in: Demesticha, S. and Blue, L. *et al.* (eds) 2020, *Under the Mediterranean I. Studies in Maritime Archaeology*, Leiden: Sidestone Press, pp. 127-146.

Figure 1. Aerial view of Patara with the silted harbour bay (@ Patara Excavation Archive).

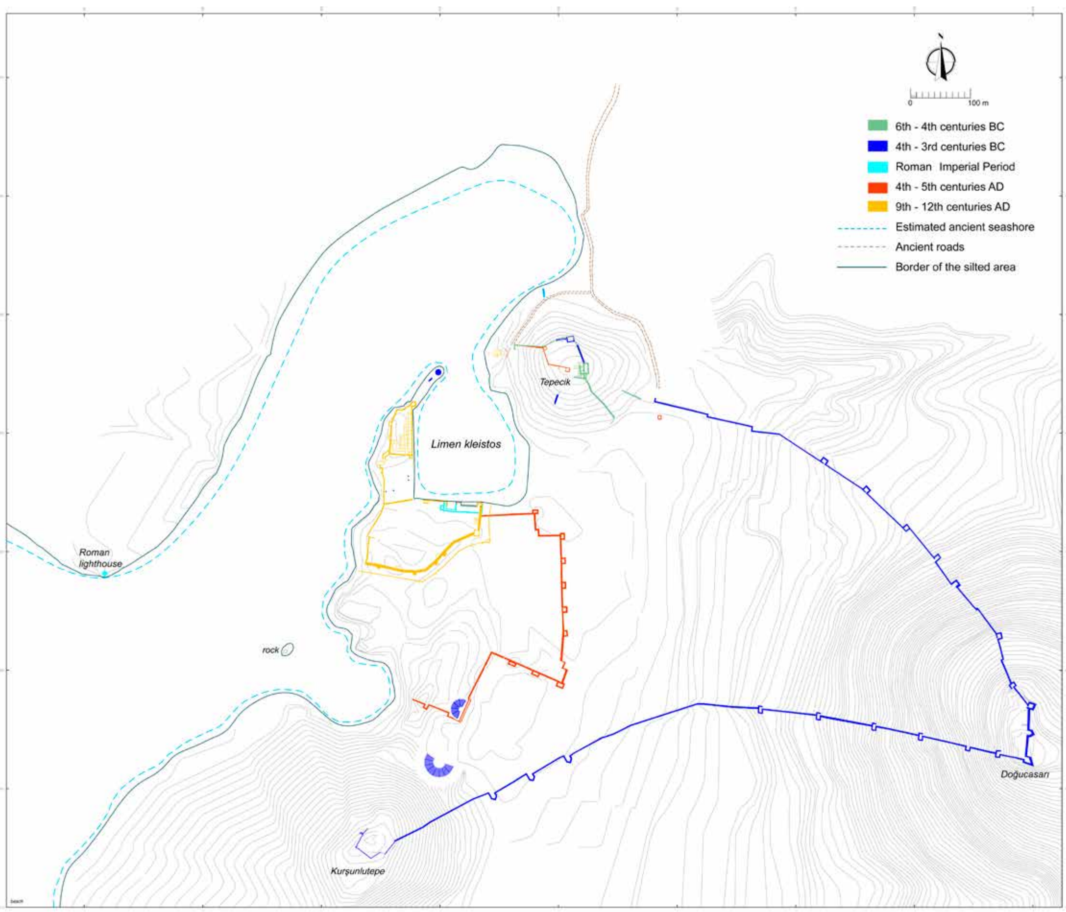

Figure 2. City plan of Patara (@ Patara Excavation Archive).

military prominence of the city seems to have diminished during the period of the *Pax Romana*, its strong logistic position in the region was maintained with the construction of its Imperial lighthouse (İşkan, 2019: 302-317) and Hadrianic *horrea* (Koçak, 2016b: 87-92). Patara obtained military prominence again in the Late Antique period, under the Byzantine (East Roman) Empire and under the Seljuks of Anatolia (The Seljuks of Rum) and into the Beylik period (Foss, 1994: 14-16; Duggan, 2010).

Late Archaic and Early Classical period (6th-5th centuries BCE)

Recent studies indicate that Tepecik, in the north of the city, which overlooks both the harbour and the land route that reaches the city from the north, played an important role in the control and defence of the harbour (Dündar, 2016: 43-44; Dündar and Rauh, 2017: 572) (Figs 2-4). The earliest remains of the defence system date from the 6th century BCE; a cyclopean fortification wall, the width of which ranges approximately 2-2.5 m. It begins with a tower (T14) on the northwestern side of Tepecik, adjacent to the harbour (Becks, 2011: 5) (Figs 4-5). This tower also controls the secondary road leading towards Tepecik from the north. In the wall that reaches the summit of Tepecik from the tower to the east, there is a door roughly 1.5 m wide to control pedestrian traffic: this door allows passage to the flat area of Tepecik via a series of steps (Fig. 6). On the east side of the door, the wall protrudes 5 m to the north before turning to the east. Thereby the door was concealed by the wall to the east, and from any threats from the northern road. Continuing to the east, the wall follows the topography on the flat top of the hill and extends to the south. This wall is connected to a building complex near the top of the hill which can be termed the 'Tower House'. This Tower House, the walls of which are around 2.4 m wide, has a sequential plan extending from north to south, including a succession of two rooms and one cellar (Işın, 2010: 93-104) (Figs 4, 7). The excavations conducted to date have not been able to show the presence of any other towers, apart from the defence tower by the harbour on the northwest slope of the hill. In this respect, it seems probable that the defence in the east of Tepecik during this period was provided by this noteworthy structure. The structures that seem most closely related to this building, unique in its dimensions to date, are in the region of Lycia at Avşar Tepesi (Zagaba) (Thomsen, 2002: 76-78) and, in the region of Caria, the Fortress of Alâzeytin Kalesi (Syangela) (Radt, 1970: 27). These examples date from the 6th and 5th centuries BCE.

The wall from the Tower House to the southwest extends for 86 m in a straight line to the foot of Tepecik

Figure 3. Aerial view of Tepecik settlement seen from the northeast (@ Patara Excavation Archive).

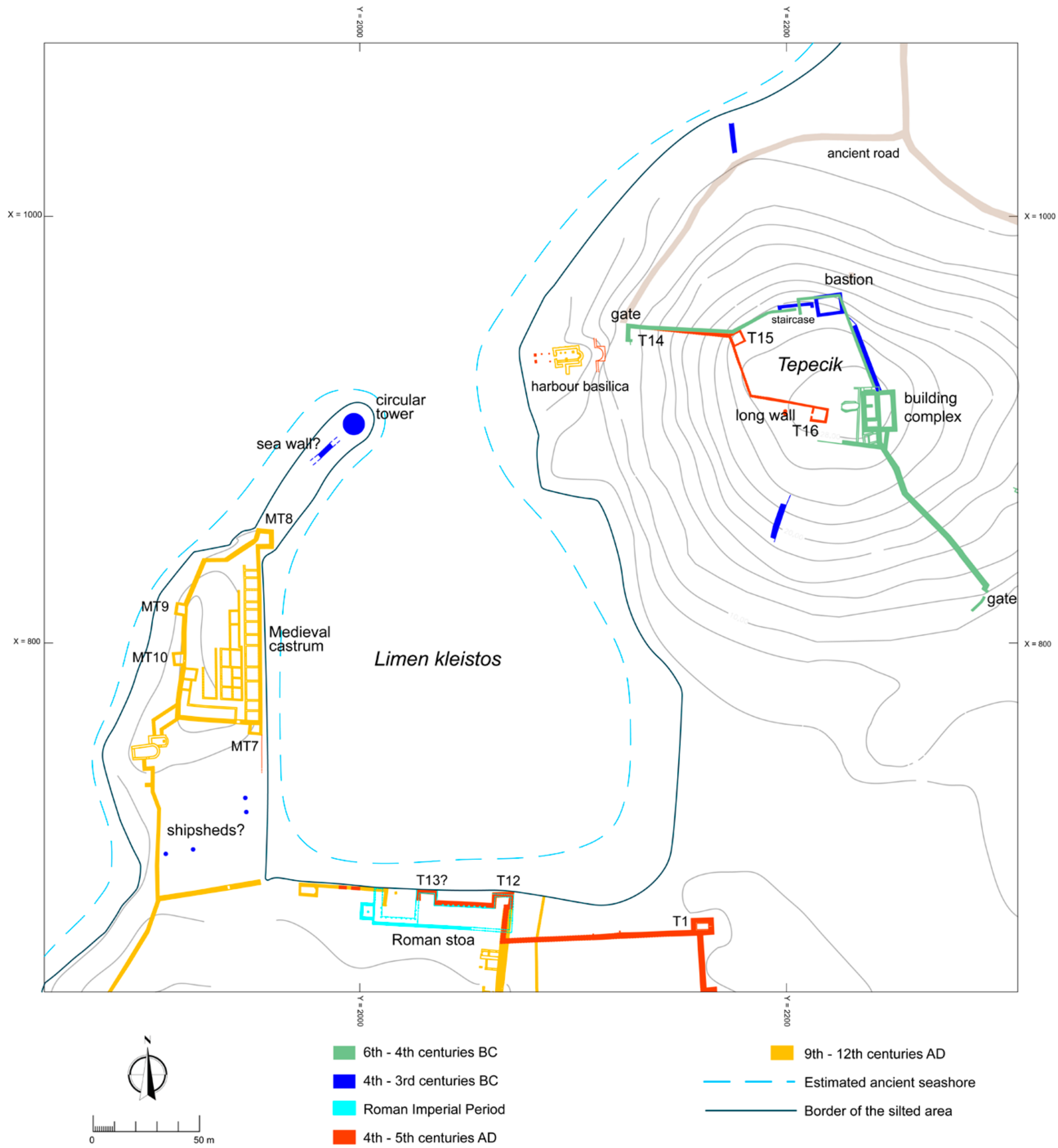

Figure 4. Plan of Tepecik settlement and the inner harbour: Roman stoa in red; (@ Patara Excavation Archive).

Figure 5. The 6th-century BCE tower on the west slope of Tepecik settlement (@ Patara Excavation Archive).

Figure 6. The 6th century BCE gate and steps leading to the top of the Tepecik settlement (@ Patara Excavation Archive).

Figure 7. The remains of a 'Tower House' on the top of the Tepecik settlement (@ Patara Excavation Archive).

and is divided by another gate, 2.4 m wide (Figs 4, 8). It is thought that the wall extending to the southwest beyond this gate was connected to the harbour. The wall that excludes the northern and eastern sides of Tepecik surrounds only the western and southern sides connected to the harbour and encloses an area of approximately 7.5 hectares. Thus, even if the defence of the harbour was not directly and actively provided from here, effective control through surveillance was exercised, in particular from the tower on the slope. Whether there were defensive structures on the promontory, which at this time extended 150 m along the northern part of the inner harbour and, if so, what form these took, are among the questions to be answered by research in forthcoming excavation seasons. It seems reasonable to suggest that not all, but at least some, of the 50 warships (Diodorus suggests 40 ships (Diod. Sic. 11.3.7)) that were sent by the Lycians to the Persian navy to fight in the sea battle of Salamis in 480 BCE (Herodotus, 7.92.1) were deployed from the harbour of Patara.[2] If this were the case, it is most probable that the inner harbour at that time had a military character.

2 Simply because the Pataran harbour is the only known harbour of the Xanthos valley capable of serving strong cities of that time such as Xanthos, Tlos, Pinara, and Patara.

Figure 8. The 6th-century BCE gate on the southwest slope of the Tepecik settlement (@ Patara Excavation Archive).

Late Classical and Hellenistic times (4th-1st centuries BCE)

Excavations in 2009 and 2013 in the north bastion, overlooking the main road into the city, to the north of the plateau of Tepecik, showed a new defence system constructed in the mid 4th century BCE. This defence system provided important new data about the defensive model used for many sites – not just Patara, but throughout southwestern Anatolia (Figs 4, 9). The find context and a lead sling-bullet inscribed Ἀλεξάνδρου-Φιλίππου (of Alexander, [son] of Philip) that was unearthed from the north bastion indicate the area was used by a garrison and that the north bastion may have been destroyed as a result of an assault in the course of the campaign in Lycia by Alexander the Great in 334 BCE (Dündar and Rauh, 2017). In the context of this find, the excavations in the bastion and by the north wall have provided important new criteria for the dating of the defence systems in southwest Anatolia. The masonry technique used for these two buildings (the north bastion and the north wall) and some defence systems in various parts of the city can, in consequence, be dated to the mid 4th century BCE. It is also possible to generalize from this identification and dating of the wall styles to other defensive structures in the area. The similarity between the masonry technique of the Tepecik north bastion, on the north wall, and that of some defence systems on Doğucasarı hill (elevation 180 m), which is the tallest hill to the east, shows the presence of freestanding bastions before the arrival of Alexander the Great or his forces. However, the masonry technique used for these buildings differs from that of the 'Hellenistic' walls surrounding the city and shows that these walls were constructed after the construction of the freestanding bastions (Dündar and Rauh, 2017: 571-572).

Lycian cities, ruled by the local dynasties under Persian control from 546-544 BCE (Bryce, 1983: 31-42; 1986: 100-101) participated, like many city-states in western Anatolia, in a rebellion that put the Persians in a difficult situation in 366-360 BCE (Diod. Sic. 16.74; Childs, 1981: 77-78; Weiskopf, 1989: 68). The leader of this uprising in the Lycian region was Pericles, who declared himself the king of Lycia. Following the failure of Pericles and the other rebels in about 360 BCE, the administration of Patara, like all the Lycian cities, was left to Hekatomnos, the satrap of Caria (Diod. Sic. 16.74; Childs, 1981: 77-78; Bryce, 1983: 39-40; 1986: 114; Weiskopf, 1989: 68). In this context, it is possible to say that the freestanding bastions located on Tepecik in the

Figure 9. North bastion and north wall on the Tepecik settlement (@ Patara Excavation Archive).

north of the city, in Doğucarası in the east, and perhaps on Kurşunlutepe (64 m) to the south, were constructed by the Hecatomnid dynasty, which for a short time ruled the city and region on behalf of the Persians. The construction of the bastions at Patara was possibly the result of a Hekatomnid decision to impose a garrison on the settlement and have control over the harbour (Dündar and Rauh, 2017: 572).

Similar freestanding bastions, built to protect and control the harbour, also existed at Kaunos. There, Schmaltz studied freestanding bastions dated, like those at Patara, to the late 4th century BCE (Schmaltz, 1994: 188, 192-201). There are important historical accounts in respect to the Kaunos bastions – Diodorus recounts that when Antigonus Monophthalmus attacked Kaunos in 313 BCE, although the whole city was conquered, the place called 'ἄκρα' overlooking the city was besieged but could not be reached or taken (Diod. Sic. 19.75.5, 20.27.2). It is also known that Ptolemy I attacked Kaunos in 309 BCE and that he, like Antigonus Monophthalmus, was able to attack the city without difficulty but that his forces experienced strong resistance from the two bastions named 'Heraklion' and 'Persikon'. It is recorded that one of these bastions was captured by the Ptolemaic forces, and the other surrendered to them. Identifying these two bastions through proper names indicates that they were the type of places that acquired individual place names and that they were in different places to the area termed *akra* in the attack by Antigonos Monophthalmus. Thus, we can understand that at least three freestanding bastions controlled the harbour in Kaunos, as we have suggested in respect to Patara (Dündar and Rauh, 2017). The fact that the forces of Antigonus Monophthalmus and Ptolemy could attack Kaunos without difficulty whenever they wished indicates that walls had not yet been constructed to surround the city and that the defence was conducted only by the Hecatomnid/Persian soldiers in the bastions (military garrisons).[3] It seems that Patara would also have been defended by troops in the bastions.

It is known that Ptolemy I Soter's effect on the area was short lived: he seized Antigonus Monophthalmus' garrison at Xanthos in Lycia with his navy via the harbour of Patara in 309 BCE (Diodosius Siculus, 19.64.5; Polyainos, 3.16) but Antigonos' son, Demetrius Poliorcetes, regained control of Patara soon after. It seems most unlikely that the city walls of Patara or other places in southwestern Anatolia, dated to the Hellenistic period, were constructed by the Ptolemaic forces within such a short period, perhaps a matter of only months.

Seawall and tower

In 305 or 304 BCE, Demetrius Poliorcetes' ships in the harbour of Patara were attacked by the Rhodian Menedemus; Menedemus set an anchored ship on fire, and also seized many cargo ships carrying provisions to the army, sending them to Rhodes (Diod. Sic. 20.93.2-5; Plut. Demetrios, 22.1). From this, it can be suggested that Menedemus could operate off the coast of Patara or within the harbour bay, but could not (or would not) intervene in the inner harbour. In other words, it can be suggested that the attack could not reach the city. In consequence, it can be inferred that the city walls of Patara had been constructed by the end of the 4th century CE and that the military inner harbour was somewhat protected (Baika, 2013: 211). Archaeological evidence that can support this view was obtained during surveys conducted in the inner harbour in 2017. Described in detail below, the evidence for this is the remains of a wall and a circular tower, which seem to be independent of each other but in fact form parts of a single seawall construction (Figs 4, 10-14). The base of the visible remains of this tower must have had a diameter of 10 m (Figs 4, 10-11). The wall that leads straight to this tower is 2.4 m wide (Figs 11-14). The building blocks of the wall, which was evidently constructed during Late Antiquity, carry a great morphological similarity to the limestone blocks used in the early Hellenistic fortification wall (Bruer and Kunze, 2010: 30-32, figs 25, 27, 29; Dündar and Rauh, 2017: 564-565, fig. 57). This raises the question of whether the blocks forming this seawall – which was constructed long after the Hellenistic period – were already there. That is to say, the blocks of a Hellenistic seawall (and a defensive wall on the promontory) may well have been re-used for the same purpose centuries later.[4] If this was the case, we can suggest that the harbour was enclosed or made closable by a seawall, as early as the late 4th century BCE, making it a *limen kleistos* (Lehmann-Hartleben, 1963: 65-74; Baika, 2013: 211).

Shipsheds?

Another indication that the Patara inner harbour may have been a *limen kleistos,* at least from the late 4th century BCE onwards, can be observed at the south end of the promontory where it is connected to the land. This is an area of about 50 x 80 m, located between the Byzantine castrum mentioned below (Bruer and Kunze, 2010: 79-101), and the medieval city fortress (Figs 4 and 14). This area is bounded to the north by the garrison and to the south by the city wall, while a wall much narrower than the others extends to the west, towards the bay. On the east side of this area, towards the inner

3 For the Hecatomnid/Persian bastion or garrison and mercenaries in Hyparna (Ὕπαρνα) near Lycia, see (φυλακὴν ἔχον ξένους μισθοφόρους). Arr. An. 1.24.4.

4 Bruer and Kunze (2010: 72) mention a 14 m wall beneath the medieval walls of the castrum.

Figure 10. The remains of a tower at the entrance to the inner harbour (@ Patara Excavation Archive).

Figure 11. Aerial photo of a tower and seawall at the entrance of the inner harbour (@ Patara Excavation Archive).

Figure 12. Remains of a seawall at the entrance of the inner harbour, seen from the south-east (@ Patara Excavation Archive).

Figure 13. The seawall at the entrance of the inner harbour (@ Patara Excavation Archive).

Figure 14. Aerial photo taken from the Tepecik settlement, in the foreground the newly excavated Late Antique tower, in the background the inner harbour (@ Patara Excavation Archive).

harbour, there are no traces of a wall. So this side was open towards the inner harbour. At first glance, there are no building remains in the area. Bruer and Kunze (2010: 71, 100) suggested that this area might have been a place where ships were hauled up out of the water, and there is the example of modern fishery practice in which hauled boats are supported on wooden posts and maintenance work conducted. However, Bruer and Kunze do not directly associate the area with military purposes. They only mention that the inner harbour was a military port (*Militärhafen*) without providing further information on this matter. A remarkable find from the survey carried out in the area, which is very difficult to access due to its dense vegetation, is four column shafts whose approximate locations are marked on the plan (Fig. 4). The northernmost of the columns still stands 1.5 m in height (Fig. 15). The second shaft, which is 13 m from the first, is on the same axis to the east and it stands about 0.5 m in height. The third is approximately 13 m north of the axis formed by former two, while the last one is 6.65 m

Figure 15. Column shaft in the south section of the promontory (@ Patara Excavation Archive).

north of the third shaft. All of these shafts are 0.5 m in diameter. How is this find to be interpreted? The location of this 'empty' area next to the inner harbour suggests these remains may belong to shipsheds.

From well-known examples of shipsheds, there seems a distinct possibility that these columns supported a roof (Gerding, 2013). The width of 6.65 m between two columns is comparable with the well-known shipsheds from Zea, Oeniadae, or Carthage (Ginalis, 2014: 62, table 1). Approximately eight shipsheds, each having a width of 6.65 m, could be placed side-by-side within this

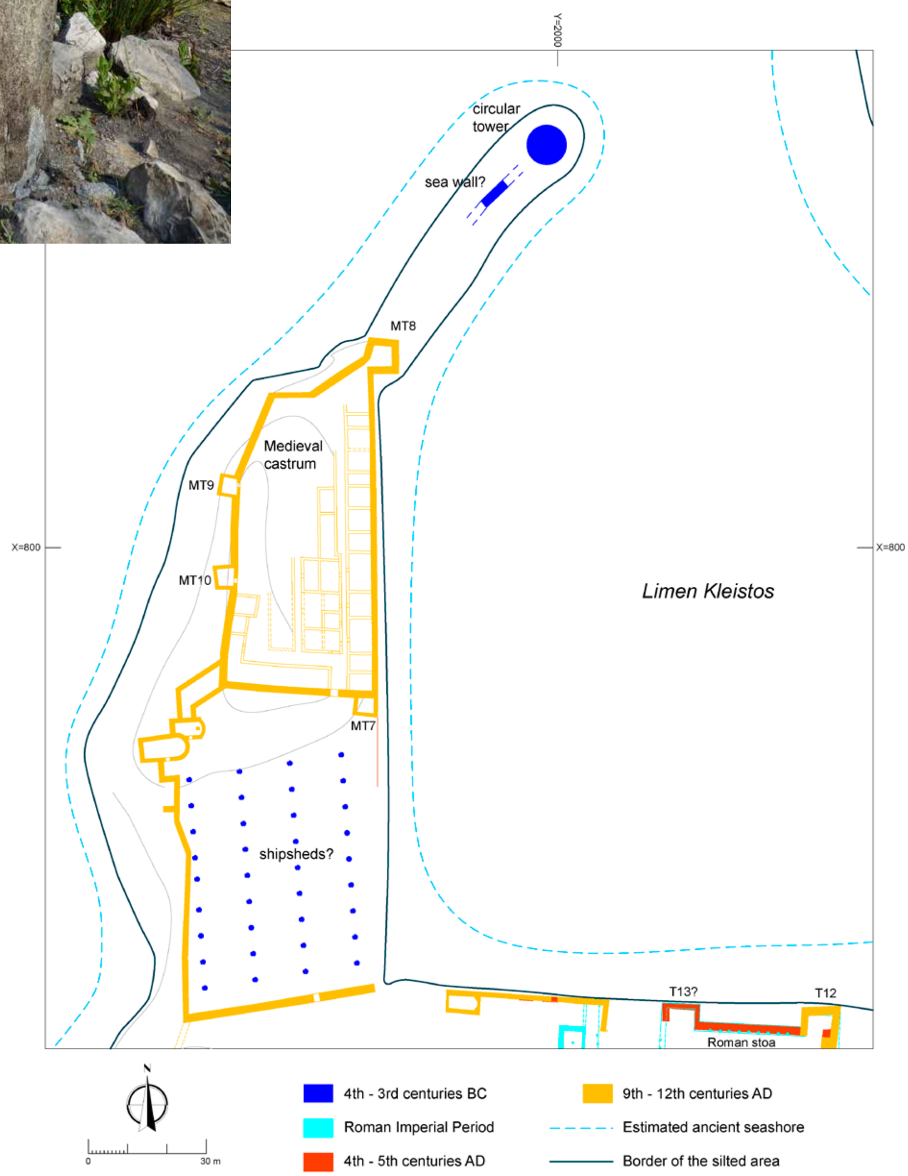

Figure 16. Reconstructed plan of the setting of the columns of the suggested shipsheds (@ Patara Excavation Archive).

area (Fig. 16).[5] In this context, the adjacent rectangular spaces in the medieval Byzantine castrum (see below) are remarkable (Fig. 4, 14). It can perhaps be suggested, from their orthogonal plans, that these stand over an earlier construction (maybe shipsheds) having a similar layout. Another noteworthy point is the layout of the north wall of the medieval city: it runs exactly parallel to the axis formed by the columns of these suggested shipsheds. The question remains whether this medieval wall re-uses a wall (a *diateichisma* or the south wall of the suggested shipsheds) for its foundation. As is known, ancient military harbours or the parts of the harbours in which military structures were located, were separated from the other parts of the city (Baika, 2013). This separation was either through the construction of a wall (*diateichisma*) or due to the topography. In this respect, it would not have been difficult to separate the promontory that forms the northern border of the inner harbour from the other parts of Patara. Besides, the promontory seems to be the most suitable place for such a military purpose, being easily separated from the rest of the city by a wall.[6]

If the suggestions made above are correct – that is, if these column shafts indicate shipsheds, it seems most probable that they were built in the Hellenistic period.[7] In this case, it can be argued that a seawall was needed to protect the shipsheds belonging to a naval base on the promontory and that it would have been first constructed at the same time. Future excavations should provide us with firm evidence concerning these matters.

Late Antique and Byzantine periods (4th and 9-11th centuries CE)

During the long period of the *Pax Romana*, until approximately 250 CE, the colossal Roman Empire did not need defensive walls for those cities lying far from the outer perimeters of the empire. Most likely, the walls that had been constructed were over time weakened due to a lack of maintenance and natural disasters, then served as stone quarries of ready-made blocks for new constructions in this period. Similarly, along the Mediterranean coast, where maritime trade thrived and developed, countless harbours no longer needed expensive defensive fortification systems, unlike in the Hellenistic period, and thus old sea fortifications shared a fate similar to the city walls.[8] We know that defensive city walls began to be constructed again in the mid 3rd century CE, notably in Athens and Rome. Many cities in Asia Minor began to be surrounded by walls constructed from re-used material. What about the harbours? Unfortunately, both the written sources and archaeological data regarding this issue are rather poor (Schmidts, 2019).

Almost all of the building remains visible today in the inner harbour of Patara date from the Middle Ages (Fig. 4). It is known that Patara was converted into a naval base and reconstructed accordingly in the 10th century CE, when Crete was recaptured by the Roman Empire in 961 CE (Zimmermann, 2016: 70), and then Cyprus in 965 CE. A small area at the south of the inner harbour was encircled and fortified by a wall with at least four towers (Figs 2, 4). And another area on the northern tip of the promontory, with a length of about 150 m and a width of 50 m, was also surrounded by walls with towers. Bruer and Kunze (2010: 87) state that this section on the north tip, with buildings placed according to an orthogonal plan, was a castrum. This castrum, which would have accommodated the soldiers of the Byzantine navy, overlooks both the bay (the commercial harbours) to the west and the inner harbour to the east. The wall is narrower at this point than the medieval city wall, which is 4 m wide on the land side. This suggests, at that time, the perceived danger from the sea was less than that from the land. Given that the castrum was probably used by the navy, it can be suggested that this was sufficient for defensive purposes with, at this time, little possibility of an attack.

Remains from earlier periods, such as the columns of the *stoa* from the Roman period on the southern shore of the inner harbour, or the tower ruins of the Late Antique City Wall may be seen among or under the medieval remains we have described (Fig. 4). Bruer and Kunze managed to follow one of them during their study of the city plan in the 1990s and 2000s: they mention the remains of an older wall under the wall of the castrum mentioned above that could be traced for 14 m (Bruer and Kunze, 2010: 72). However, no photograph, detailed description, or other information about the exact location of the wall was published. Unfortunately, we did not encounter this wall in the work we undertook, but it is not possible to see every part of the area today, as it is buried beneath very dense vegetation. It is hoped that in the future we will be able to obtain more precise data concerning the remains of this wall.

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5 Whether the area inclines towards the water or not, has not yet been determined.

6 In addition, to date we have not found any other place in and around Patara which would be more suitable for such a purpose.

7 According to Livy and Polybios, the Roman general Quintus Fabius Labeo burned 50 ships belonging to Antiochus III at the harbour of Patara in the early 2nd century BCE (Liv. 38 39; Plb. 21.46). It is perhaps more plausible to consider that these 50 warships were set on fire not in the sea with their soldiers onboard, but perhaps on the slips in the shipsheds (?).

8 Archaeological surveys show that some military shipsheds were used for commercial purposes during the Roman period (Blackman *et al.*, 1996).

Figure 17. A view of the Late Antique City Wall seen from the east (@ Patara Excavation Archive).

Above, we have briefly mentioned the remains of two structures that formed a part of a harbour 'defence' system that must have been constructed before the 9th-11th century CE Byzantine constructions. The first is the remains of a wall in the northeast about 40 m from the tip of the promontory, which extends on a northeast-southwest axis (Figs 4, 11-14). This wall, termed a *Kaimauer* (quay wall) by Bruer and Kunze (2010: 72), has a length of 7.5 m and width of about 2.4 m.[9] It has been preserved to a height of about 2 m. The wall is disconnected at both ends from the whole structure, and it has no visible connection to the promontory (because of dense reeds). It is double-shelled and was built with large limestone blocks using a technique close to the isodomic system. In elevation, the differences between the block sizes were overcome by using small stones between the joints, to create, as far as possible, a horizontal seating area for the upper row of blocks. In some places, the vertical joints were filled with small stones. It is observed that while the mortar filler of the double-shelled wall mostly contains crushed stones, very large pieces of amorphous limestone were also used. It was also observed that in the broken parts of the wall some of the narrower blocks were used as headers (Fig. 13).

The other remains are located on the same axis about 20 m to the northeast of this wall (Figs 10-11, 14). Because entering this area was rather difficult at the time, Bruer and Kunze assumed that these remains belonged to a wall. Nevertheless, when we carefully investigated it, it became clear that it belonged to a circular structure – to a circular tower – rather than a wall. A part of the filling includes mortar and rubble stones: the outer shell, made up of the ashlar blocks, and four curved limestone blocks can be seen *in situ*. The filler, which contains pieces of pottery or brick, is approximately 2 x 3 m. The three courses of the outer shell, 2.5 m in length and 1.5 m in height, can be seen. The courses are composed of blocks with a height of about 600 mm, a depth of 800 mm and a length of 1-1.4 m. This part of the tower collapsed inwards. Either there was a stairwell here, or the waves carved out this part of the filler, causing it to fall down over time. It is not possible to clarify the situation further without conducting an excavation.

Only the upper surfaces of the outer face of the curved blocks *in situ* are visible. They have a depth of about 0.80 m and a length of 0.80-1.5 m. A calculation based on the existing arc suggests that the remains belonged to a tower with a diameter of about 10 m. It is not clear if there were stairs inside. Perhaps the entrance to the tower was via the wall, using a ladder. Since they are on the same axis, the wall we have described above and this tower would, it seems, have been connected. In consequence, the presence of a seawall (about 60 m long) from the promontory to the northeast and ending in a large tower seems most probable although, unfortunately, the connection of the wall with the land (that is, with the tip of the promontory) has not yet been determined due to the problem presented by the dense vegetation mentioned above. It can be anticipated that this seawall and the tower had a counterpart stretching into the sea

9 Bruer and Kunze also use the term 'Seemauer', meaning seawall; although the terms employed are somewhat ambiguous; they mention that, in the same place the 'Kaimauer' protected the inner harbour and was defensive (Bruer and Kunze, 2010: 72-73). Schmidts (2019) suggests that it must have been defensive.

from the opposite side of the harbour, perhaps from the place where the remains of a Late Antique basilica lie (the so-called harbour basilica, Yurttaş and Çevik, 1992: 240-242, figs 15-17) (Fig. 4). However, no evidence has yet been found to confirm this supposition.

The most important problem concerning this seawall with a circular tower at its end is its date. According to Bruer and Kunze, the structure was built at the same time as the Late Antique City Wall (Bruer and Kunze, 2010: 79-101). Indeed, its building technique can, for instance, be compared with a part of the Late Antique City Wall of Patara (abbreviated as LACW) (Fig. 17), north of 'Nero Bath' by the Agora.[10] The walls have similarities and dissimilarities. In both walls, an isodomic appearance was attempted, with the differences in elevation eliminated by using small, amorphous stones between the blocks. Yet, there are few header blocks in the LACW. Its filler is wider than the shells. A kind of inner wall was built using large tufa blocks in the fill.[11] Most importantly, the reclaimed materials used in the LACW have a heterogeneous appearance, while the blocks employed for the seawall at the harbour display a homogeneous structure.

Bruer and Kunze do not refer to this matter, but the blocks used on the seawall show a very strong morphological resemblance to those of the early Hellenistic fortification wall, as described above (Bruer and Kunze, 2010: 30-32, figs 25, 27, 29; Dündar and Rauh, 2017: 564-565, fig. 57). The early Hellenistic fortification wall, however, does not contain small stones between the blocks. In this case, it seems evident that the seawall was built later, using the blocks from the Hellenistic fortification. But when did this happen? From which part of the early fortification were the blocks taken and brought here? Did they have any relationship with the 14 m of 'early' wall that Bruer and Kunze saw beneath the Byzantine walls? Was there an older wall in this location? As yet, there are no definite answers to these questions, but it is possible to provide some arguments. For instance, a large number of blocks that must have belonged to the early Hellenistic fortification were re-used in the part of the LACW, where the excavation is still in progress (Figs 18-19). Perhaps the reason why almost no trace of the south wing of the early Hellenistic fortification wall has been found is that the last blocks of the Hellenistic fortification that had survived until Late Antiquity were then removed and re-used in the LACW. Several scenarios can be put forward:

Figure 18. The Late Antique City Wall, re-used ashlar blocks from the Hellenistic city wall (@ Patara Excavation Archive).

1. The seawall was constructed from the blocks removed from some part of the Hellenistic land fortification wall during the same period as the construction of the LACW.

2. On the promontory, there was a wall that was built with the same masonry technique and in the same period as the Hellenistic city wall. The blocks of the seawall were taken from this Hellenistic wall during the construction of the LACW.

3. The blocks of a seawall that was built in the same place during the early Hellenistic period and had become partially destroyed after being left to decay, were used again in the same process as the LACW.

4. The seawall was built later than the LACW.

As has been shown, determining when the LACW was built is of great significance in order to date the tower (towers) and the seawall that closes the entrance of the harbour. The LACW has not yet been very clearly dated from the archaeological evidence (ceramics, stratigraphy, and so on).[12] Particularly marked are two different periods in this respect: the 4th or 5th century CE and the 7th century CE (Bruer and Kunze, 2010: 100; Niewöhner, 2010). The general approach is that the Late Antique walls were built for display in the 4th or 5th centuries CE and for defensive purposes in the 7th century CE. Niewöhner

10 The excavation work on this part of LACW is still ongoing. See the publication *Kazı Sonuçları Toplantısı* 42, 2020, forthcoming.

11 However, it is not easy to determine if this difference is due to two or more different workshops.

12 To date we have been able to open only one test trench at the foundation of the LACW. The evaluation of the finds is ongoing, but there are no pottery sherds dating from later than 3rd century CE. In addition, as our numismatist, Savas Dinçer Lenger, informs us, the numismatic finds date from no later than the 4th century CE: for the preliminary reports of this excavation see *Kazı Sonuçları Toplantısı* 42, 2020, forthcoming.

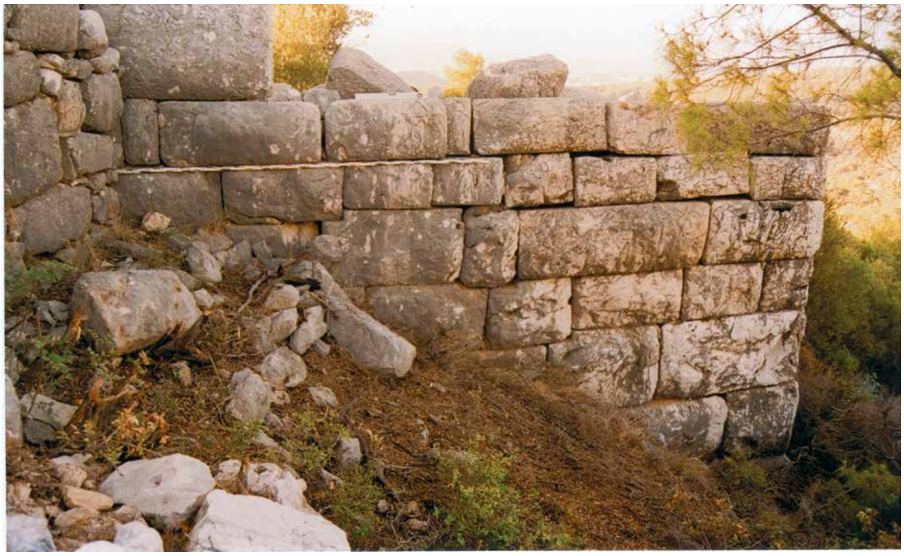

Figure 19. A view of the Hellenistic city wall from Doğucasarı (photo: Stephanie-Gerrit Bruer).

argues that the Pataran LACW was built for defensive purposes and dates it to the 7th century CE (Niewöhner, 2010: 254-257), citing its width – about 2.4 m – and its being 'undecorated' (no flamboyant sculpture was used on the wall and there was no decorated city gate). Although the full assessment of the LACW has not been completed because excavation is ongoing on a part of it, it is possible to mention a few points here. The intensive use of sculpture, for example, the Late Antique City Wall at Aphrodisias, which is very well dated with its building inscription and was clearly oriented towards display, is regarded by Niewöhner as an important criterion (Staebler, 2007; Niewöhner, 2010). Only in one place at Patara has a figure-relief been observed and in very few places have architectural ornaments been found. Patara has no known ornamented gate like those of Aphrodisias or Constantinople. From these facts, the Pataran City Wall cannot be placed in the same category. However, the following factor should not be ignored: when assessed proportionally, the number and types of the sculptural artefacts recovered at Patara, where excavations have been conducted over the past 30 years, is not comparable in any way with those from Aphrodisias. This is no different from Limyra or Xanthos, where excavations have been conducted over a long period: the number of sculptures found in Aphrodisias is probably a few times the number recovered from the whole of Lycia (see Erkoç, 2016). This phenomenon, which should be investigated separately, must have been reflected in the 'embellishment' of the Pataran LACW. So, it would not be the right approach to apply this criterion to every city in the Late Antique world.[13]

Although the Pataran LACW was not decorated with sculptures and reliefs, a strong concern for presentation can be observed. For instance, as Bruer and Kunze noted, this wall does not appear to have been built in haste in response to a threat.[14] On the contrary, in many places, the blocks were laid with care, to establish an isodomic appearance as far as possible (Fig. 20). It is obvious that there was a plan – a plan for display – behind it. For example, the blocks were consistently placed in the same way, so that their undecorated sides face outward. In other words, these features of the LACW follow the tradition of smooth-façade walls of previous periods. In addition, a certain aesthetic was created by plastering the joints (probably using a red plaster) (Fig. 21).[15] That is to say, some effort was also made over presentation for the Pataran LACW.

There is only one known city gate in the LACW (Fig. 22). It is located in the south at the former agora. In comparison with the city gates of Aphrodisas or Constantinople, this gate is very simple and exhibits no decoration. But this side of Patara was not the most significant

13 In the Late Antique city wall of Aphrodisias, lots of sculpture from the necropoleis of the city was re-used. In Aphrodisias and many other cities the Roman period tombs had rich sculptural decoration including reliefs. It was the opposite in Lycia: you can hardly find a tomb building that exhibits any sculpture on its façade. But also in Patara there are lots of other artefacts that were re-used in the LACW, particularly inscribed altars from sepulchral contexts.

14 Bruer and Kunze (2010: 57) see the LACW of Patara in the best tradition of ancient Roman wall construction.

15 The same plastering can be observed on the walls of two Roman bath buildings in Patara.

Figure 20. A view of the Late Antique City Wall (@ Patara Excavation Archive).

Figure 21. Evidence of plastering on the Late Antique City Wall (@ Patara Excavation Archive).

in the Late Antique period since the agora had been demolished and was no longer in use. The important side was definitely the north, the harbour side. Because of this, the 2nd century CE Roman *stoa* on the south side of the inner harbour was not demolished at the time of the construction of LACW, but it was integrated into it (Bruer and Kunze, 2010) (Fig. 4). The front columns of this *stoa* were integrated into the LACW to form a decorative facade with half columns, indicating that the constructors of the LACW had some decorative intent.

In addition, although the LACW of Patara is noted for its width of 2.4 m, one can show many sections and techniques which are not very suitable for defence. For example, in many places, the outer faces were not properly connected with the inner fill (Fig. 23) which could have caused the faces to fall apart in large pieces if under attack. Thus, the width of a wall on its own is a poor indicator that it was constructed to serve a defensive purpose.

From these assessments, we can suggest that the Pataran LACW belongs to Niewöhner's category of 'representative city walls' and can be dated to the 4th or 5th centuries CE (compare with the recently excavated tower (T15) and wall of Late Antiquity on

Figure 22. City Gate in the south part of the Late Antique City Wall (@ Patara Excavation Archive).

Figure 23. A part of the Late Antique City Wall. The ashlar blocks of the outer shell are not truly connected to the filling (@ Patara Excavation Archive).

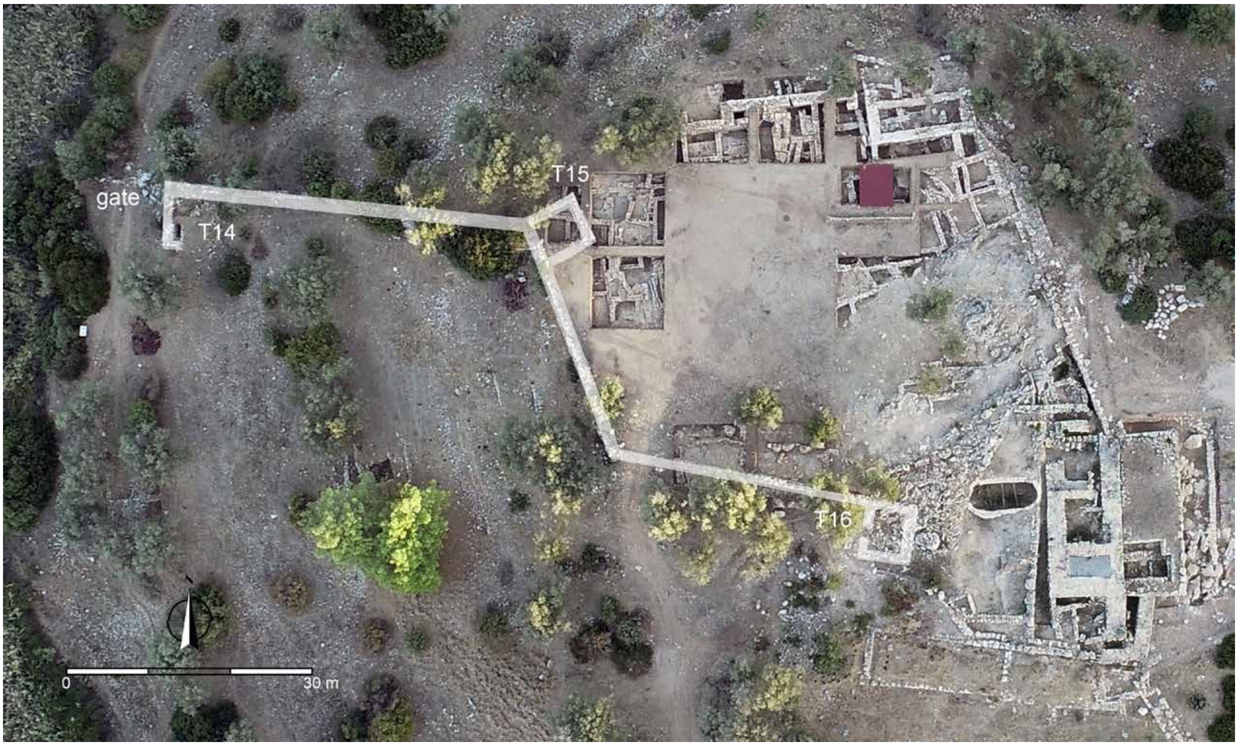

Figure 24. The Late Antique defence system on Tepecik settlement (@ Patara Excavation Archive).

Tepecik settlement below). However, it is necessary to further explore the criteria mentioned above for this dating, which is presented here as a hypothesis. In this case, it would be correct to date the LACW of Patara with the aid of the finds and those finds discovered in archaeological excavations.

Despite its width, the seawall and its circular tower at the entrance of the inner harbour were an object of prestige representing the strength and wealth of the city. There is no evidence that the seawall and the tower were constructed in haste to face an acute threat. However, at present, this proposition has to remain a research hypothesis based upon the visible archaeological evidence and should be supported or refuted by several studies to be conducted in the near future.[16]

General outpost on Tepecik hill?

The excavations conducted on Tepecik in 2018 have resulted in new and important conclusions concerning the defence of the city and harbour in Late Antiquity. In the excavations carried out in quadrant H-18 at the northwest of the flat area of the hill, the foundations of a tower (T15) (Figs 4, 14) approximately 6 x 5 m in area, with a wall thickness of 700-800 mm, oriented to face northwest-southeast, were identified. The outer face of the wall of T15 employed hammer-faced ashlar blocks and the inner face employed small, irregular stones, quarry-faced and for the most part polygonal and arranged in irregular courses. The coins and pottery found during the excavation show that the tower was built in the 4th-5th centuries CE.[17] The hammer-faced ashlar blocks used for its outer face exhibit similarities with the north wall and the blocks of the bastion located

16 Which naval force in Late Antiquity posed a threat sufficient to necessitate such a defence? The groups of 'barbarian tribes' who came from Europe and disturbed Anatolia and Greece from time to time did not constitute a serious maritime threat. Therefore, we seem to have very many harbour fortification walls from that time. The next serious threat came from the Muslims who attacked the harbour cities of Lycia from the sea from the second half of the 7th century CE into the ... ...11th century CE (Hellenkemper, 1993; Foss, 1994: 2-3, 15). There is a variety of opinions concerning this, as well as the degree of impact of the Muslim raids on the population of the Lycian coasts, and of the earthquakes and endemic and epidemic diseases that led to a dramatic population decline in this period (Duggan, 2004; 2005). It is very possible that the Pataran seawall was re-used in this period. But at the moment we don't have any firm evidence for this suggestion.

17 The latest datable ceramics include grooved ceramic pieces and LR1 amphora handles dated to the 5th century CE. The latest coin finds (Constantin II, Valentinian I, Valens or Valentinian II) from this area are dated to the second half of the 4th century CE. For the preliminary reports of this excavation see *Kazı Sonuçları Toplantısı* 42, 2020.

to the north of the flat area of the Tepecik. Probably, some of the blocks belonging to the north wall and the bastion, which was no longer functioning by the 4th-5th centuries CE, were re-used in the construction of T15.

During the excavations a wall about 22 m in length, extending in an east-west direction, was unearthed approximately 30 m south of T15. The masonry technique for this wall, which is about 700 mm to 1 m wide, used entirely rubble stone, somewhat different from that of the T15. As with T15, it is possible to date this wall to the 4th or 5th centuries CE from the finds obtained during excavation (Figs 4, 24).[18]

This long wall, which surrounds the southern part of the upper plateau of Tepecik, has been exposed for 22 m and found to be connected to another tower or building to the east (T16), square in form and approximately 7.35 x 7 m in area (Figs 4, 24). In this tower, which, like T15, has re-used hammer-faced limestone blocks in the western wall, there is a masonry technique which generally employed mortar as a binder between small rubble stones (Işın and Dündar, 2011: 3).

When we look at these three structures on Tepecik, it is seen that T15 and T16 are connected by the long wall mentioned above. However, this defence system is also connected with T14, which is on the western slope of Tepecik overlooking the east entrance of the harbour (Figs 4, 24). As a result of these excavations, it was established that T14 seems to have been in use from the 6th century BCE to the 5th century CE (Becks, 2011: 5).

The data obtained in the 2018 excavation season showed that the upper plateau of the Tepecik was reorganized (as before the *Pax Romana* was established) and was re-used for defensive purposes in the 4th-5th century CE. These excavations showed that the wall widths and tower dimensions of this defence system, with its three towers and connecting walls between them, are both thinner and smaller than the LACW in the city centre extending to the south of the harbour.[19] However, the defence system on the Tepecik is visible from the guardhouse or tower on Adatepe, east of the Kısık Strait, which connects the northern road to the Xanthos valley via a narrow pass.[20] Its narrow walls mean this Late Antique defensive system, although it dominates the road to the north and the harbour in the west, cannot be interpreted as having been constructed to withstand dangers arriving from the north and it seems reasonable to think from the data concerning the Late Antique defence system, that Tepecik formed an outpost, which allowed observation of the harbour and the road and which was connected by a line of sight to another outpost on Adatepe.

Conclusion

Patara was an important harbour city of the Xanthos valley. It also had an advantageous location in terms of maritime routes and had a well-sheltered outer harbour and an inner harbour (for the possible use of pre-Hellenistic regional harbours, see Keen, 1993a: 71-77; Keen, 1993b). Patara was also the cult centre for the oracle of Apollo, the fame of which spread through the Aegean and Mediterranean worlds from the early 5th century BCE, if not earlier (Hdt.,1182; Koçak, 2016a: 550-557). When combined with the written sources, some of which are given above, the status of the city makes it highly probable that it had a military harbour. Since research on Patara harbour is in its infancy, the attempt has been made to assess some of the visible remains within the above-mentioned framework (the status of the city and the ancient sources).[21] From this evaluation of the ancient sources, Patara's strategic location and the archaeological remains, the following research hypothesis has been established:

1. Patara harbour bay played a dominant role in the emergence of the settlement as the city had no fertile hinterland.

2. From the late 6th century BCE to the early 5th century BCE at the latest, Patara could have been home to the whole or a substantial part of the Lycian navy.

3. The defensive buildings from this early period that protected or controlled the harbour are concentrated on the south-southwest slopes of Tepecik settlement (cyclopean walls, freestanding tower) (the promontory has not yet been excavated).

4. During the late Classical period, under the rule of the Hekatomnids, bastions were constructed on the three

18 The latest datable ceramic and coin finds from the wall are the same as from T15.

19 Wall width in Tepecik averaged 0.70-1 m: in the LACW the average is 2.5 m. The tower size in Tepecik averaged 7.4 x 6.7 m, in the LACW averaged 13 x 9.5 m.

20 The distance between Tepecik and Adatepe is approximately 1750 m. For the guardhouse or tower on Adatepe, see Işık, 2011: 28.

21 In the 1990s, Ertuğ Öner carried out geoarchaeological studies at the harbour of Patara (Öner, 1999). In 2012, Harun Özdaş carried out geophysical prospections (sidescan sonar) in the two remaining ponds from the harbour bay (İşkan and Koçak, 2014). In 2017, geoarchaeological studies commenced again (Johannes Gutenberg University-Mainz and Şeyh Edebali University-Bilecik). The analysis of the core samples taken during these studies is in progress.

hills overlooking the harbour and these played a key role in the defence and control of the harbour.

5. At the end of the 4th century BCE, walls were built surrounding the city of Patara. During this period, the entrance to the inner harbour is likely to have been converted to a *limen kleistos* protected by seawalls and towers.

6. The finding of four column shafts, observed on the promontory, probably indicate the former presence of shipsheds. The early phase of these shipsheds may date from the early Hellenistic period.

7. During the period of the *Pax Romana*, harbour defence became unnecessary. In this period, the shipsheds may have been used for other purposes (possibly as warehouses).

8. In Late Antiquity, a fortification wall was built at Patara and the area of the defended city shrank. The exact date of the construction of this wall is not certain, but it seems possible that it dates from the 4th or 5th centuries CE.

9. It seems probable that the seawall and the tower were built at the harbour entrance in a later period (7th century CE?). It is observed that the blocks dating from the Hellenistic period were re-used at that time.

10. In the 10th and 11th centuries CE, Patara was turned into a naval base once again. A *castrum* was built on the northern end of the promontory. During this period, the seawall and the tower (or towers) may have still been standing and may have continued in use.

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The Harbour(s) of Ancient Torone

The search for their location and reflections on Honor Frost's hypothesis concerning shipbuilding in the area

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Torone, towards the southwestern tip of Sithonia, Chalkidiki, remained an active port from the Early Bronze Age to the Byzantine period, often considered to have been of great strategic importance. Its economy seems to have focused on the wine and timber industries, the latter making the port of particular interest to maritime historians. This paper begins by speculating about Torone's role in the timber trade and then reviews attempts to precisely locate the city's limen, first by underwater exploration, which has revealed transformations of its coastline, and currently by the geophysical investigation of its environs, which points to the same phenomenon.

Keywords: Palaeogeography, coastal evolution, ancient harbours, ancient shipbuilding, tomography, Chalkidiki.

Land excavations at Torone on Sithonia, initiated in 1975 by the University of Sydney under the auspices of the Athens Archaeological Society and subsequently conducted by the Australian Archaeological Institute at Athens in collaboration with the Athens Archaeological Society, provide evidence for continuous occupation on the site from the Early Bronze Age to the Byzantine period. The current archaeological evidence available suggests that the coastal settlement dates from *c.*3000 BCE, a time marked in the Chalkidiki by a general movement from more-inland Neolithic sites towards the sea and that it quickly established itself (Morris, 2010: 3-5; and, more specifically on the dating, 14; cf. Tsigarida, 2015: 38-39). The archaeological record from that earliest period points to a community locally self-sufficient, yet with enough imports from around the Aegean to suggest that it was no modest, isolated beachhead:

> As a prominent headland flanked by shores appropriate for beaching prehistoric ships [sc. Bronze Age trading vessels], just north of a large, deep protected harbour… Torone may have served a constellation of coastal sites active throughout the Aegean Bronze Age. (Morris, 2010: 5; cf. 8)

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Nor, with reference to beachheads, should we think simply in terms of a Greek intrusion into Thracian lands. Kyranoudis (2015: 248) registers the toponym Toroni as

in: Demesticha, S. and Blue, L. *et al.* (eds) 2020, *Under the Mediterranean I. Studies in Maritime Archaeology*, Leiden: Sidestone Press, pp. 147-162.

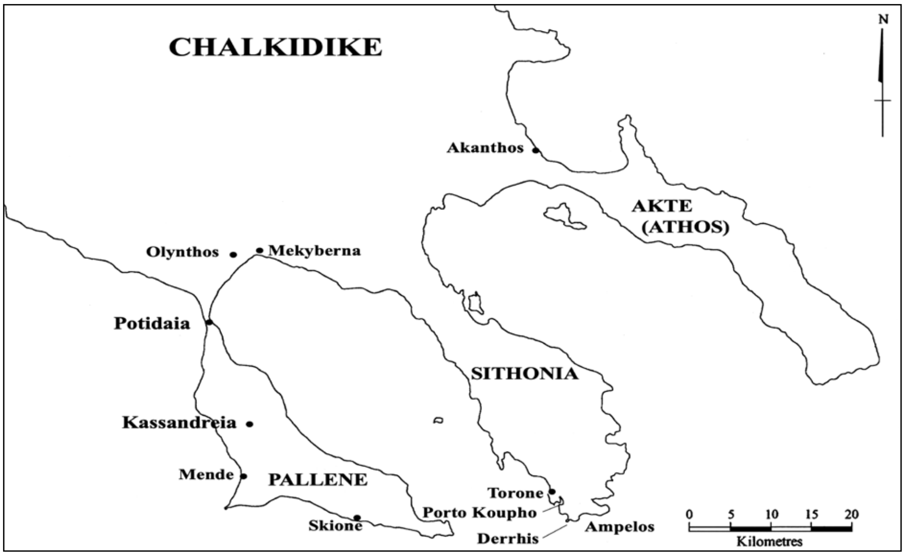

Figure 1. Map of the Chalkidiki, showing Torone towards the bottom centre (Republished, with kind permission, from Meditarch 28-29, 2016: 142).

'pre-Greek'. If this is so, the mythological embroideries concerning Proteus, Herakles, and the sons of Proteus (discussed below), are Hellenic rationalizations of the name encountered. For what it is worth, the 'Epitome Vaticana' of the geographer Strabo speaks of about 30 *poleis* being peopled by Greeks (explicitly registered as Chalkidians from Euboia) 'jointly with the Sithonians' (Strabo, 7, frg. 11). The image of cooperation is not singular. Confrontations along the Thracian coast were often violent, but Pseudo-Skymnos speaks of colonists 'co-habiting' with the natives of Samothrace (he speaks of *synoikismos*; Damyanov, 2015: 300) and the current archaeological work at Argilos suggests cooperation (Perreault and Bonias, 2009). Most of those 'cities' on Sithonia, if we may trust the number, seem to have succumbed to local opposition – Strabo speaks of the majority of these settlements being 'ejected' – or from lack of competitiveness; Olynthus, at the head of the Toronaian Gulf, being the beneficiary of these expulsions and relocations.[1] Torone throve.

Torone's port and its trade

Almost at the southwestern tip of Sithonia, the middle prong of the Chalkidiki peninsula (Fig. 1), Torone was a flourishing trading station, the region being celebrated in the Classical era for its wine and for one of the most valuable commodities of classical antiquity: timber. Both, it can be assumed, were at the heart of Torone's prosperity. No specific literary evidence connects Torone to the wine trade,[2] but at the time of the city's archaic and classical floruit, the amphora and the *oinochoe* (or wine jug) were emblematic of the city (Papadopoulos and Paspalas, 1999; Hardwick, 1998; cf. Killen, 2017, on *parasema* more generally). The earliest archaeological evidence for the domesticated grape at Torone comes from an early Iron Age tomb, though such domestication can be dated in the north Aegean to the Early Bronze Age (Papadopoulos, 2005: 571-572) and the town at the southern tip of Sithonia – falling within the territory of Torone – was called Ampelos (grapevine) (Herodotus, 7.122; cf. Pliny the Elder, *Natural History*, 4.10.37). 'Mendaian' may have served as the 'brand name' for wines of the region, but should not obscure Torone's share of the market (Papadopoulos and Paspalas, 1999: 165, 178-179, 181-183; Peirce, 2001: 495-496; Papadopoulos, 2005: 572). It is timber, however, that draws our attention.

A high premium was placed particularly on shipbuilding timber. The *locus classicus* is Theophrastus, *Enquiries Concerning Plant,s* 4.5.5 (cf. Meiggs, 1982: 118-119). This was particularly the case given the equilibrium between a resource-rich territory and the oftentimes dominating presence of a resource-poor state like Athens (Grove and Rackham, 2001: 171-172). The 'need' was constant during the periods that Athens was in, or hoped to be in, the ascendant.

1 The very question of 'colonization' at this site by Euboean Chalcidians (to whom Strabo attributes the 30 settlements) is a hotly debated matter in modern scholarship, and one to which justice cannot be done here. For what might be called the standard view, see Tiverios, 2008: 45-49; and Zahrnt, 2015: 36. For a contrary view, Papadopoulos, 1996: 152-163, 165-174; 1997: 205; 2011: 123-124. We leave engagement with this debate until a later date.

2 Unless the text of Hippocrates, *Diseases* 2.47b.2, dealing with the therapy following pneumonia, is amended so that amongst the ingredients recommended for ingestion is 'Toronaian' wine (Potter, 1988: 271, n. 1; cf. Henry, 2004: 59-60).

Timber represented, along with mineral deposits, one of those resources that made the Macedonian and Thracian hinterlands of the north Aegean coast both so attractive and prosperous (Herodotus, 5.23.2, for recognition of those resources by the Persians; cf. Vasilev, 2015: 88), helping to make the north Aegean such an axis of exchange and interface (Archibald, 2013: 193-194; cf. Isaac, 1986: 41). The importance of timber in antiquity can scarcely be overestimated (Meiggs, 1982; Bissa, 2009: 111-140) and the appreciation of Macedonian and Thracian timber cannot be gainsaid (Borza, 1982: 2-8; Borza, 1987; Borza, 1990: 55-56; Bissa, 2013: 111; 112-115; 123-124; 125-127; 149-151).[3] Fir was the most highly prized for triremes (Theophrastus *loc. cit.*) but was probably not present on the Sithonia peninsula, since fir is rarely found below 800 m and the highest peak in Sithonia's Itamos range is 811 m; yet pine was also used and valued for shipbuilding; and fir might, in any case, be rafted southward down the relatively sheltered Toronaian Gulf. While sparse stands of fir are found on Mt Athos, the vegetation of Sithonia is marked by a diverse mixture of pine woodlands, evergreen broadleaved species, and garrigue (or phrygana) (Panajiotidis, 2015: 306).

With regard to the importance of timber in the economic politics of the north Aegean, the evidence is cumulative; witness the Athenian angst caused by the fall of Amphipolis in the winter of 424/3 BCE – with specific reference to timber (Thucydides, 4.108.1); the treaty between Perdiccas II of Macedon, around 417-413, dealing with the supply of oars exclusively to Athens (*IG* I³ 89; cf. Borza, 1982: 7 n. 13); *IG* I³ 117 (treated below) and Andocides, 2.11, boasting of Macedonian contacts; and the treaty between Amyntas III of Macedon and the Chalkidians in the 390s or 380s (Rhodes and Osborne, 2003: 12, 54-58). The north loomed large in any strategic thinking undertaken by powers to the south – in particular, of course, Athens (Borza, 1987; Faraguna, 1998: 367-368; Vasilev, 2015: 202-204, esp. n.193). Finally, we might note the Roman intervention in 167 BCE, interdicting Macedonian exploitation of timber suitable for shipbuilding (Livy, 45.29.14).

From a single evocative find, a lead letter ordering wood, dated by Alan Henry in its *editio princeps* to around 350-325 BCE, it can be speculated that trade in the latter half of the 4th century, at least, was both brisk and competitive. This rare find was made at Torone in August 1976 on the neck of the city's principal promontory (*SEG* 43.488; Henry, 1991 [1993]; 2001; 2004: 72-74 [T 91]; Cambitoglou and Papadopoulos, 2001: 55; Harris, 2013; Archibald, 2015: 386); it requests the urgent supply of wood (two lacunae sadly prevent the identification of species of wood being ordered) and pronounces the cancellation of the order if not satisfied within seven days. The same document appears to identify a nearby market in clear and close competition: Mende on the neighbouring peninsula of Pallene (Cassandreia). Ordered in bulk as it is, the wood was probably intended for burning (Forbes, 1996: 84-88, on timber for fuel). Attempting to draw generalizations from solitary data is clearly a risky exercise, but the item's 'accidental' status actually enhances its value.

Toronaian shipbuilders?

The suggestion that Torone prospered from timber-based commercial enterprises, involving more than simply the bulk-purchased wood that was the focus of the above transaction, must, then, as with any speculation about the wine trade, be based on inference rather than hard evidence. But the inference is attractive – not to say, *séduisante*. This raises the question of how the commodity was exported in the classical period: a matter of relevance to the harbour facilities we are seeking to uncover and one of personal interest to Honor Frost. A pseudo-Demosthenic speech (if genuine, an anti-Macedonian work now thought by many scholars to have been delivered in 331 or 330 BCE) indicates that timber was shipped to Athens over great distances ([Demosthenes] 17 'On the Treaty with Alexander' 27-28).[4] But that was no easy matter. *Xyla naupegesima* (shipbuilding-timber) was procured 'with difficulty and from afar (*mógis kaì pórrothen* [= *prósothen*])' (*loc.cit.*; cf. Bissa, 2009: 108-109). There was perhaps, when the circumstances permitted, a more economical option.

Honor Frost, at the 2nd International Symposium on Ship Construction in Antiquity held at Delphi in 1987, floated (so to speak) the argument that Macedonian shipbuilding timber, sold to the Athenians by Philip II, may have been worked by shipwrights in the Chalkidiki, and

3 See also the observations of Kleigenes, the Akanthian envoy to Sparta in 383 BCE, of the abundance of ship timber in the region of Olynthos and of the revenues deriving from the many harbours and trading posts (*emporioi*) in the vicinity (Xen. *Hell.*, 5.2.16).

4 The speech was once more commonly thought by those who deemed it to be a genuine speech to have been delivered in the period 336-335 BCE (Thalheim, 1905: col. 185, 18-24; cf. Bissa, 2009: 134-135). A strong argument has now placed it in the years 331-330, and related it to the abortive war initiated by Agis III of Sparta against Macedonian rule at that time (Trevett 2011: 288, and n. 10 for an alternative argument and a date of 333 BCE; Worthington, 2013: 288-289, and n. 62 and references). Even if the speech belongs, as has been argued, to the 3rd century (Trevett 2011: 287-288 and nn. 6-7, for references), the item remains relevant to the present discussion. We are grateful here for discussions with Mills McArthur and Ian Worthington.

then transported southwards virtually as 'empty shells'. This idea was prompted by the discovery in Limani Zea, Athens, of 18 large pyramidal stone 'anchors', which she believed at the time to be of a volcanic stone found in northern Greece. These shells were, Frost posited (1987), shipped for finishing and equipping in Athens with the primitive anchors used on the southward voyage as 'both emergency anchors and ballast' before being jettisoned in Athens.[5] This attractive hypothesis sparked a difference of opinion between her and Harry Tzalas, which in friendly contention was never resolved (even though the stones in question were probably *not* anchors and need not have originated in the north).[6] At the very same conference, her friend David Blackman also explored the likelihood that, where circumstances permitted, shipwrights might seek to build ships near the timber sources (Blackman, 1987: 47-48; Frost, 1988: 212-214, 225); he drew upon the important evidence of *IG* $1^3$117, an Athenian decree, probably dating to 407/406 BCE, honouring the Macedonian king, Archelaos, for apparently allowing such building to occur in Macedon at a time of great need for the Athenians (Meiggs and Lewis, 1969: 91 [277-280]; Walbank, 1978: 90; Fornara, 2010: 161 [192-194]; Osborne and Rhodes, 2017: 188). There is general disagreement about the extent of Athenian shipbuilding activity in Macedon and outside Athens generally and a long bibliography pertaining thereto, but it makes much sense to envisage very active shipyards dotted along the north Aegean's Thracian and Macedonian coast (cf. Garland, 1987: 97, 99, 204; Isaac, 1986: 41). Unfortunately, such facilities are likely to have left little or no archaeological trace (Blackman, 1995: 233).

Frost would have been warmed by Maria Areti Errietta Bissa's discussion of the Telegoneian *naupagia* (Telegonian shipyards) to which allusion is made on *IG* II^2 1611, 127-133, a 4th-century inscription from the Piraeus, part of a series documenting the accounts of the *epimeletai to neoriou* and dating to the period 377-322 BCE (Morrison, 1995: 63-65), referring to a trireme 'taken over half-built' from the said *naupegia* (Bissa, 2009: 135-136). Bissa infers that the shipyards to which allusion is made were in Attica but draws attention to the fact that Telegonus was neither an Attic hero nor a name otherwise known in Attica. She points, rather, to the mythological connection with Torone. We may expand on that. Telegonus and his brother Polygonus (Tmolus in some accounts) were sons of Proteus ('Toronaian' Proteus in Nonnus' *Dionysiaca* 21.289; 'Thracian' Proteus in Eustathius' commentary on Dionysius Periegetes' *Periegesis tes Oikomenes* 1.327, [C. Müller (ed.) *Geographi Graeci Minores* II (Paris, 1861), 276]), who was, in turn, in various ancient versions and *repertoria*, the husband or the father of Torone – after whom, according to various late ancient sources, the city of Torone was named (Henry, 2004: 82-88 [T 110-119]; cf. 12-13 [T 10; 13]). Telegonus and Polygonus, rationalized as local tyrants of the area in Speusippos' *Letter to Philip*, were notorious for their deadly harassment of foreigners, before being wrestled to their deaths, at Torone, by Herakles (Henry, 2004: 84-88 [T 114; 116-119]). Bissa suggests that Torone, captured for Athens by Timotheus in 364 BCE (Diod. Sic. 15.81-6), was possibly the location of shipyards utilized by Athens in the 360s, but that, after the port was lost to Athens by 357 (Isocrates 7.9), the shipbuilders were relocated, 'either voluntarily or not', to Athens. For good measure, and not without effect, Bissa throws in a prosopographical argument: the possibility that the Pamphilos, one of the shipbuilding *architektones*, to whom reference is made in the above-mentioned accounts (*IG* II^2 1612.156; 164; 176; and 184), can be identified with Pamphilos of Torone, buried in Athens in the first half of the 4th century BCE (*IG* II^2 10454).

Alternatively, we might suggest that the reference to a 'half-built (*hemiergon*) trireme' be used to strengthen Frost's earlier hypothesis.[7]

Locating the harbour

In any case, Torone prospered, a prosperity reflected in the Classical period in the significant sums drawn from the city by way of tribute to the Delian League (Henry, 2004: 41-43) and other products and resources of the area, some no doubt suitable for export (Henry, 2004: 57-63; Beness and Hillard, 2010: 89-91; Papadopoulos, 2005: 5745). The broad outline of the city's trajectory has been traced by others, although the classic reference point, Oberhummer (1937), has been overtaken by subsequent archaeological work on the site (Cambitoglou and Papadopoulos, 2001: 37-88; Paspalas, 2007; Paspalas,

5 For *naupegia*, shipbuilding yards, in the north Aegean, see Bissa, 2009: 129; 132-135; 150.

6 We are grateful again to Mills McArthur for reminding us of the response to Frost's paper which Harry Tzalas delivered to the 5th International Symposium on Ship Construction in Antiquity held at Nauplia in 1993, in which he argued that these pyramidal blocks were stone weights serving as mooring stones (Tzalas, 1999). Tzalas enlisted the assistance of Dr Stathis Styros of the Institute for Geological and Metallurgical Research of Athens who pronounced that the stones 'all derive from recent geological formations common to all of Attica as well as the neighbouring island of Aegina and the volcanic region of Methana. The same stone formation is also widely found in most of the Cyclades' (437-438). This observation in itself does not eradicate Frost's hypothesis, even if it obviates her reason for floating the idea in the first place.

7 For a very different reading of the evidence, consult the detailed analysis of local Athenian shipbuilding by McArthur (forthcoming), arguing that this was the standard practice. We look forward to the publication of his study.

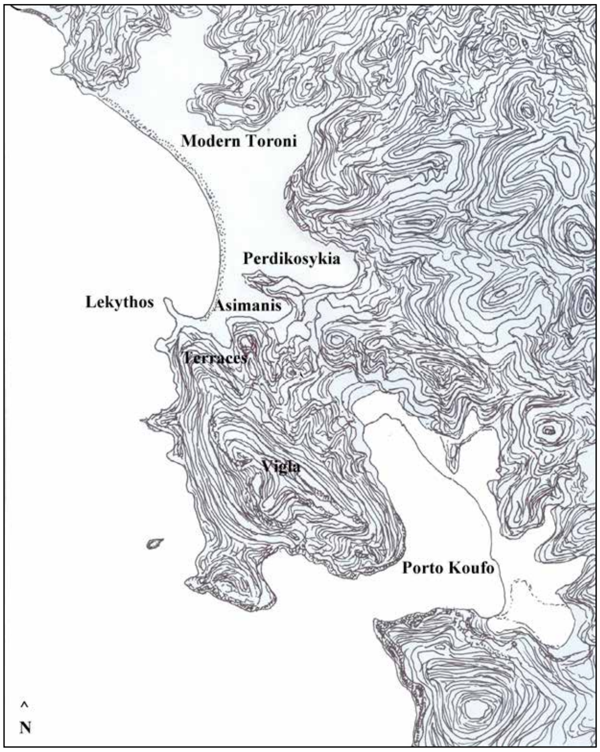

Figure 2. A sketch map of Torone's environs (based on Greek military maps 4456/2, 4456/4, 4457/1, 4457/3). The drawing is not to scale, but a sense of distance is provided by the fact that it is approximately 3 km between the Lekythos and the bay of Porto Koufo. The knoll between Perdikosykia and Asimanis is known locally as tis kalogrias to aloni. 'Terraces' marks the area of the classical city's extension (Map T. Hillard).

2013; and for *testimonia*, Henry, 2004). Torone was clearly one of the more substantial settlements among the 65 *poleis* listed for the Chalkidic peninsula in the Inventory of Greek *poleis* (Flensted-Jensen, 2004: 847-848 [no. 620]; cf. Archibald, 2013: 62-63). The strategic importance of the site is underlined by the multiple violent assaults that it suffered both in antiquity and in the Early Modern period. In 1659 CE, the Venetian Francisco Morosini destroyed the Ottoman fortress on its Lekythos promontory because it was 'an important place of refuge for the Turkish fleet' (Henry, 2004: 49-51), possibly referring to Porto Koufo to Torone's immediate south (Figs 2-3). The strategic importance of this north Aegean location and the attractions of that anchorage, discussed below, continued; during the Second World War, Porto Koufo served as a German U-Boat station.

Whether or not, to return to the classical period, the *polis*, in the sense of any central authority, prospered would depend on fluctuating geopolitical fortunes (see, in passing, the comments in this regard by Broodbank, 2013: 549-556), but the harbour must have been the continuous focus of public life at Torone (de Graauw, 2017: 86 [no. 1110], where it is coupled with Koufos [cf. no. 1111]; Mauro, 2017: 244-246). After the defeat of the Macedonian forces at Pydna in 168 BCE, the Romans divided Macedonia into four discrete republics. The Chalkidiki was one, and – listing its assets – Livy registers the thriving cities (*celeberrimae urbes*) of Thessalonica and Cassandrea; Pallene, a fruitful and fertile land (*fertilis et frugifera terra*); the maritime facilities (*maritimae opportunitates*) by virtue of the ports (*portus*) at Torone, Mount

Figure 3. Porto Koufo. Looking southeast from the Vigla (or 'Citadel'), 230 m. The narrow and diagonal entrance passageway to the protected anchorage can be seen at the centre of the photograph (Photo T. Hillard, 20/9/2016).

Athos, Aenea, and Acanthus, 'some of which face Thessaly and Euboia and others the Hellespont' (Liv., 45.30.4).[8]

The location of the harbour, or harbours, at Torone is therefore of some considerable importance. The Toronaians were spoiled for choice and will have utilized more than one anchorage. Immediately to the south, approximately 2.5-3 km distant, was Porto Koufo (Figs 2-3); in terms of safe anchorage, one of Greece's best natural harbours. This roadstead was the feature that struck all modern visitors coming to the site, and a number, as well as observing the ready modern usage of the anchorage, remembered an ancient saying that unambiguously links this protected basin to ancient Torone. On October 23, 1806, the impressive Colonel Leake approached by sea, rounding the southern tip of Sithonia 'a little to the north of which is Kufó, a land-locked harbour, and then the ruins of *Torone*, still preserving the ancient name' (Leake, 1835/2005: 119). Leake had correctly taken his cue from the name of the modern hamlet of *Toroni*, then considerably more modest than the tourist destination of today, although that was not an identification universally accepted. Leake continued:

> Kufó also is ancient, being the ordinary Romaic form of Kophòs (deaf), which gave rise to the Greek proverb kophóteros toû Toronaíou liménos [that is to say 'quieter than the harbour of the Toronaians'], the harbour having been so called, according to Zenobius, because, separated from the outer sea by two (sic) narrow passages, the noise of the waves was not heard in it.

It should be noted that Leake further observed: 'It was perhaps the same mentioned by Thucydides as the harbour of the Colophonii', appending in a note both a reference to Thucydides 5.2 and the question: 'Ought we not to read *Kophón* instead of *Kolophoníon*?' Leake was thus the first to suggest an emendation that, offered by Plugyers in 1857, is now generally accepted (Hornblower, 2004: 425-426).

The young Benjamin Meritt also approached by sea (in January 1922) and, given the difficulties of a wintertime approach, was naturally impressed by the 'comparative calm… in all weathers' of the kophòs limén, 'flanked on both sides by cliffs which rise perpendicularly from the water' and, within the entrance, opening out 'about a mile deep and a mile across' with 'hills gradually [sloping] down and [giving] place to sand beaches towards the east'. This harbour, he observed,

> is the only one on the peninsula which could in any modern sense of the word be designated as a harbour, and certainly there is no other which could at any time have been called kophòs … even at the present day [a] safe retreat for fishermen in time of storm, and a port of call for Greek steamers plying to Sykia [on the east coast of Sithonia] when the sea is too rough to permit their anchoring in the bay of Sykia. (Meritt, 1923: 453-454)

The roadstead had long been this celebrated; see the 16th-century observations of Piri Reis (Loupis, 1999: 180; Kyranoudis, 2015: 261 n.53). Piri Reis seems to have regarded Kophòs as *the* harbour of the entire Sithonia peninsula (which he calls *Longos*, Sithonia's medieval and early modern name).

The proverb, turning on the tranquillity of the harbour of the Toronaians (which survives in many sources), surely puts beyond doubt that Koufo was within the territory of Torone – and an anchorage associated with Torone (Henry, 2004: 89-92; cf. Beness *et al.*, 2010: 69-70; Kyranoudis, 2015: 260-261). Thucydides, as noted above, reports its forced reception of an Athenian fleet in 422; and an exciting archaeological survey in 2003, utilizing sidescan sonar, a submersible and ROV, has demonstrated the presence of shipping in this harbour, or, at the very least, ships perhaps seeking refuge in this bay in bad weather, in the Hellenistic and Byzantine periods (Mela, 2001-2004; cf. Theodoulou, 2015: 90; Paliompeis, 2018: 38-40; Tourtas, 2018: 231). Yet this was not the city's port in the Classical period, leaving aside the obvious observation that Koufo was secure in terms of the weather only, and far removed from the city's classical fortifications. Narrating the Athenian attack on Torone in 422 BCE, Thucydides reports, trusting the generally accepted emendation noted above, that the offensive force put into Koufo and was then divided, with ten ships 'sailing round to the city's harbour' (Thuc., 5. 2-3). This harbour must be sought to the north and closer to the city.

In between the visits of Leake and Meritt, the young Frenchman Charles Avezou arrived on horseback from the north in the spring of 1914. He was touring the whole Chalkidiki, plotting areas of archaeological interest. He had followed the picturesque but tortuous coastal track that would, in his day as in antiquity, have discouraged long-haul land-transportation of goods in any quantity in this vicinity. The entry in his day-journal for 18 May reads: 'The road follows pretty much exactly the sinuosity of the coast, strikingly cut with peninsulas, coves and marshes' (Feissel and Sève, 1979: 271). Arriving at the site on Tuesday 19 May, sometime between 8.30 and

8 Given the reference to *montem Atho Aeneamque et Acanthum*, one must suspect that the reference is to the quantity or quality of trade flowing though these ports rather than to, as would apply in the case of Torone, the naturally appointed gifts of the topography.

Figure 4. Torone's 'West Bay', showing the heavily weathered southwestern face of the Lekythos. Note the small, pebbled beach and the otherwise inhospitable shoreline. The ruins atop the Lekythos, where once stood a temple of Athena, are those of the 'Byzantine kastro' (Photo J.L. Beness, 13/10/2012).

9 am, having ridden for more than two hours, he also had no doubt that he was at the site of ancient Torone. Noting various vestiges of the ancient city, he crossed the ridge to the south and observed the beauty of Koufo, 'an extensive basin of deep water', perceived almost 'as a lake'. It was here perhaps that, from 10.30 am to 1.20 pm, he took 'rest under a fig tree, a bath and [enjoyed] an improvised lunch'. He had already noticed, however, that the 'action' was to the north. A caïque was anchored off what Avezou describes as a vast sandy bay, busily loading granite 'for the pavements of Salonica' – which is to say, assiduously despoiling what was left of the ancient site (Feissel and Sève, 1979: 271). The southern point of that 'vast bay' was the logical spot to beach or weigh anchor for those wishing immediate access to the city and its remains. Large-scale 'quarrying' of the site had been in full swing in the 19th century, with hundreds of labourers employed. Memories of this despoliation remained vivid in the mid 20th century (Papangelos, 1976: 69, n.7).

Regarding Figure 2, readers will have noticed another possible location for a harbour, the small bay nestling between the two promontories that will have fallen within the city's defensive walls; that is to say, to the immediate south of the promontory marked 'Lekythos' on that map. This, however, could have served only as a fair-weather anchorage, being open to often violent weather, as evidenced by the battered southwestern face of that promontory which Thucydides called by this name: '[the] Lekythos' (Thuc. 4.113.2; Beness *et al.*, 2010, plate 2.1) (Fig. 4). It also provides, as will be seen, very limited beaching space.

It was tempting, therefore, assuming the pertinence of the current topography, which we would challenge, to locate the city's *limen* in the sheltered area to the immediate east, and in the lee of the Lekythos (Fig. 2), and this was customarily the case (Cambitoglou and Papadopoulos, 2001: 47, 67, fig. 2). Moreover, and in partial vindication of that presumption, underwater fieldwork was later to map a line of ashlar masonry that almost certainly served as docking facilities in this vicinity (Samiou *et al.*, 1995; Beness *et al.*, 2010: 71-72).

Modern explorations: underwater investigation and geophysical prospection

In 1990, Beness and Hillard conducted a reconnaissance of the underwater area just northeast of the Lekythos and discerned that aforementioned line of ashlar masonry lying 38 m offshore. In 1993, they formed a *synergasia* with colleagues, Drs Chrysiis Samiou and Nikos Lianos from the Greek Ephoreia of Underwater Antiquities, to scientifically explore this sector of the site. The exercise was conducted at that time as an adjunct exercise of the University of Sydney-based Australian Expedition to Torone (directed by Professor Alexander Cambitoglou), under the auspices of the Australian Archaeological Institute at Athens and the Athens Archaeological Society. During the first underwater field season, conducted within an all-too-short fortnight with a team of five Australians and eight Greeks, an area 100 x 50 m to the northeast of the Lekythos, and immediately to the north of the isthmus, was laid out (with the longer, southern side of that rectangle roughly corresponding to the current shoreline) by means of 11 jackstays, each 50 m long, arranged at 10 m intervals on north-south axes. Each of those ten 10 m strips was investigated *seriatim*, first by snorkel, and then by scuba, by paired members of the team using a 10 m swimline stretched between the two bordering jackstays at each 5 m interval along the jackstays. Items of interest were drawn, while using both scuba and narghile (surface-supplied air) and mapped by means of a total station to produce both a map and a digital terrain model (Samiou *et al*., 1995: 90-93). The overall revelation was that this area had once been terrestrial, and apparently occupied according to some rough town plan with buildings aligned to the same (distinctive) north-west, south-east orientation as found in structures earlier uncovered by the land expedition (Samiou *et al*., 1995: 94, 99).

Most significantly for an understanding of ancient Torone's shoreline, it was possible, by mapping lines of beachrock exposed by significant alterations to the shoreline in the past, to re-draw the line of Torone's classical beachfront which had once been 1.75 m lower than the present water level and at one point lay approximately 40 m off the current shore (Samiou *et al.*, 1995: 95-96; Beness *et al.*, 2010: 71, fig. 2; Allan, 2010: 100) (Fig. 5).

In 1994, attention was paid to structures situated along the present shoreline, confirming the findings of the earlier season. A tiled patio, approximately 2 x 2 m, was cleared, with ceramic sherds coming from immediately above the surface of the pavement dating from late (Roman) antiquity. Immediately beneath the northeast corner of this flooring, and running at an angle roughly corresponding to the present shoreline, was the base of a wall approximately 1 m wide and, given the section uncovered, at least 12 m long. The painstaking excavation by Samiou of two sondages in this difficult littoral location brought to light, from the floor-level of the building, sherds of black-glazed pottery that were sharply angular, that is to say, not at all water-worn, indicating that this locus was sealed before the rise in relative sea-level. This wall ran at an acute angle to the Hellenistic fortification wall, several courses of which are still visible along the northeastern face of the present isthmus, and every indication is that the wall, which could not be uncovered in its entirety, ran under that Hellenistic wall

Figure 5. The submerged area lying off the northeastern shore of the Lekythos photographed in 1993. The two lines of beachrock can clearly be seen running across the area, the inner line lying at its furthest point 20 m from the current beach; the outer, 38 m. In the distance is the plain of Asimanis, bordered on its north, at the centre-top of the photograph by the knoll tis kalogrias to aloni, and on its south by 'Hill 3' (also called Asimanis by local people) at the top right of the photograph (Photo T. Hillard).

(Cambitoglou, 1994: 143-148, plates 77b and 78; Samiou, 1999; cf. Beness *et al.*, 2010: 71-76; Beness *et al.*, 2016: 21 n. 15). In 1997, further investigation of the architectural features in proximity to the present shoreline, principally directed by Samiou and Lianos, exposed the foundations of the Hellenistic city wall. While these fortifications are currently lapped by seawater, the foundations are about 1 m below the present sea-level. Other installations currently to seaward of the present shoreline also indicate that this area was not submerged in classical, or even Late Roman antiquity.

Given the region's seismicity (Hillard, 2010), the two narrow lines of beachrock, with their discrete edges to landward (Cambitoglou, 1994: 146, under Trench V), suggest to us that two successive episodic transformations of the site provide the most likely explanation of these phenomena (Samiou *et al.*, 1995: 99-100; Beness *et al.*, 2010: 72-73). Unfortunately, these two natural features remain undated and, thus, the date(s) of these two putative events are unknown, but the vestiges of occupation prior to submersion suggest that the disturbances were post antique (Beness *et al.*, 2010: 72-73; Beness *et al.*, 2016: 21, n. 15). The conclusion was that the area left for anchorage before the seabed dropped off dramatically (Samiou *et al.*, 1995: 92-93, and figs 2-3) was not large enough to have served as a safe harbour of any great capacity. Shipping would have needed to utilize the less-protected area of Torone's extensive beach.

Given the perceived inadequacy of this area to have served as the sole location of Torone's harbour and given the distance to the inlet at Porto Koufo, our attention turned to the large floodplain lying inland of the modern beach and closest to the classical city; this is locally called Asimanis (Figs 2, 6, 7). Earlier speculation as to the location of the harbour had embraced the two floodplains to the northeast of the ancient site, currently in large part marshland. Asimanis, whether as an embayment or lagoon, was regarded as a possible location for anchorage and beaching, and so, even, was the larger plain further north, Perdikosykia (or Perdikos'kia) (see Papangelos, 1976: 90-92, for references to earlier arguments) (Fig. 2). Local memories survive that boats once enjoyed the shelter of lagoon-like conditions behind the beach and the oral tradition asserts that boat construction has once been conducted here (Vasilios Koutlianis, pers. comm. 12/10/12). Towards the southwestern corner of Asimanis and relatively close to the beach lie the ruins of a paleochristian basilica of Agios Athanasios (Fig. 6), indicating that this area at least was not under water in the 5th century CE. Hand-augering was undertaken in 1999 by Richard Dunn (Norwich University, Vermont) and a small amount of organic material extracted by that shallow coring. Seven hand-driven sediment cores were taken; unfortunately, Dunn was not able to penetrate more deeply than 1.5 m on average and only three C^{14} samples could be extracted. Nevertheless, the sediment units retrieved were consistent with onetime 'shallow marine, beach, lagoon and floodplain environments', although strictly limited resources did not permit at that time a detailed analysis of the organic material retrieved. This suggested to Dunn that the area had in an earlier period, and certainly in the classical era, been a shallow marine embayment. Radiocarbon ages extracted from Dunn's core TO5 suggested to him that a restricted lagoon may have come into existence as early as *c.*200 CE (1820 ± 40 Yrs BP) 'and possibly earlier'. Sediments in the base of his core TO7 suggested to him that marine conditions prevailed at that core site until about that date (Beness *et al.*, 2010: 80). In 2010, Beness, Dunn and Hillard produced a series of hypothetical maps representing an impression of how and at what stages the area may have filled in (Beness *et al.*, 2010: 77-83).[9] That hypothesis we now find open to challenge – in particular, that part of it positing that a major role was played by sand deposition transported from north to south by a dominant longshore current. Following discussions with Drs George Syrides and Konstantinos Vouvalides (Aristotle University of Thessaloniki), we are inclined to explore the possibility that the floodplains, both Asimanis and Perdikosykia to its north, were filled by deposits carried by the number of watercourses entering the plains from the mountains to the east. These are usually dry today but subject to occasional flash flooding, as seen in July 2017.

In 2015 the authors, together with Grigorios Tsokas, Panagiotis Tsourlos (Aristotle University of Thessaloniki) and Richard Jones (University of Glasgow), inaugurated a geophysical survey of the Asimanis plain by means of a 164 m-long dipole-dipole array, a line of 48 electrodes spaced at 3.5 m intervals and running on a north-south axis across Asimanis [ERT 1] close to its eastern edge, producing an electrical resistivity tomography, i.e., an approximately 150 m-long 'section' of the area (Fig. 8), with the results being presented graphically here as a 2D image of resistivity distribution at defined subsurface depths. This tomography (Fig. 9) reveals high resistivity beneath the surface (represented by the 'hot' colours) and its inverse (the 'cold' colours) and may illustrate the onetime depth of the bay, or perhaps lagoon, that is to say, the recess lying beneath the current plain. What is remarkable is that beneath the relatively hard surface of the plain, there is no indication of geological bedrock until a depth of around 20 m, perhaps suggestive of a once deep embayment, with the exception of one

9 Note that in our earlier studies we used the term *Perdikosykia* for all the floodplain(s) north of Torone. We have now, on local advice, refined the toponyms as per Figure 2.

Figure 6. The plain of Asimanis, looking north-east from the 'Anemomylos' (probably the acropolis of the classical city) from a height of approximately 90 m. To the left is the beach. In the centre of the photograph, the remains of the Basilica of Ag. Athanasios are clearly visible. The darkly greened knoll at centre right is tis kalogrias to aloni. Beyond is the floodplain of Perdikosykia (Photo J.L. Beness, 11/10/2012).

Figure 7. Torone Bay and Asimanis from the 'Anemomylos', looking northward. Asimanis is seen at the centre of the photograph. At the centre-right of the photograph, partially under an olive grove, is 'Hill 3', which may have been the 'suburb' of the classical city (proásteion) to which Thucydides (5.2) refers (Photo J.L. Beness, 11/10/2012).

Figure 8. Aerial photograph of Asimanis, Basilica of Ag. Athanasios, with the line of ERT 1 superimposed. The beach is to the right (west). (The original photograph, undated, is from the Archives of the Australian Archaeological Institute at Athens. Published by kind permission of the AAIA).

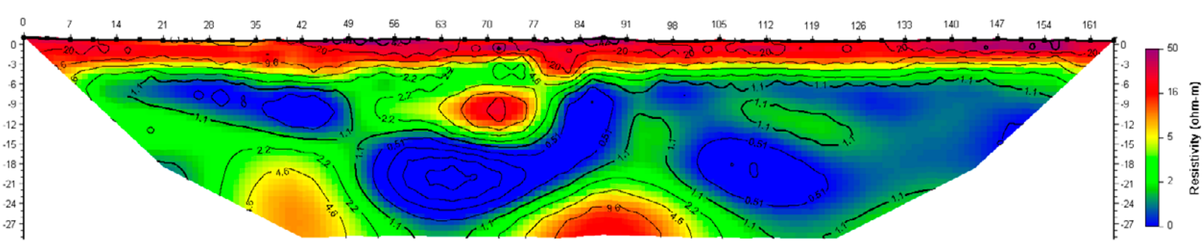

Figure 9. ERT 1. An Electrical Resistivity Section (tomography) created in 2015. The hot colours represent degrees of resistivity; the 'cold' colours represent conductivity.

'floating' anomaly (Fig. 9) that will need to be investigated in future fieldwork (Beness *et al.*, 2016).

In 2016, after clearing corridors through the marsh, a similar methodology was employed, but more comprehensively, with five more arrays laid out in Asimanis, three on a roughly east-west axis and two on a roughly north-south axis, allowing for a more (though quasi-) three-dimensional impression of the subsurface area of the plain (Fig. 10). These confirmed the picture of Asimanis' proposed depth (in its western sector), while the more easterly points, not unexpectedly, revealed a 'shallowing' of the area (Beness *et al.*, 2016). All indications thus far obtained are consistent with the existence here of an area that would have been suitable for a sheltered anchorage and, perhaps, beaching in its easternmost reaches. The knoll to the plain's north, known locally as *tis kalogrias to aloni*, formed of upright schist, provided a clear geological delineation and bordering of the area, as do the hills that are part of the archaeological site of ancient Torone to the south (Fig. 2).

Determining the chronology and nature of the plain's infilling, and whether the area is to be envisaged as having been a marine or lacustrine environment, requires deeper coring and detailed sedimentologi-

Figure 10. The ERT arrays laid out in 2016 (Republished, with kind permission, from Meditarch, 2016, 28-29. Mapping by G. Tsokas and P. Tsourlos, using Google Earth 2016 CNES Astrium).

cal and micropaleontological analysis of the data thus obtained.[10] This work, to be undertaken by George Syrides and Konstantinos Vouvalides, together with a similar investigation of the larger plain of Perdikos'kia to the north, which we now speculate played an important role in the evolution of Torone's northern environs, was scheduled for September 2017. Unhappily, unseasonable heavy rain on 19 July, followed by local flash flooding, prevented this exercise. It was planned that, weather having permitted, the work would be resumed in 2018. These hopes were dashed by an unusually wet period in the Chalkidiki.

10 Parallels and *comparanda* are perhaps provided by the paleoenvironmental work undertaken just to the north at the Tristinika marsh, a mere 6 km away (Panajiotidis, 2015); and the current investigation of the landscape evolution at Paroikia Bay, Paros (Karkani *et al*., 2018) where similar methods used to explore the disappearance of a semi-enclosed lagoon are revealing what seems to be a distinctly different process and set of circumstances.

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The Hellenistic-Early Roman Harbour of Akko

Preliminary finds from archaeological excavations at the foot of the southeastern seawall at Akko, 2008-2014

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Between 2009 and 2012, a large excavation, preservation, and restoration project was carried out along 220 m of the southeastern seawall of Akko, Israel. In 2013-2014, a combined Israeli-American excavation team, supported by HFF, searched for the continuation of the terrestrial features under water. The excavations exposed for the first time Hellenistic features below the present sea-level: a stone-built quay, large mooring stones, a shipshed, and other structures that provide a layout for the ancient Hellenistic port. In addition, a thick layer of port sludge rich in pottery vessels continued down to bedrock.

Keywords: Ancient harbours, shipshed, preservation, coastal changes, underwater archaeology.

At the beginning of the 3rd century BCE, the Ptolemaic Egyptian and Seleucid Syrian dynasties were the dominant powers of the eastern Mediterranean. The coastal regions of Coele-Syria and Phoenicia lay between the rival empires and were aggressively claimed by both. From the 270s BCE until the mid 2nd century BCE, seven Syrian Wars were fought for possession of this fertile territory and its strategic coastal fortresses (Kasher, 1988: 22-23; Beeri, 2008). Seapower was vital to the Ptolemaic strategy for holding Coele-Syria (Ben-Yosef, 2008: 293), and the military port and colony of Ptolemais-Ake (modern Akko, Acre) was established by Ptolemy II as a critical part of Egypt's maritime defences.

Akko occupied a strategic position almost exactly halfway between Raphia on the borders of Egypt and the Eleutheros river on the borders of Seleucid Syria. With Ptolemaic investment, the natural anchorage soon developed into the pre-eminent port of the central Levant. We learn about the importance of the harbour from the 2nd-century BCE letter of Aristeas (Aristeas, 47): 'The country has good ports providing for its needs at Ashkelon, Jaffa, Gaza, and also Ptolemais which was founded by the king…' (Rappaport, 1970: 2-3). Aristeas describes Akko as one of the four major port cities in the land of Israel, and as its most important northern port. The 1st-century geographer Strabo referred to Akko as a large city – a 'megalopolis' (Strabo, *Geography* 25.2.16) and noted that the Persians used it as their base of operations against Egypt. Akko housed the Ptolemaic mint (Tal, 2006: 304-306), and later served as the centre of

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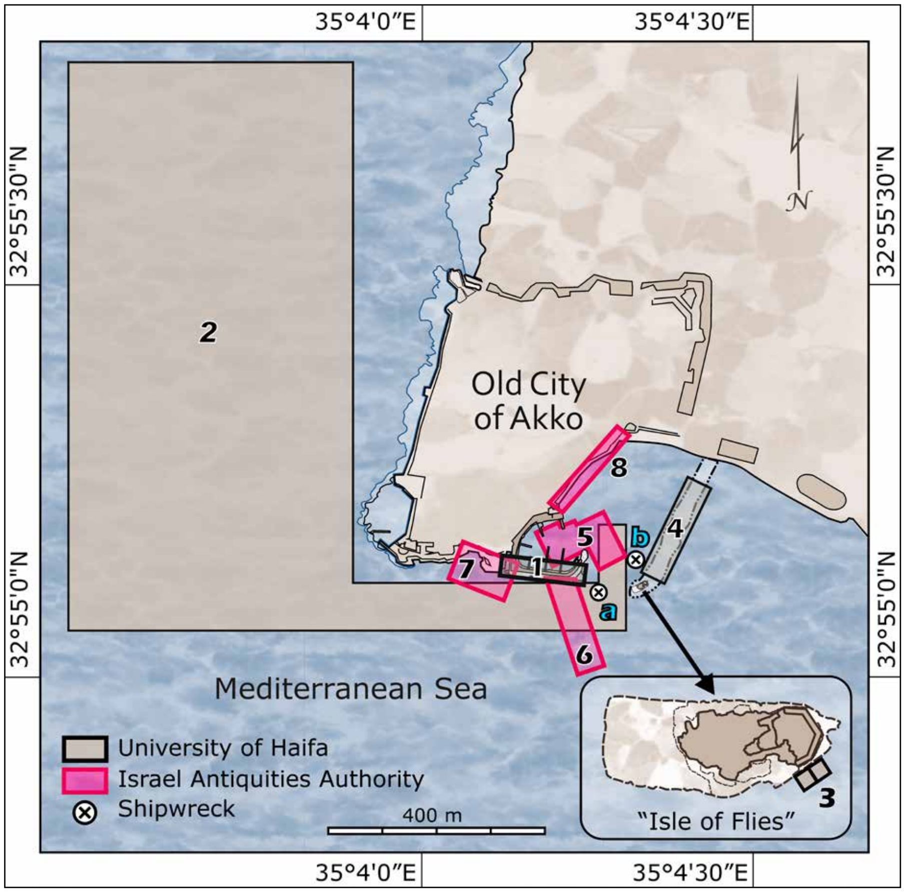


Figure 1. Location map of the surveys and excavations carried out in Akko harbour and surroundings beginning in 1964 until 2012: 1) Linder and Raban, 1964-1966: excavation of southern breakwater and seawall; 2) Linder, Flinder and Hall, 1966: Magnetometer survey; 3) Linder and Raban, 1976-1978: Test trench in the foundations of the Isle of Flies; 4) Kahanov and Yurman, 2006-2008: Test trench in the eastern rampart; 5) Galili and Sharvit, 1992-1993: Deepening of Akko port; 6) Galili and Sharvit, 1995: Survey for the extension of the southern breakwater; 7): Galili and Sharvit, 1993: Underwater survey in the Pizani anchorage; 8): Sharvit and Planer, 2008-2012: Excavation along the foot of the seawall; a) Raban, 1986: Excavation of 18th-century shipwreck Sydney Smith; b) Cvikel and Kahanov, 2006-2008: Excavation of 'Akko 1' shipwreck (Drawing: S. Ben-Yehuda).

operations for Ptolemy VI when he recaptured Coele-Syria during the Seventh Syrian War (147-145 BCE).

Both the Ptolemies and (after Antiochus III) the Seleucids maintained powerful navies, and herein lay Akko's value as one of the few defensible ports along Israel's dangerously exposed coast. But while the triremes that formed the backbone of earlier Classical period navies required nothing more than a smooth beach to draw up on, Hellenistic fleets were dominated by larger vessels. Maintaining even a small number of decked warships at Akko year-round would have required sheltered docks and slipways, workshops, and other facilities; a fully provisioned fleet would have needed a true deep-water port. The central place of Ptolemais-Akko in the war narratives of the late 3rd and early 2nd centuries BCE demands that special attention be paid to the nature of Ptolemaic arrangements for the port (Grainger, 2010). On at least one occasion Akko was captured by the Seleucids with a Ptolemaic squadron still in port, either at anchor or hauled up on slipways. This was during the Fourth Syrian war, when a number of northern towns quickly went over to the Seleucids (Polybius, 5.62.6), including the strategic cities of Scythopolis and Philoteris (Polybius, 5.70.4-5), and the crucial ports of Ptolemais (Akko) and Tyre. These coastal fortresses were seized by the local Egyptian governor Theodotos when he resolved to join the Seleucid cause (Polybius, 5.61.5-6). Here – probably at Akko – he obtained a large squadron of well-equipped warships: 20 cataphract (decked) warships and a variety of smaller vessels (Polybius, 5.62.2-3). Until recently, no facilities to support such a naval force had ever been found at Akko, and the location and dimensions of its ancient harbours were unknown; there was no evidence of a deep-water port. Yet it was difficult to see how Akko's shallow eastern basin could have accommodated even the comparatively small squadron seized by Theodotus, let alone the full might of the 3rd-century Ptolemaic fleet on campaign, which numbered more than 300 warships (Morrison, 1996: 37-38; Grainger, 2010: 84-85).

From 1965 onwards, Elisha Linder and Avner Raban led the first underwater excavations and surveys at Akko (Linder and Raban, 1966; Raban, 1978: 238-240; Flinder *et al*, 1993: 199-226). These excavations revealed sections of a southern breakwater and foundations of a possible 3rd-century BCE lighthouse structure built according to the Phoenician header technique on a rocky islet at the western end of the southern breakwater, known today as the Tower of Flies (Fig. 1). After the Linder and Raban excavations, no further underwater archaeological excavation of the ancient port occurred for the next 28 years, excluding underwater surveys, shipwreck excavations, and harbour-maintenance dredging (Fig. 1). The renewal of underwater excavations relating to the port facilities began in 2006 with the investigation of the submerged eastern breakwater that joins the beach and the Tower of Flies (Fig. 1.4), a fortification attributed to Ibn Tulun in the 9th century CE (Kahanov *et al*., 2007: 16-18; 2008: 19-22).

In 2007 a conservation engineering survey of Akko's southern seawall revealed large gaps and cracks as well as extensive marine abrasion of the wall's stones. Due to the severity of the damage, the Israel Antiquities Authority (IAA) and Old Acre Development Company initiated a comprehensive conservation project of the entire southern seawall down to its foundations. This project began in 2008 and ended in 2013. During this time, the IAA excavated a trench along the base of the seawall, 5 m x 270 m. These were the most extensive excavations to date in the area of the ancient port, and the work also revealed new information about the construction of the Ottoman seawall.

In 2010-2014 the excavations were extended, and underwater trenches were dug in collaboration with a team from the University of Rhode Island and the University of Louisville, Kentucky. The findings corroborate for the first time the existence of a military port dating to the Hellenistic Period in Akko and point to its location in the eastern basin. In this article, we will discuss the main findings and present the preliminary conclusions from the excavations.

Excavation and findings

The historic and archaeological importance of Akko was first acknowledged during the British Mandate. Under the auspices of the British Mandate Department of Antiquities between 1920 and 1948, a structural survey of the city fortifications was undertaken that included operations to reinforce the southern seawall (Makhouly and Johns, 1946). The reinforcements consisted of placing layers of cement-filled sacks along the base of the wall with a cement beam cast over them (Winter, 1944: 9-10). Following these early operations, the Old Acre Development Company and the Conservation Department of the IAA continued to perform occasional structural surveys and limited conservation works along the southern section of the wall during the 1990s. In 2006, a survey

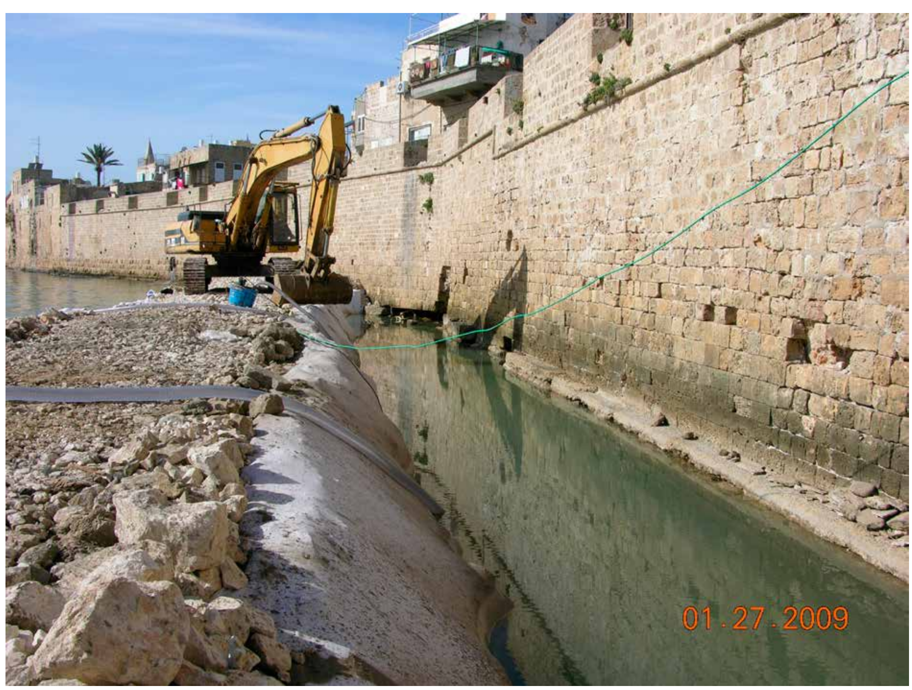


Figure 2. Building the dam along the foot of the seawall. The area between the wall and temporary rampart/service road was divided into six separate pools, from which the water was pumped out in succession as the archaeological and conservation works progressed (Photo: D. Planer).

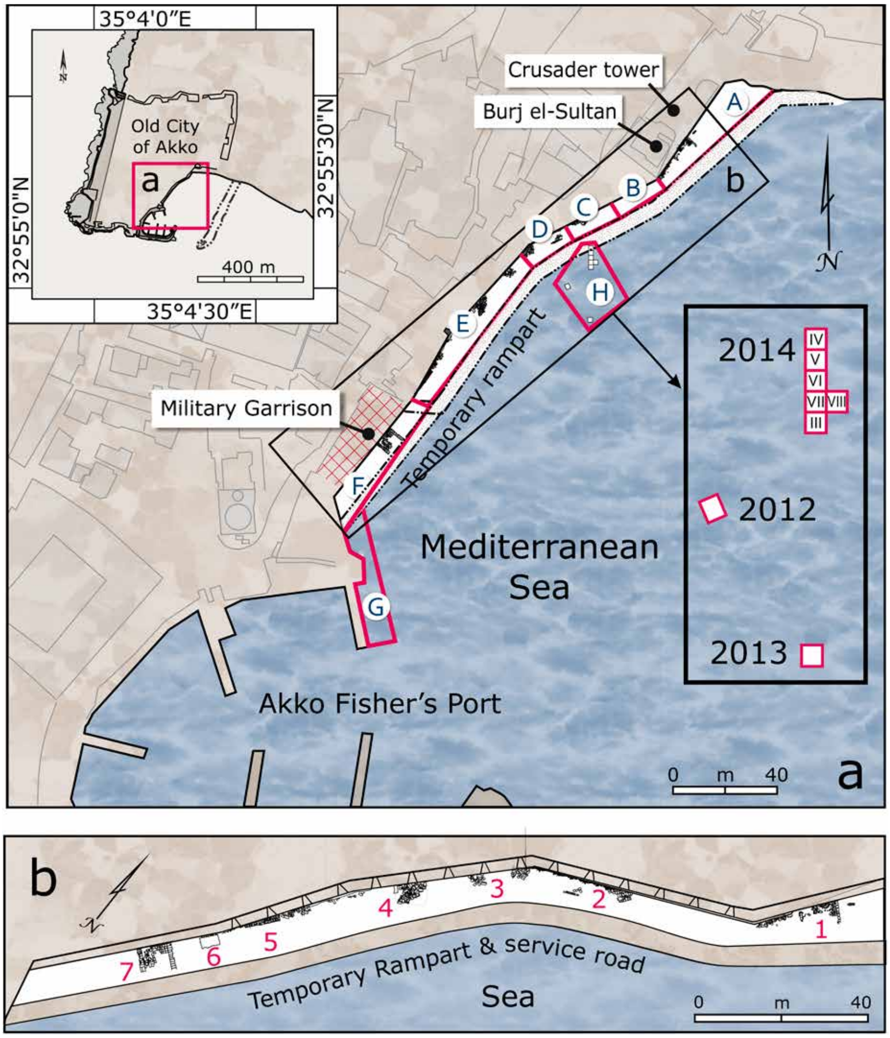


Figure 3. Plan of excavation areas (A-G) and location of the structures and installations discovered (lower strip): (1) remnants of an Ottoman structure approaching the wall; (2) Hellenistic dock; (3-4) collapsed buildings; (5) rectangular Hellenistic building; (6) Ottoman wooden pole foundations; (7) Hellenistic shipshed (Drawing: S. Ben-Yehuda).

revealed large sections in danger of collapse. Archaeological investigations along the foot of the wall, between the shore and the Crusader tower, Burj el-Sultan, were carried out to gather structural and archaeological information for planning purposes (Sharvit and Planer, 2008). The trenches revealed that the foundations of the wall were built on unconsolidated natural sediments and ancient debris of collapsed buildings and that the bedrock lay at depths 2-2.6 m below the modern sea-level. In view of this, the reinforcement of the wall was undertaken from the bedrock up to the wall foundation. As this kind of operation could not be executed underwater, a temporary rampart was laid out parallel to the wall to function as a service road and dam (Fig. 2). The channel formed between the wall and rampart was divided into six separate pools (Areas A-F; Fig. 3), and seawater was pumped out of each pool in turn. Conservation and archaeological excavations commenced simultaneously. Due to the risk of the collapse of the foundations, excavation squares were dug alternately until the completion of the reinforcement along the base of the seawall (Schaffer *et al.*, 2014).

In the area between the shoreline and the Crusader tower Burj el-Sultan, ancient wall foundations made of large, finely cut stones built directly upon the bedrock (beach rock) were revealed (Area A; Fig. 3.1). The base layer of the Ottoman seawall was built on top of the remains of the ancient wall, using it as a foundation. The excavation yielded decorated capitals, fragments of columns, and Byzantine pottery. It is possible that this section of ancient wall belongs to the remnants of the renowned convent of the Order of Saint Clare or Franciscan sisters (Fig. 4). When Akko fell in 1291, tradition records that the sisters disfigured themselves to escape dishonour at the hands of the Mamluks (Dichter, 1973: 178; Schiler, 1983).

Excavation in the southwestern corner of the Crusader tower, Burj el-Sultan (Area B, Fig. 3), revealed that its foundations were also built on bedrock at a depth of 2.3 m below the modern sea-level, and were construct-

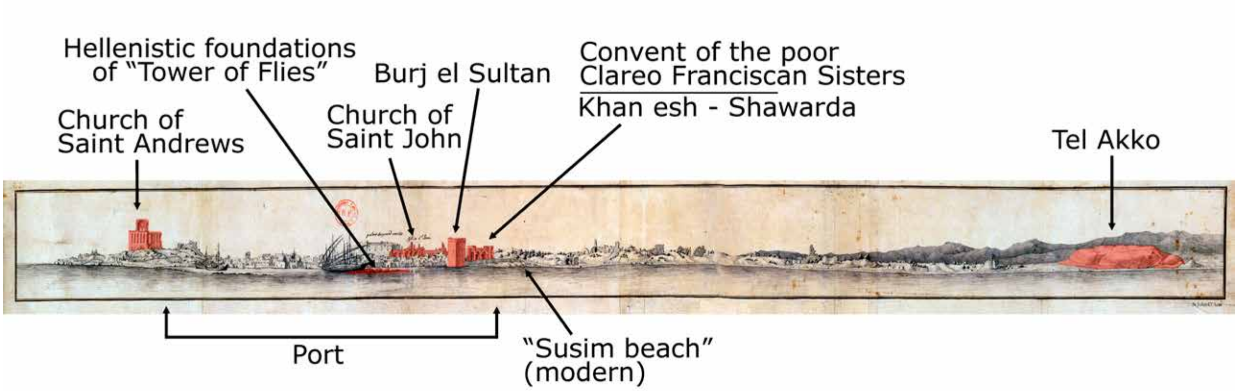
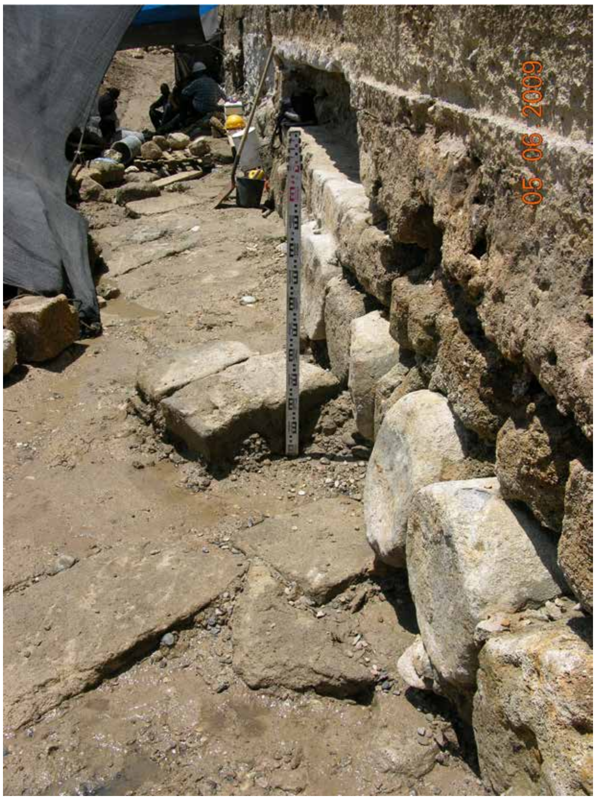


Figure 4. Painting of Acre, c.1686 (Phot. Bibl. Nat. Paris. Rés. Ge. DD. 226 [14]) (Kedar, 1997: fig. 7). View of the city and the harbour from a south-east point in the sea, showing the main structures (marked in red) of the city before the construction of the Ottoman seawall.

Figure 5. The southwestern corner foundation of the Burj el-Sultan tower built on the bedrock at a depth of -2.2 m. The foundation was exposed during underwater excavation in the 2009 season.

Figure 6. East-West view of the Ottoman seawall foundation made of a row of columns in secondary use placed on top of the Hellenistic docking platform floor (Photo: J. Sharvit).

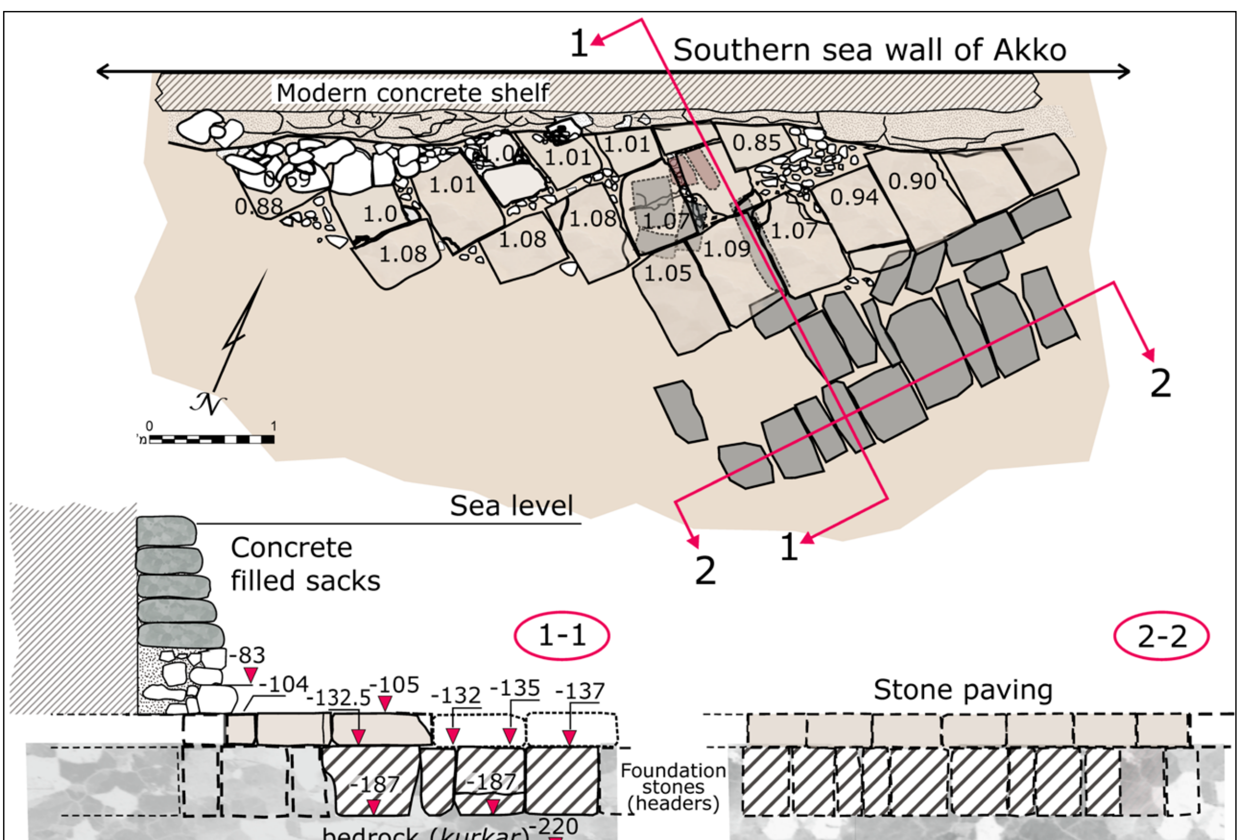


ed of shaped blocks of *kurkar*, a local coastal sandstone (Fig. 5). Approaching the Burj tower from the southwest was an Ottoman rampart built directly upon the bedrock lying at 2.4 m below the modern sea-level. The battery was constructed of a mixture of fieldstones bonded together with a type of cement made of lime and animal bones. Two layers of granite, marble, and Roman *kurkar* columns in secondary use were placed horizontally over the battery, and the first stone layer of the seawall was constructed on top (Fig. 6). The columns, marble capitals, and large ashlar stones were shipped from the ruins of Caesarea Maritima and from the crusader castle of Château Pèlerin at Atlit to build the Ottoman walls of Akko (Winter, 1944; Makhouly and Johns, 1946: 56).

Near the southern edge of the Ottoman battery, an impressive floor built of stone slabs, each measuring 0.8 x 0.4 x 0.15 m, was exposed (Area C: Fig. 3.2). The length

Figure 7. North-south view of the Hellenistic docking platform (Area C) after removal of the British Mandate reinforcement of cement beam and sacks. The exposed wall foundations are comprised of marble, granite, and kurkar columns placed directly on the Hellenistic quay (Photo: J. Sharvit).

Figure 8. Plan of the Hellenistic quay and an east-west section of the seawall and the platform.



of the exposed area is some 30 m, and it continues both northwest underneath the wall and southeast under the temporary rampart or dam (Figs 7, 8). The stone slabs were placed on a layer of cut *kurkar* blocks arranged in the header technique, which is a typical feature of Phoenician and Hellenistic Greek construction in the region (Stern, 1992: 104-105; Tal, 2006: 33-34). A test pit was dug under the floor, revealing a sealed layer of sludge characteristic of the bottom of a harbour. This layer contained numerous Hellenistic finds from the 4th-1st centuries BCE, indicating that the quay was built or refurbished during the Late Hellenistic when Ptolemais-Akko was still the major port of the central Levantine coast. The southwestern parts of the quay under the wall were disturbed, and missing parts of it could be seen under the temporary rampart (Fig. 3.2).

During the construction of the Ottoman fortifications, a line of columns was placed over part of the quay floor pavement to serve as the foundation for the seawall (Figs 6, 7). This shows that the Ottomans were aware of the submerged ancient floor and used it as a foundation. The existence of the quay structure was also known during the British Mandate period, as they even published a version of the 14th century CE map of Marino Sanudo depicting this feature (Makhouly and Johns, 1946: fig. 10) – though it appears no one made the connection between this structure and the 'lost' Hellenistic port of Ptolemais.

A few metres southwest of the quay in Area D (Fig. 3.3), excavation revealed a 30 m-long scatter of dressed stone blocks (0.6 x 0.6 x 1.2 m; see Fig. 9). This included some large intact ashlars (Fig. 10; blocks numbered 22-23). Under these ashlars, the sealed layer of harbour sludge contained Hellenistic finds. Under these stones, there was a sealed layer of harbour sludge lying upon the bedrock which contained Hellenistic finds. It appears that the collapsed blocks belonged to a large building that was originally part of the quay.

A rectangular Hellenistic structure was discovered (oriented east-west) in Area E (Fig. 3.5). The entire eastern section of this building was fully exposed, as were sections of the northern and southern walls of the structure that continued underneath the seawall. The structure is built directly on the bedrock and consists of five layers of smooth kurkar ashlars; it is 8 m long and approximately 1.6 m high (Fig. 11). A row of wooden posts rises from this rectangular structure and continues beyond it; the entire row of posts extends approximately 100 m along the base of the seawall.

Each post is 3 m high with a diameter of 200-300 mm. Most posts are spaced 300 mm apart, though some stand immediately adjacent to each other (Fig. 12). The bottom tip of each post is sharpened to a point and fitted with a metal spike approximately 400 mm long. The spikes have a 200 mm-long cast tip and three barbs (Sharvit *et al.*, 2013: 45, fig. 8). The metal spikes facilitated the insertion of the posts into the ground, and the wings

Figure 9. East-west view of massive rockslide of ashlar stones belonging to Hellenistic building situated near or part of the harbour installations (Photo: J. Sharvit).

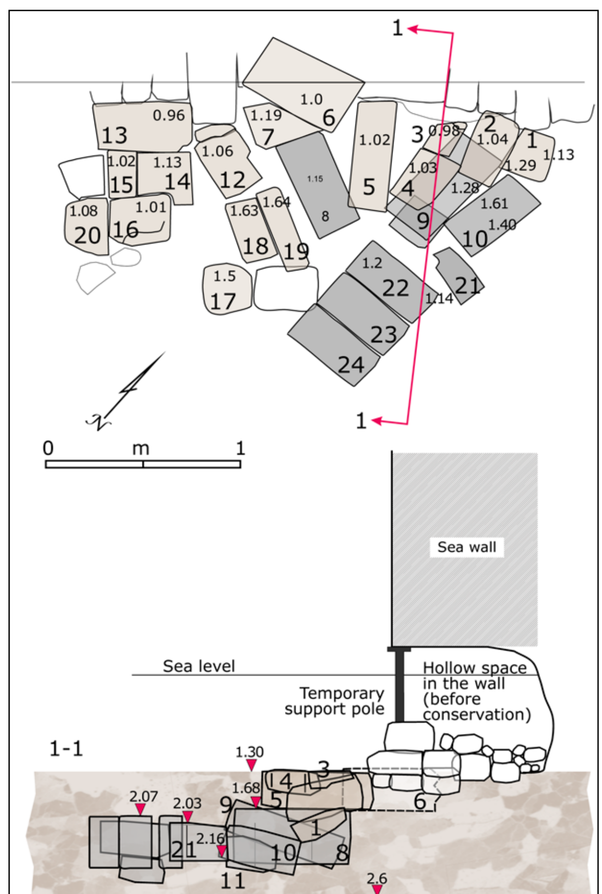


Figure 10. Plan and cross-section of the rockslide and the part of the foundation, stones 22-24 (Drawing: S. Ben-Yehuda).

Figure 11. The eastern face of the rectangular Hellenistic structure discovered in Area E. The structure is 8 m long and 1.6 m high and is built directly on the bedrock (Photo: J. Sharvit).

Figure 12. A row of wooden posts and beams that served as a foundation for the Ottoman seawall. The first row of stones was laid directly on top of the wooden beam. In some cases, the posts penetrate through all the layers into the bedrock (Photo: J. Sharvit).

were intended to prevent removal of the posts. A horizontal wooden frame, sawn from longer posts, was fixed with iron nails to the top sections of the upright posts. The first stone layer of the wall, consisting of large hewn stone blocks with chiselled edges, was placed over these timber frames. The posts were made of a species of tree, *Pinus brutia,* which grows in the northeastern part of the Mediterranean (Turkey, Cyprus). Samples of wood were dated by C14 to the years 1816-1846. This shows that the posts belong to the Ottoman wall foundation and that the wall was constructed after the city was conquered by the Egyptian Ibrahim Pasha.

In the centre of Area E (Fig. 3.4), another scatter of ashlars (0.6 x 0.6 x 1.2 m) belonging to a large building was uncovered, with some building blocks intact. This collapsed structure covered and sealed a layer of harbour sludge lying on the bedrock, which contained Hellenistic finds from the 3rd-2nd century BCE.

Figure 13. East-west view of the shipshed and slipway foundation. The size of the exposed structure is 5 m long and 8 m wide in total, the inner width is 6 m (see Fig. 14) (Photo: J. Sharvit).

At the foot of the military-style Ottoman building in Area F (a continuation of the fortification system), a section of a rectangular building was unearthed: it is 5 m long and 8 m wide with a general east-west orientation (Fig. 3.7). This structure continues underneath the Ottoman building, as well as extending seaward underneath the temporary battery (Fig. 13). The structure is built of two thick walls made of large cut *kurkar* slabs laid out in the Phoenician-style header technique (Arad and Artzy, 2007: 78, 82). Between the walls is a stone-paved floor some 6 m wide, which slopes down toward the sea.

In the centre of the floor, there is a groove 0.4 m wide and 0.2 m deep. There are perforations (*c.*100 mm diameter) in some of the nearby paving stones that may have held vertical timber props for supporting ships (Fig. 14). At the end of the floor close to the dam or rampart (facing the sea), there are many large, collapsed blocks that once belonged to the wall. In the adjacent excavation trench, several large, detached mooring stones were found. They may have originally been integrated into the dock and used for tying up ships (Fig. 15). Finds discovered in the foundations of the structure are dated to the Hellenistic period (3rd-2nd century BCE). The structure's location, size, and building technique all point to an installation intended for hauling ships (slipway) or for storing vessels for dry docking, probably a shipshed. It seems that the central groove was made to accommodate a ship's keel and protect it during hauling, while wooden props supported the vessel during maintenance. Similar installations have been studied in many ancient harbour sites around the Mediterranean: Piraeus, Bauindinai, Corfu, Sarkuzi, and others (Baika, 2003: 103-108; Blackman, 2003: 81-90; 2014: 531-536; Lovén, 2011: 15-30).

To determine whether the slipway continued into the sea to the east of the modern rampart, we excavated two underwater test pits inside 2 x 2 m metal caissons. We found a continuation of the structure 15 m from the wall in the first pit, and 17 m from the wall in the second pit, at 2.2 m depth below the modern sea-level. Beyond the easternmost pit, the seafloor had been disturbed by the construction of a modern fishing jetty, and by dredging and deepening of the harbour entrance channel to admit local boat traffic. The information from the pits nevertheless allowed us to calculate the slope of the slipway floor to *c.* 4-6 degrees.

From 2012-2014, the excavations were extended into the sea to locate the rest of the ancient quay, with a focus on finding the edges of the now-submerged structure and revealing its overall dimensions. During the excavation in 2012, we exposed the continuation of the quay floor at a distance of 24-25 m from the seawall.

In 2013 we opened a second underwater square 40 m from the seawall, at a depth of 1.3 m. This time, we did not find the quay floor, only layers of fill sediments mixed with articulated bivalve seashells at a depth of 1.8 m, and pottery dated to the Roman-Byzantine era (Fig. 16). At a depth of 2.5 m, the bedrock was exposed. Here, sections of a coral colony were found *in situ* and attached to some of the pottery sherds (Fig. 17). C14 tests of some of the coral samples dated them to the early 1st century BCE.

In the third year of excavation (2014) we opened a series of underwater test pits perpendicular to the wall and to the east of the platform that was exposed in Area C (Fig. 3; Squares III-VIII) in order to locate the edge of

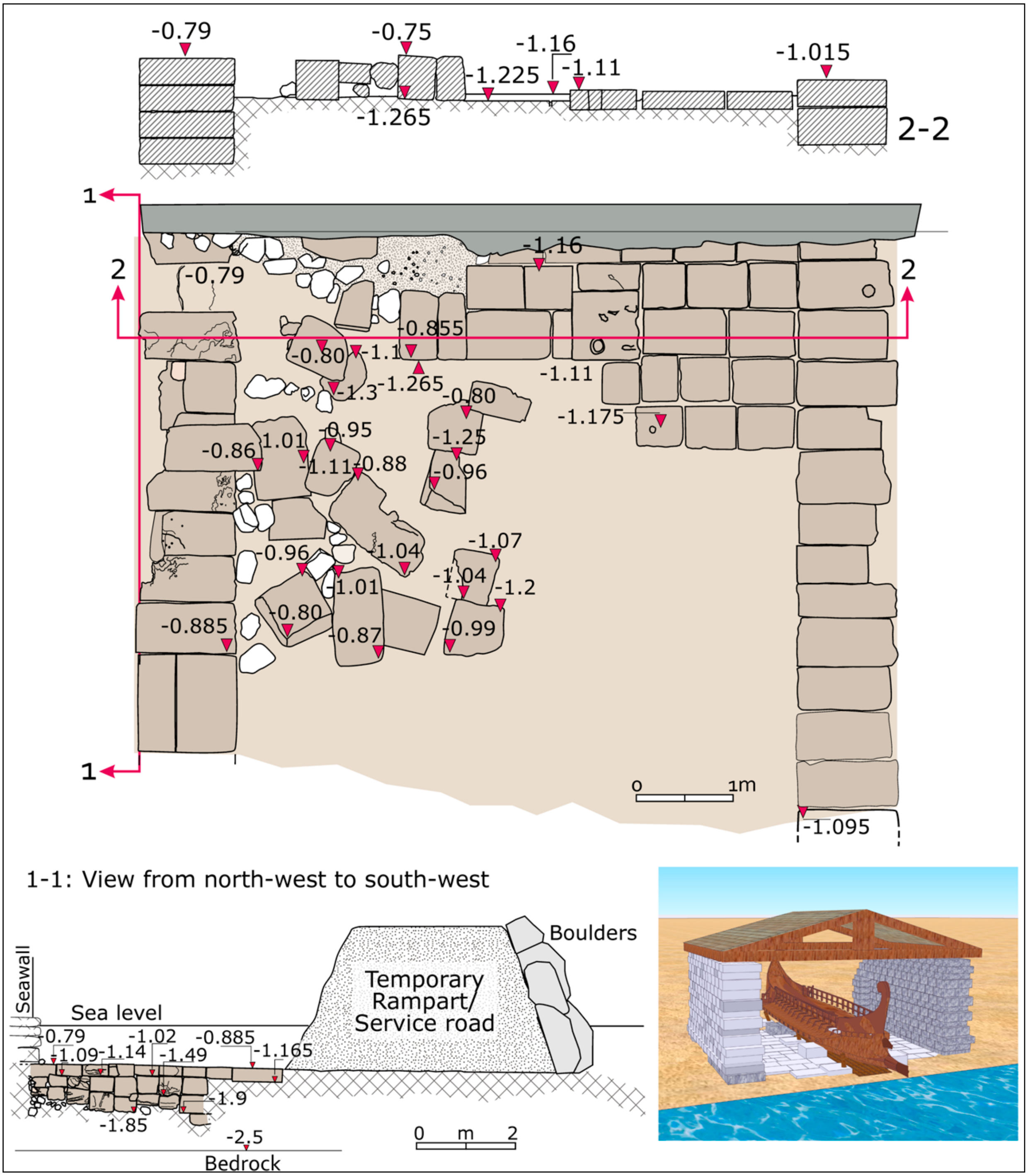


Figure 14. Plan and cross-section of the shipshed, on the lower right a possible reconstruction of the shipshed (Drawing: S. Ben-Yehuda).

the quay. Excavation in Square III continued down to the bedrock (-2.4 m depth) through fill layers of sediments and pottery, as in 2013 (Fig. 3). The excavation in the other squares (VI-VIII) exposed a new section of the quay floor and foundations built with massive *kurkar* blocks (1.5 x 0.6 x 0.3 m; Fig. 18). In Squares VII and VIII, the edge of the quay was exposed, comprising three levels of large *kurkar* blocks (1.5 x 0.6 x 0.5 m; Fig. 19) arranged in the header technique; these blocks rested directly on the bedrock (-2.6 m depth). The total height of the quay was 1.5 m.

Figure 15. Mooring stone excavated in Area F (Photo: J. Sharvit).

Figure 16. Underwater excavation in Square II (2013) revealed layers of fill sediments mixed with shells and Roman-Byzantine pottery continuing down to bedrock at a depth of 1.8-2.6 m (Photo: J. Sharvit).

Figure 17. Sample of a coral colony (Cladocora caespitosa) found on the bedrock and on some of the pottery sherds dated to the 1st century BCE; evidence for environment change (Photo: J. Sharvit).

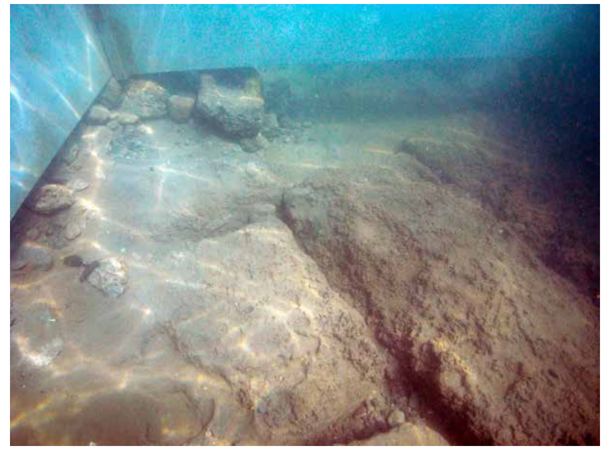


Figure 18. Excavation in Square V (Area G) exposed a Hellenistic quay floor built from massive kurkar blocks (Photo: J. Sharvit).

Figure 19. Diver excavating along the quay edge built with massive blocks in the header technique (Square VII, Area G) (Photo: J. Sharvit).

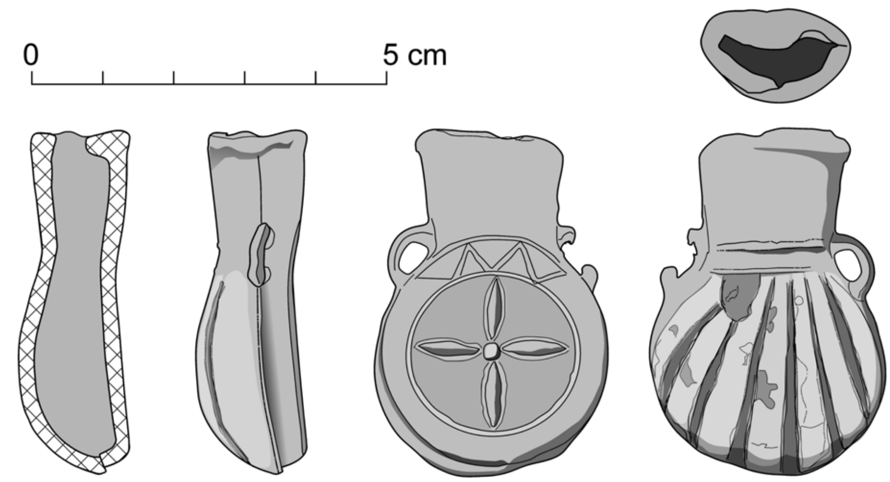


Figure 20. Pilgrim's lead ampulla dated to the 12th-13th century. The ampulla was found on the slipway/shipshed floor (Drawing S. Ben-Yehuda).

Pottery vessels

The archaeological excavation exposed six archaeological strata: I Modern (British Mandate); II Ottoman period (18-19th century CE); III Crusader period (12th-13th century CE) (Fig. 20); IV Byzantine (3rd-6th century CE); V Roman period (1st century BCE-1st century CE); and VI Hellenistic period (3rd century BCE-mid late 2nd century BCE) (Fig. 21).

The Hellenistic material represents the largest ceramic corpus of this date yet published from underwater archaeological excavations at Akko harbour. The excavation provides an outline of the ceramics used by the city's residents, and of the culture and the economy of Akko between the 3rd century BCE and the early 1st century CE. The Hellenistic artefacts were recovered from the 0.6 m-thick layer above the bedrock and underneath the quay at Areas C-G. The assemblage includes a large number of amphorae and amphora handles with stamps, black-ware vessels, black and red 'Megarian' mould-made bowls (Fig. 21: 5-6), Eastern Sigillata ware types A-D, as well as Western Sigillata ware. The material represents both imported wares and common local wares (Fig. 21: 1-2; Ratzlaff *et al.*, 2018). Assessment of the volume of vessels by category verifies the diversity of pottery passing through the Hellenistic harbour: 41% tableware, 34% storage jars, 20% kitchen or utility vessels, 3% personal vessels, and 2% miscellaneous (Fig. 22). Depositional patterns during the height of the harbour activity show trade, or transfer, or storage of small groups of the small types of vessels (Ratzlaff *et al.*, 2018). The distribution of the vessels suggests a domestic environment within a predominantly Phoenician or Punic material culture, and with continuous commercial connections with mainland Greece, the Aegean islands, and Cyprus, as well as major centres on the coasts of Asia Minor.

Most of the Roman and Byzantine material was recovered near the surface at the topsoil of the quay floors from the 2013 and 2014 underwater seasons. In these two cases, the finds came from the harbour fill beyond the edge of the quay. The finds included a few coins, some metal objects, and numerous whole and broken ceramic vessels that belonged to imported and local amphorae, cooking pots, bowls, plates, and Eastern Sigillata ware. In the same layer of Roman-Byzantine Period material, coral fragments and colonies were found *in situ* on the seabed (2.3-2.6 m depth). Analysis of the well-preserved corals confirmed that they were buried alive and sealed with a protecting layer of sediment, possibly during a sudden and singular environment event. The presence of corals indicates that the area was originally clear of sediments because the corals cannot survive underneath sediment; the function of the 1.5 m-high quay only makes sense if it was constructed when the bedrock was exposed. From this information, we conclude that during the Hellenistic and Early Roman Periods there was much less sediment in the bay, which was likely more exposed. Pottery sherds from the Hellenistic and Roman Periods covered by marine organisms and corals show that the sherds lying on the seabed were not buried in sediment for many years after deposition (Giaime *et al.*, 2018: 1-20). Therefore, we conclude that the sedimentation of the site occurred during the Byzantine period and happened over a short period.

Figure 21 (opposite page). Finds from the sealed sludge layer: 1) bowl fragment bearing a relief in the shape of Hypnos, a winged child holding a baton in one hand and clutching a lion in the other: on the external side of the bowl is a white decoration of dolphins swimming among reeds (not shown); 2) jar; 3) jug; 4) lead slingshot bearing a relief of a scorpion; 5-6) mould-made pottery bowls; 7) marble figurine of a woman's head (Photo J. Sharvit).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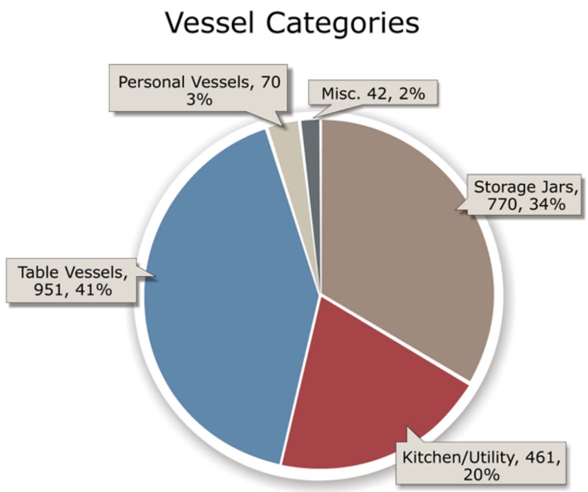

Figure 22. Chart showing the composition of the ceramic vessel assemblage.

Summary

Since the first research in Akko, efforts have been made to locate the harbour that was established as part of the military colony called Ptolemais in the year 261 BCE (the reign of Ptolemy II Philadephus). However, there was no evidence for the precise location of the military port before the excavations and discoveries of 2009-2013. During Ptolemy II's eventful reign, which saw the escalation of conflict between Egypt and the rival Seleucid Empire, Ptolemais and its port played a key part in Ptolemaic strategy (Tal, 2006: 6-7). The harbour facilities were an integral part of Egyptian defensive arrangements, a hub of administrative authority and a critical port for the Ptolemaic fleet. Ptolemais-Akko was therefore critical to Ptolemaic naval control of the Levantine coast, and a conduit for supplying the Egyptian terrestrial forces (Morrison, 1996; Finkleszjn, 2000: 207-220; 2013: 105-113). The fall of Ptolemais early in the Fifth Syrian War (201-198 BCE) was one of the critical factors that led to the collapse of Egyptian power in the region.

The Seleucid conquest of the former Ptolemaic possessions in the Levant, under Antiochus III Megas, brought about a boom of development in the city and port (Tal, 2006: 8). Akko benefited from increased Seleucid investment in naval power as Antiochus III and his successors sought to expand westward, and it maintained its status as the most important harbour of the southern Levant, and as a safe anchorage for the Seleucid fleet.

It appears that the port was built based on the Greek planning concept that divided the facilities into two separate spheres: the western part of the port was more commercial, and the eastern part was military. The southern breakwater, the Tower of Flies, and other port installations all conform to conventional Hellenistic harbour design. The findings of archaeological investigations in the modern port area (the fishing-boat port and marina) point to commercial maritime activities beginning in the 3rd century BCE and continuing until the present day (Galili *et al.*, 2010: 191-211). However, no clear evidence for the precise location of the military port has yet been identified.

The port installations discovered during the seawall excavations (monumental quay, mooring stones, large buildings, slipway and shipshed structures) all attest to the existence of a well-organized harbour built by a powerful and affluent central authority. Since these installations were built on the waterfront in the shallow water near the 1.5 m-high quay, it appears likely that they belonged to a naval facility established close to the city. Since all the floors were found 1-1.2 m below present-day sea-level, the ancient shoreline did not lie where it does today.

The distribution of the harbour installations reveals a large port sprawling over some 90 *dunams* (1 *dunam* = 1000 sqm), the outline of which extends from the shoreline in the north, the breakwater and western wall in the south (the modern port and marina), the island of the Tower of Flies and the submerged rampart in the east, and the port installations discovered along the foot of the seawall in the west. A port of this size could accommodate a large and varied number of vessels such as warships, commercial ships, and small fishing boats. Polybius (5.62.2-3) wrote about the presence of a military port in Akko, and the town's prominence as a highly contested strategic asset during the Syrian Wars confirms that the Ptolemies relied heavily on its facilities for their navy.

From archaeological as well as historical records we know that ancient warships were not left anchored in the open sea more than necessary, and were hauled onto land and housed in military shipsheds between campaigns. It is possible that the collapsed structures discovered along the foot of the seawall were components of a line of shipsheds, similar to the well-documented structures from other Hellenistic naval facilities, such as Zea harbour in Piraeus. Unfortunately, most of the Akko structures are now buried under the Ottoman seawall, and it is not possible to investigate the full extent of these Hellenistic installations.

To summarize, the builders of Akko's Hellenistic period port facilities almost certainly followed the Greek convention of constructing two or three separate harbours for commercial and military vessels. The commercial port was likely near the Tower of Flies, with the military port extending under the modern marina to the west. It was here, under the relatively shallow modern fishing-harbour, that recent drillings into the sediment have revealed the existence of a deep basin –

over 12 m deep – that could have accommodated even the largest ships of the Hellenistic world (Sharvit, 2013). A key question for future studies will be whether this basin once also supported colonies of coral, which would indicate that it filled with sediment over a short period, or perhaps even in a single catastrophic event such as an earthquake or tsunami.

The chronological groupings within the overall assemblage of the excavations reflect three phases in the development of material deposited in the harbour complex at Akko. The foundation of the Hellenistic harbour complex dates to the early 3rd century BCE, with occupation extending through the mid 1st century CE; there is no evidence of an earlier Classical or Iron Age phase of development, even though Akko was certainly already an important naval base before the Hellenistic period (Gambash, 2014).

The main period of activity in the port area is illustrated by the abundance of pottery dated from the mid 3rd century BCE through the early 1st century CE. Within this range, the sub-phases include: Strata IV Phase 1 (mid 3rd-mid 2nd century BCE), Strata IV Phase 2 (mid 2nd-mid 1st century BCE), and Strata V Phase 3 (mid 1st century BCE-mid 1st century CE). Phase 1 is characterized by a prominence of local and regionally produced vessels such as Central Coast fine ware, carinated cups, and incurve rim bowls, as well as neckless cooking pots from the area of Akko. At the same time, small quantities of vessels from the Aegean and Asia Minor were imported into Akko, particularly black-slipped bowls and 'fish plates'. Other regionally common vessels present in this initial phase of the harbour's operation include Phoenician bag-shaped jars in coastal fabrics; these are present throughout the first and second occupation phases of the harbour.

The first phase correlates to the founding and initial period of the harbour facilities as a base for the Ptolemaic fleet in the 1st century BCE. It should be noted that residual material from possible shipwrecks was deposited as fill during harbour use in the 4th-6th centuries BCE, but in such small amounts that the material makes up less than 0.025% of the total assemblage (the sample consists only of a few diagnostic sherds such as basket-handle jar-handles from Area E); these materials are not included in the general chronology. Similarly, Crusader period material from contexts mostly in Areas A, B, and C was not analysed as part of this assemblage.

The second phase (mid 2nd-mid 1st centuries BCE) represents the likely physical expansion of the harbour and increased commercial traffic, as indicated by the substantial increase in the volume of pottery present in Areas E and F in particular. This period also experiences an influx in new vessel types and wares entering the regional market, including BSP, Eastern Sigillata A (ESA), and Phoenician semi-fine tableware. While there are new forms of fine wares present throughout the harbour, the cooking vessels, in contrast, are locally produced. These vessels display variations their rim morphology, as exhibited by the addition of necked ledge-rim cooking pots and casseroles with bevelled and folded rims. During this phase, the Hellenistic harbour likely reached the height of its commercial importance in terms of volume of pottery passing through it, as well the physical expansion of the port, with vessel types from this phase distributed through each area.

The assemblage during phase three (mid 1st century BCE-mid 1st century CE) demonstrates some continuation of certain forms of ESA and semi-fine wares along with the addition of new vessel types both in fabric and shape, such as the ESA conical cup. New additions of imported fine wares include Cnidian grey ware carinated cups from Asia Minor, thin-walled beakers from Italy, and Western Sigillata plates, as well as a single example of an Italian baking pan (not uncommon in Palestine). There is also a significant decline in the appearance of Phoenician bag-shaped jars during this period. The final, third phase has material present in relatively small quantities throughout the harbour's excavated areas with a clear concentration in Area F.

The Ptolemaic foundation of Akko's Hellenistic harbour in the 3rd century BCE came at a turning point for the region. Ptolemy II Philadelphus rebuilt and rejuvenated the city, renaming it Ptolemais in 280 BCE (Diod. Sic. 19.93.7). The development of the harbour facilities fits well with the Ptolemaic interests in establishing an administrative and economic foothold controlling the central coast of the Levant. It was also at this time that the main area of habitation apparently shifted to the low-lying peninsula adjacent to the Hellenistic port, and away from the hill of Tell el-Fukhar, which had been the focus of Akko's occupation beginning in the Bronze Age (Berlin and Stone, 2016: 134; Dothan, 1976: 1-30). Over time, the harbour complex seems to have evolved beyond its primary military-administrative function into an important node in the regional trade network (Vitto, 2005: 153-179; Regev, 2009: 115-191), as well as the broader Mediterranean maritime economy. The architectural and ceramic finds from Akko reveal its importance as a centre of maritime trade, a place where goods brought in from production centres around the eastern Mediterranean could be bought and sold (Tatcher, 2000: 28-29). The ceramic remains exemplify the tendency towards mixed cargoes on smaller merchant vessels typical of the tramp trade that dominated the ancient Mediterranean maritime economy. Assessment of the volume of vessels by category reiterates the diversity of pottery passing through the Hellenistic harbour:

41% tableware, 34% storage jars, 20% kitchen or utility vessels, 3% personal vessels, and 2% miscellaneous.

By the end of the 2nd century BCE, territories in northern Palestine were only loosely controlled by the Seleucids, or else held by the Hasmoneans. Rather than suffering under the circumstances of instability, commercial activity in the Akko harbour prospered significantly, reaching the height of occupation sometime in the late 2nd century BCE. This correlates with other archaeological evidence for economic and settlement expansion during this period of weak administration in northern Palestine under the Seleucids in the late 2nd century BCE.

The ceramic assemblage from Akko shows a downturn in commercial activity by the end of the 1st century BCE and abandonment sometime in the 1st century CE (likely by mid century). Politically, the decline and eventual abandonment of the Hellenistic harbour coincides with the construction of Herod's harbour of Sebastos and the new city of Caesarea between 22 BCE and 10 or 9 BCE. With the construction of its new massive harbour, in 6 CE Caesarea became the provincial capital of the Roman province of Judaea. The economic and administrative focus of the region shifted to Caesarea, and maritime commerce followed; Akko did not recover its former status as the region's principal international port until the Crusader period. While some political reasons existed for Herod and his Roman patrons to have invested in Caesarea rather than Akko, the evidence of rapid sedimentation and collapsed port structures left *in situ* at Akko may indicate the city suffered from an earthquake or other catastrophe that rendered its harbour unusable, paving the way for the rise of Caesarea.

Nevertheless, Akko's strategic position continued to attract the attention of foreign invaders seeking a foothold on the long, exposed coast of the Levant. Burj el-Sultan was originally a Crusader tower built on the bedrock and may have guarded the opening to the 'internal port' in the Venetian quarter. This feature of medieval Akko could be identified with the harbour called La Busheri that was located between the arsenal and the city wall, from where Frederick the Second sailed back to his country in 1229. Based on the IAA's recent excavations in Akko, we suggest that during the Crusader period, building stone from the Hellenistic port was repurposed, creating a 20 m-wide gap between the Burj and the remaining quay, 2.5 m deep from modern sea-level to bedrock. During the Ottoman Period, probably while preparing the foundations for the wall, a massive rampart was constructed that re-sealed the opening between the Burj and the Hellenistic dock. This is the only place along the wall where a rampart was constructed, or where Ottoman foundations extended down to the harbour bedrock, revealing that in this section there was once a substantial opening. Clearly, the fortification planners deemed it crucial to close off the gap.

Around the area of the deeper inner harbour that filled up with sediment, the ancient structures and installations were probably demolished during the Mamluk period, and the Han el-Shawardeh was built over this area in the 18th century. The Ottoman seawall sustained heavy damage in the numerous battles fought over the city during the 18th and 19th centuries and was therefore in a perpetual process of repair and reconstruction. The excavation findings reveal that the wall's foundations were constructed and repaired using a variety of different techniques: a) layers of stone columns in secondary use (granite columns brought from Caesarea and *kurkar* columns from the rubble of Akko); b) a rampart; c) building over earlier construction remnants; and d) building on wooden frames supported by wooden posts. The use of wooden posts was not known in Akko before the IAA excavations along the foot of the seawall, and to date are unique in Israel. The date-range of these posts establishes parameters in which significant historical events took place, leading to restoration or rebuilding of the wall. The earlier date-range indicates construction during the reign of Abdullah Ibn Ali, who was appointed Pasha (governor) of Akko in 1819, and who built fortifications to resist a siege by land and sea, led by Suleiman, governor of Damascus, in 1821. The second possibility is the rehabilitation works carried out by Abdullah Pasha in 1831 as a pre-emptive move against the punitive siege of Akko launched by Ibrahim Pasha, the son of Muhamad Ali of Egypt. This siege ended after seven months with the occupation of the city by Ibrahim Pasha. The third alternative is the reconstruction of the city's fortifications by the Ottoman Turks after they renewed control of Akko in 1840. Our understanding of the extent of modern alterations to the ancient port facilities is still limited, but this will be an important focus of future research.

The underwater excavations at Akko over the seven years of restoration work along the Ottoman seawall have revealed the existence of ancient harbour structures built on an ambitious scale that befit Akko's status as one of the most important strategic hubs of the eastern Mediterranean during the Hellenistic period. Further investigations are needed to determine the exact dimensions of the ancient port and answer the intriguing question of how it became submerged and buried in sediment more than a metre beneath the modern sea-level. Future investigations will help solve these questions and contribute to our understanding of the Hellenistic Period in Akko.

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The Submerged Monumental Complex of the Roman Harbour of Fossae Marianae, Gulf of Fos, France

An overview of preliminary results

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In the Gulf of Fos (southern France), lie the remains of one of the main harbours of the northwestern Mediterranean dating to the Roman period, ideally located at an entrance to the Rhone Valley. This *statio*, mentioned by ancient authors, is situated at the end of the Fossae Marianae, a presumed canal dug by Marius to avoid the dangers of the Rhone river delta. Known since the 19th century, widely looted since the 1950s, and very partially studied, the port site, now submerged in 1-4 m of water, covers nearly 40 hectares. The resumption of fieldwork and multidisciplinary studies undertaken since 2014 have led to the identification of a large-scale monumental complex in the centre of Saint-Gervais bay.

Keywords: Ancient Mediterranean harbour, submerged buildings, Roman wetland construction, Fossae Marianae.

The Gulf of Fos is located on the French Mediterranean coast, on the eastern edge of the Rhone river delta. In the inner gulf, lie the remains of one of the western world's most important Roman harbours. Strategically located at the mouth of the Rhone, the harbour of Fos was the main gateway between the Mediterranean world and the northwestern inland provinces of Gaul, Germany, and Britanny, via the Rhone, Saone, and Rhine rivers. The current name of the town, Fos-sur-Mer, derives from Fossae Marianae, referring to the canal dug by Marius at the beginning of the 1st century BCE. The canal and perhaps the *statio* established at its mouth are mentioned by several ancient authors, in particular, Strabo (*Geography*, IV, 1.8) and Plutarch (*Life of Marius*, XV), but also Pomponius Mela (*Geography*, V), Pliny the Elder (*Natural History*, III-34), and Ptolemy (Geography, II-10, 2-11), and both appear in the *Itinerarium Maritimum* and the *Itinerarium Antonini Augusti* (for a complete overview of ancient sources mentioning the Marius Canal and the harbour of Fos, see Leveau and Trousset, 2000; Tréziny, 2004). The canal, initially dug for military purposes by General C. Marius' troops to bypass the dangerous river mouth of the Rhone, permitted vessels loaded with troops or goods to reach the safe and navigable part of the river, to the south of Arles. Its management

in: Demesticha, S. and Blue, L. *et al.* (eds) 2020, *Under the Mediterranean I. Studies in Maritime Archaeology*, Leiden: Sidestone Press, pp. 181-194.

Figure 1. Localization of the Fos Gulf on the Mediterranean south coast of France, at the eastern extremity of the Rhone river delta (Souen Fontaine, Imagerie 2018 TerraMetrics).

and profits, first entrusted to the autonomous city of Marseille (Strabo, IV, 1-8), were transferred to the young colony of Arelate (Arles) following the defeat of Marseille by the troops of Julius Caesar in 49 BCE. The harbour complex, implanted at the canal's seaward outlet into the Gulf of Fos, played the role of the maritime outer port of the city of Arles and the role of a redistribution port on the main trade route between Italy and Spain for at least three centuries. Whether or not the canal quickly silted up and vessels used the natural mouth of the river directly again (Long and Duperron, 2016),[1] the intensity of Fos harbour's commercial traffic is clearly attested until the beginning of the 3rd century CE by the very abundant ceramic corpus found in the port area (Liou and Sciallano, 1989). On the Peutinger Table, the *Fossis Marianis Statio* is indicated by a semi-circular horreum-shaped icon, similar to that indicating the port of Ostia. The geographical representation and mention of the place by Greek and Latin authors have captured the interest of scientists since the 16th century but, despite many hypotheses, the route of the Fossae Marianae has not yet been identified. And, despite many archaeological discoveries recorded in the Gulf of Fos since the 1950s that have made it possible to locate the Roman port, the organization, the topography of the port and the associated city, and the chronology of the facilities are still very poorly defined and, paradoxically, very little studied.

The gulf and its coastline configuration have changed considerably since Roman times because of its deltaic environment. Meanwhile, human occupation of the site has also undergone significant changes. Its commercial and strategic roles seem to have disappeared at the end of Antiquity, and during the Medieval and Modern periods the site was only a small village with no significant role in the economy and the political context of the region. Fos-sur-Mer became popular as a seaside resort in the first decades of the 20th century up to the 1960s and 1970s, at which time the government chose to install there the largest petrochemical and industrial port on the French Mediterranean coast.

Most of the Roman harbour-remains are now submerged to a depth of 0-4 m on the west side of the rocky headland of Saint-Gervais. Underwater archaeological investigations conducted by scientists and by amateurs

1 The discovery of many ancient shipwrecks and of a large area of port dump, off Saintes-Maries-de-la-Mer, in front of the mouth of an arm of the Rhone, suggests there may be another port of Arles (Long and Duperron, 2016). The bulk of these wrecks, nearly 50, were loaded with cargoes of heavy raw and semi-raw material (marble and metals, for example). A recent study sees this as evidence of the specialization of port spaces at the mouths of the Rhone (Djaoui, 2017).

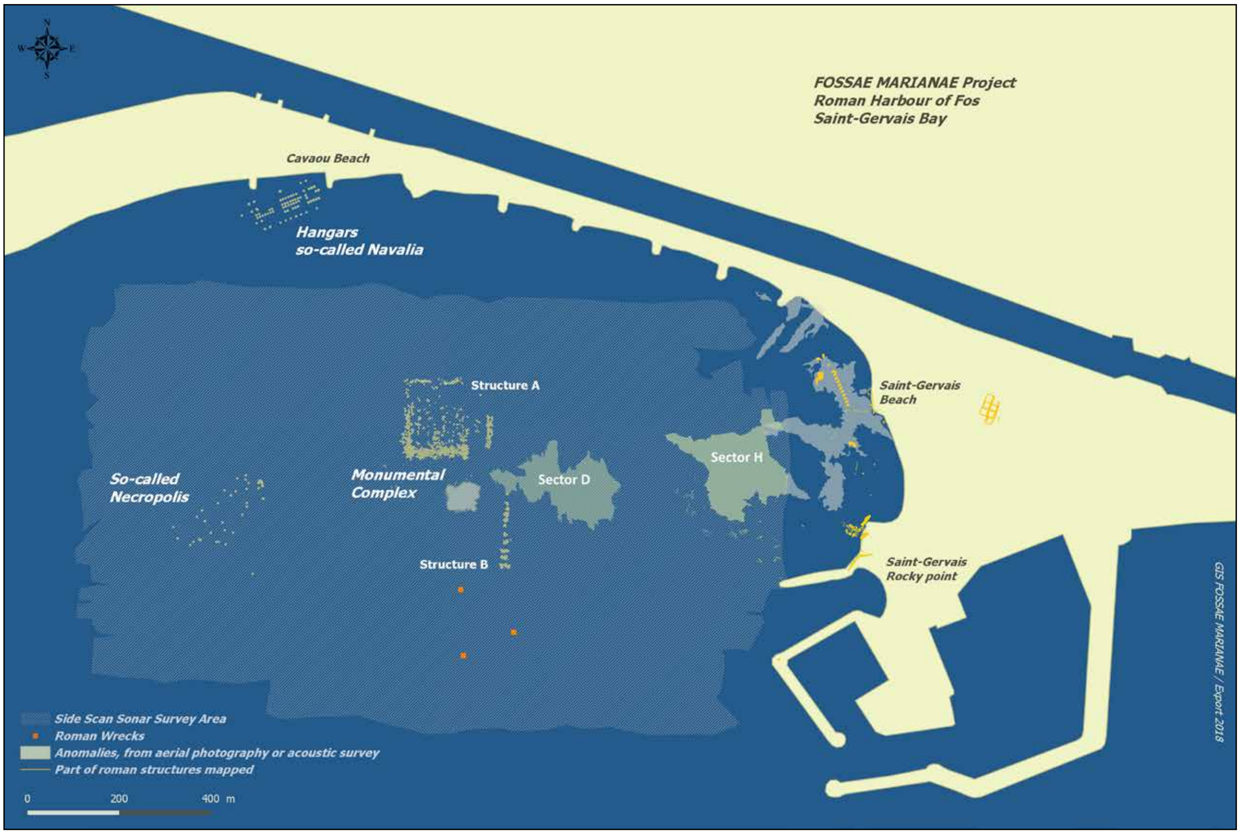

Figure 2. Map of the main remains known in Saint-Gervais cove at Fos-sur-Mer (GIS Fossae Marianae, Souen Fontaine, DRASSM).

since the 1970s in the area of Saint-Gervais cove have identified various archaeological sites, among them: four Roman wrecks, several 'hangars' (two are the so-called *navalia*), a possible necropolis, and portions of walls.

These remains, sometimes reported by divers rather than archaeologists, with more or less accuracy, are spread over more than 40 hectares (Fig. 1).

The deltaic environment of the site generates very poor visibility most of the time, which makes any attempt at classic underwater survey difficult. This, combined with the difficulty of studying a submerged harbour spread over such a large area has discouraged archaeologists and so the potential of the site has remained scientifically under-explored for decades.

Since 2014, a multidisciplinary research group has taken up the entire 'archaeological dossier' of Fos harbour and the Fossae Marianae. Since 2016, underwater and terrestrial field operations have been included in the framework of a research project called *Fossae Marianae: Le systeme portuaire antique du Golfe de Fos et le Canal de Marius*, led by the Centre Camille Jullian (Aix-Marseille University and CNRS) and the DRASSM (French Ministry of Culture). This is the first large-scale interdisciplinary project carried out in this rich area and will probably be the first step in a long-term research programme: the underwater campaigns have been used for the past four years as a field school for the students in the Master of Maritime and Coastal Archaeology (MoMArch) programme at Aix-Marseille University.

The monumental complex of Saint-Gervais cove

Some of the first underwater fieldwork carried out under the project, in 2014, was a wide sidescan sonar survey conducted in Saint-Gervais cove (Fig. 2) and in a sector in the eastern area of the gulf, on the site of La Marronède.[2] The resulting acoustic map revealed the presence of a monumental complex comprising different buildings, two of them more than 100 m long (Fig. 3). The three central monuments are built on the same orientation (north-south) and are probably contemporaneous. From three underwater survey campaigns carried out in this area at the end of the 1980s by Jean-Marie Gassend (IRAA, Aix-en-Provence), we knew that some sections of wall

2 On the La Marronède site, an excavation was conducted by the project team in 2012, 2014, 2015, and 2016 revealing an important construction on piles dated to the middle of the second century CE. For more information, see Fontaine *et al*, 2019.

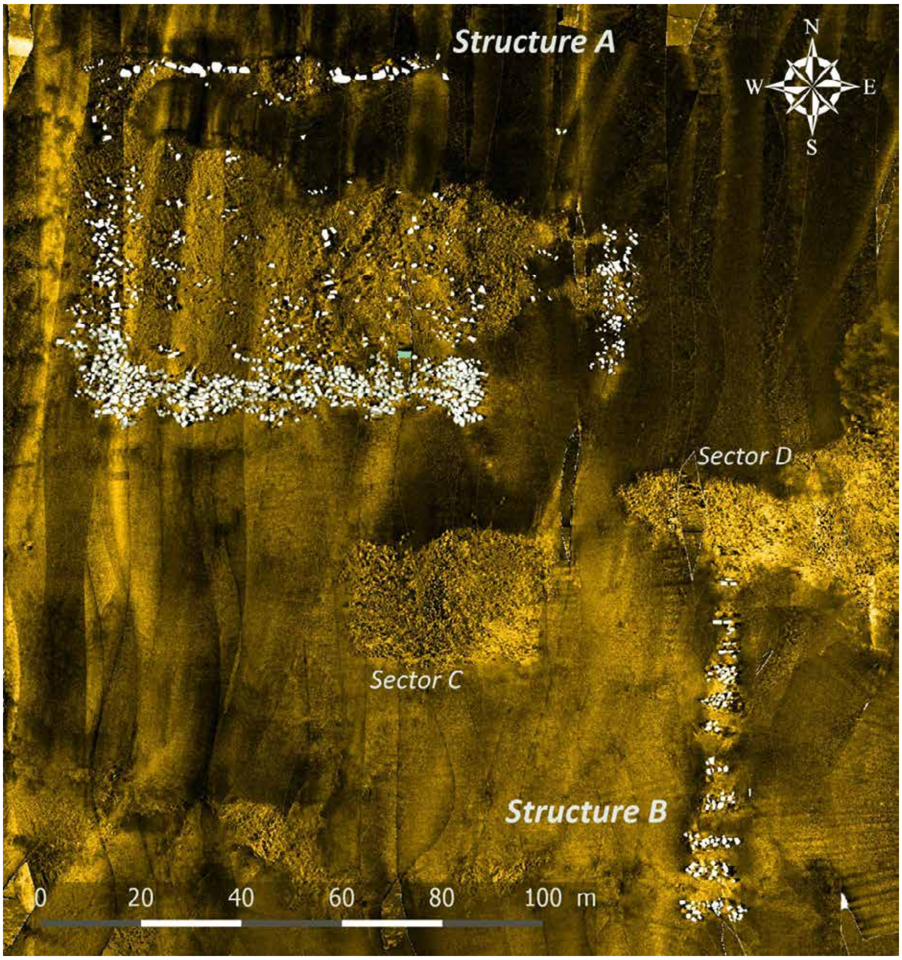

Figure 3. Acoustic map (sidescan sonar survey) and drawing of the main built elements (wall, ashlar blocks) of the monumental complex in the centre of Saint-Gervais cove (Map Denis Dégez, Adrien Domzalski and Souen Fontaine, DRASSM).

had already been recognized (Gassend, 1988; Gassend and Maillet, 1989). Most were disconnected and isolated and there was little in the reports to suggest that they belonged to *in situ* buildings, even though aerial photography in 1965 by L. Monguilan gave an overview of this square structure in the middle of the bay (Monguilan, 1977; Liou, 1987: 60-61, fig. 2).

The identification of built structures with connected walls of this size, preserved *in situ* in 3-4 m of water, revived the geoarchaeological questions posed by the submersion of the Fos harbour complex. This cannot be attributed only to the rise of the vertical sea-level, which has been no more than 0.6-0.7 m on this coastline area since Roman times. The primary aim of the archaeological studies of these buildings was, therefore, to define if they could have been built on land and then submerged or if they could have been originally built in shallow water. Supported by the recent archaeological results on this specific question (see 'Structure A', below), the second step of the study was concerned with the recovery of previously published geomorphological data for the period (Vella *et al.*, 1999; Vella and Provansal, 2000; Vella, 2002; 2004) combined with the analysis of cores taken in the previous two years, to try to reconstruct this complex and unstable sedimentary environment (probably lagoonal) and to understand the succession of events (of high or low energy) suffered by the site.

The past three years of fieldwork have focused on the two main structures of the monumental complex recognized in the centre of the cove: Structure A and Structure B.

Structure A

The northern structure, the one closest to the current shoreline, is square with sides of more than 100 m. Despite the overall shape of the structure and the apparent connection between each side of it, we cannot be sure, for now, that it is a single coherent building as the north side is made differently from the others. The southern, eastern and western sides are composed of a huge number of ashlar blocks, some of them more than 3 x 2 m in size. In some parts, a heap of blocks is spread over an area more than 15 m wide. For now, we only have a global overview of this part of the structure,

Figure 4. Excavation in progress on the north wall of the Structure A (Massifs 7 and 8, Trench S-A1, campaign 2017) (Photo Loïc Damelet, CNRS-CCJ).

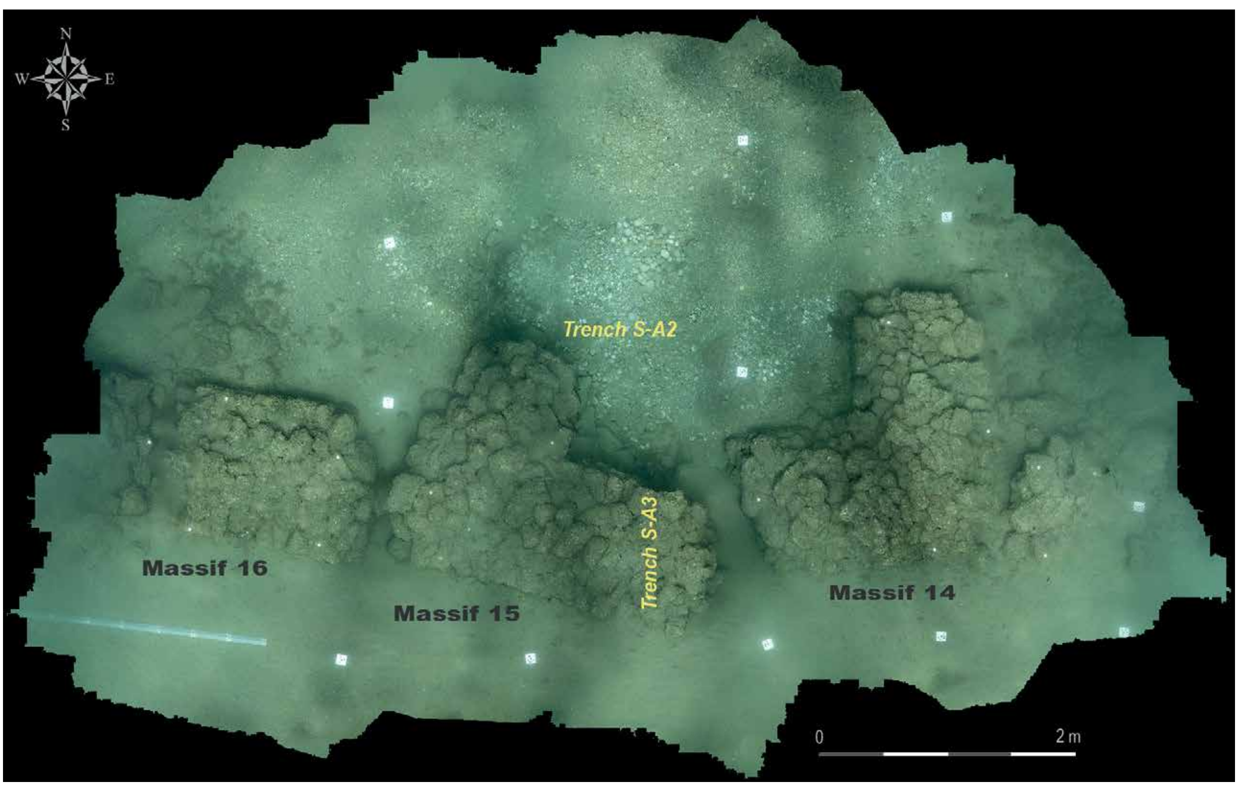

Figure 5. Ortho-photography of a portion of the Structure A north wall: Massifs14-16. Localization of the trenches S-A2 and S-A3 (photogrammetry Laurent Borel, CNRS-CCJ; DAO Souen Fontaine, DRASSM).

provided by the acoustic map augmented by *in situ* observations (Fig. 3). Precise mapping of this huge pile of ashlar blocks requires extensive photogrammetric and topometric work, which will be conducted during the forthcoming campaigns.

On the north side, the frontage is made up of several segments of wall (each 3 m long), built of small stone rubble bound with mortar (Fig. 4). Between each wall segment or 'massif', a space of *c.*500 mm is observed. These empty spaces may correspond to missing wooden elements or could be the result of a violent event that disrupted the wall. The photogrammetric restitution of the entire north frontage is still in progress. It is hoped that, when complete, it will help to check if it could have been a single wall broken, regularly, in several parts. The wall is preserved for three courses and comprises a very

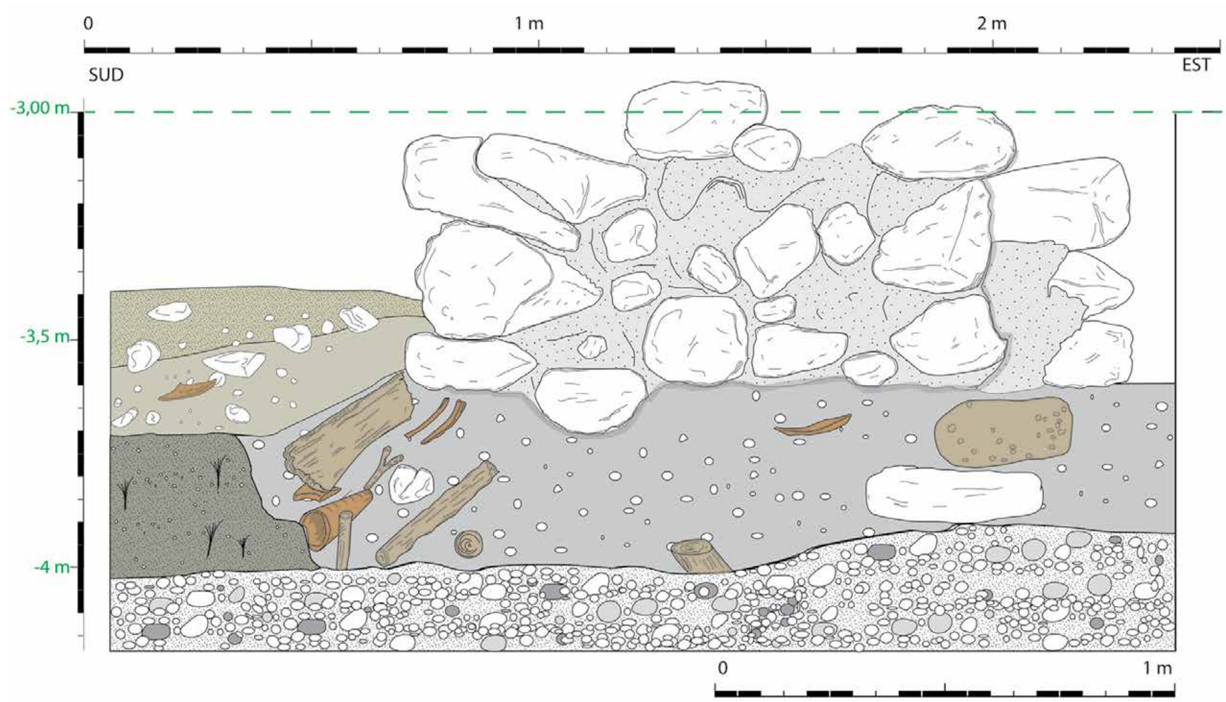

Figure 6. Stratigraphic section of the eastern part of the Massif 15 of the Structure A north wall (Trench S-A3, campaign 2018) (Mourad El-Amouri, Ipso Facto Co-op).

regular facing on each side. The filling is made of the same stone rubble and mortar.

The observation of the stratigraphy of two trenches excavated on different portions of the north wall, between Massifs 7-8 (Fig. 4) and on Massif 15 (Fig. 5), revealed several elements. The stratigraphic sequence is thin and the wall is not preserved under the sediment. Under the surface-level sand, a second layer is composed of sand, ceramics, and stone rubble from the wall: it is a destruction layer, more or less disrupted by the sea-currents in this shallow-water environment. Just under this layer and a very thin layer of organic material, the sediment layers have no further trace of anthropic presence. The natural layers include levels of sand and pebbles and a clearly visible level of silt in which remains of posidonia are preserved where they once grew. The last level reached in the trenches is composed exclusively of pebbles, well known in the area and called 'galets de la Crau', an ancient geological level formed by the overflow of the Durance river.

The last trench cut in 2018, on Massif 15 (Fig. 6), cut across the wall to observe a neat section of the building method.[3] The organization of the stone facing and infill of the wall disallows the hypothesis of a wall built in water. Moreover, a trace of a foundation trench is visible under the wall and this configuration confirms that this wall was built on dry land. Below the section where the wall starts, three wooden piles are preserved in place.[4] Finally, a large piece of driftwood tree trunk was discovered lying just below the lower part of the wall. Its position cannot be the result of a storm, or any event capable of moving a trunk of this size. Although our first thought was that it could be a kind of *sablière* or cil-beam, a system often used to build in wetlands, radiocarbon analysis dating the wood to 2036-1889 BCE suggest it was 2000 years old when the wall was built: this led us to believe the trunk had been preserved in the wetland environment in which the wall's foundation trench was dug.

Regarding the composition of the mortar, a first analysis of the samples shows a low density of mortar and the presence of volcanic material that does not match sand local to Fos.[5] The filling-mortar of the wall was sampled in 2018 and some complementary analyses are now in progress. Three small, well-preserved twigs were trapped

3 Fieldwork done under the scientific supervision of Laurent Borel, CNRS, CCJ.

4 Dendrological studies of these pieces of wood, by Sandra Greck of Ipso Facto research group, are in progress.

5 The analyses by P. Excoffon and P. Dubar aimed to compare the data of the ROMACONS Project (Oleson *et al.*, 2014) and the data of later research focused on the constructions of the Forum Iulii (Excoffon and Dubar, 2011).

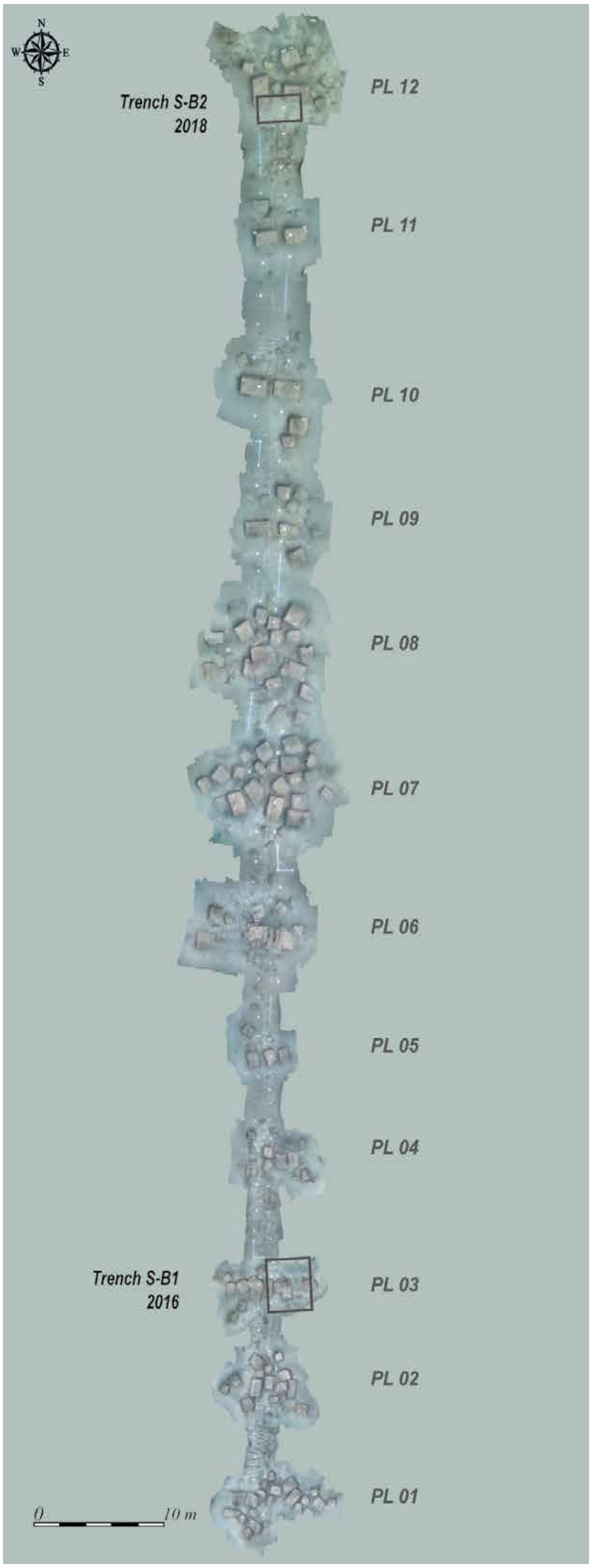

Figure 7. Ortho-image of the entire Structure B, from Pillar 1 (south) to Pillar 12 (north) and localization of the Trenches S-B1 (Pillar 3) and S-B2 (Pillar 12) (Photogrammetry Laurent Borel, CNRS-CCJ, DAO Souen Fontaine, DRASSM).

in these new samples, which should allow radiocarbon analysis to give a date for the building of the wall.

Structure B

Structure B is located 60 m southeast of Structure A and about 380 m from the current beach (Fig. 2). Of the monumental structures identified in the centre of the cove, it is the farthest from the coast and the closest to the Roman wrecks known in the bay (Marlier, 2018; Fontaine *et al.*, 2019, 37-43). Oriented North-South, it is composed of a succession of 12 built pillars (or *pillae*) emerging from the sand, distributed over a total length of 100 m. The spacing between the pillars varies from 3-6 m, some heaps of ashlar blocks being more extensive than others. The initial spacing is likely to have been more regular (Fig. 7). The structure emerges from the sand at a maximum depth of 4.5 m to the south, towards pillars (PL) 1 and 2, the farthest offshore. At the north end, towards the interior of the bay, PL12 is covered by less than 3.5 m of water. The junction of the pillar alignment with the large, scattered heap of blocks immediately to the north suggests a possible connection between PL12 and a destroyed building. Generally speaking, the pillars are in the form of a pile of fairly large ashlar blocks. The various traces of execution and assembly left on the hard limestone blocks testify to a high-quality architectural project. The blocks are regular and are of significant sizes (several formats are identified: the most common is about 1.5 m x 1 m). The pillars are preserved for one or sometimes two courses above the sand. No mortar has been identified as present.

Revealed by the first survey tests in 2013, it was very quickly identified as an arched structure and became the subject of several survey and documentation campaigns. The complete structure was the subject to a photogrammetric survey, which allowed a plan to be drawn up (Fig. 7). Two trenches were cut, one at PL3 (Fig. 8), towards the southern end, and one at PL12, the northernmost pillar, towards the coast. As this structure appears to have been connected to a building on land and it extends south into the water, towards the area where wrecks have been found, we hoped to distinguish different foundation methods used at each of its ends. Considering that this structure on arches probably depended on a construction on the ground to the north and advanced into the sea to the south, towards the sector where the wrecks lie, we hoped to be able to observe a difference in the mode of foundation between both ends of these pilae. The pillars are not preserved below the level of surface sand, which is mobile and moves during storms: the stratigraphy preserved is probably very much altered by the movements of the marine currents. The pillars, north and south, are simply blocks laid on a level of coarse sand mixed with fragments of ceramics.

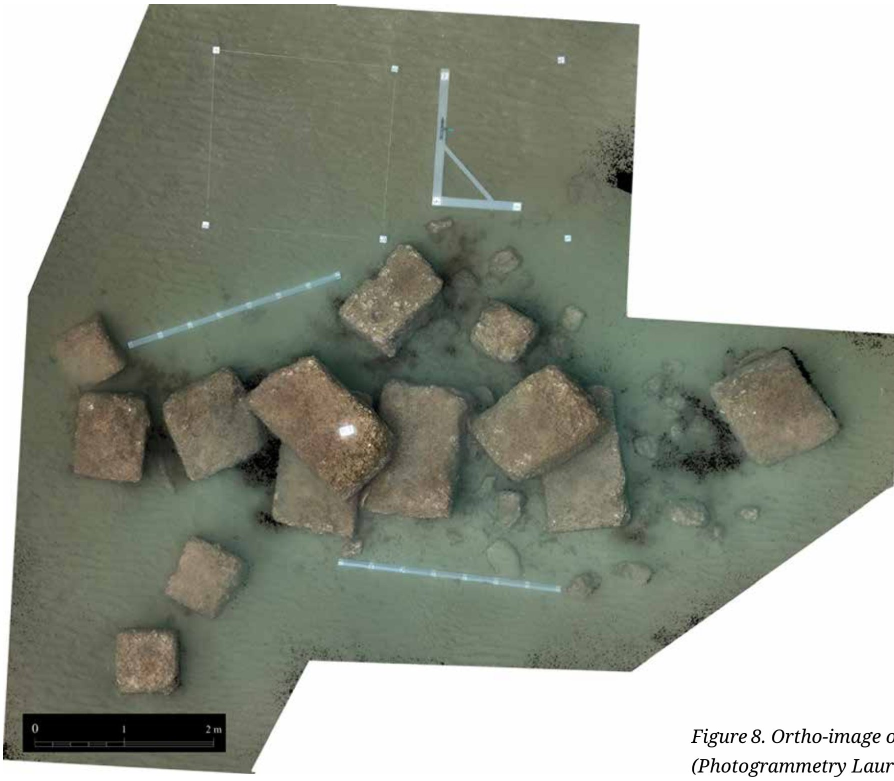

Figure 8. Ortho-image of Pillar 3, Structure B (Photogrammetry Laurent Borel, CNRS-CCJ).

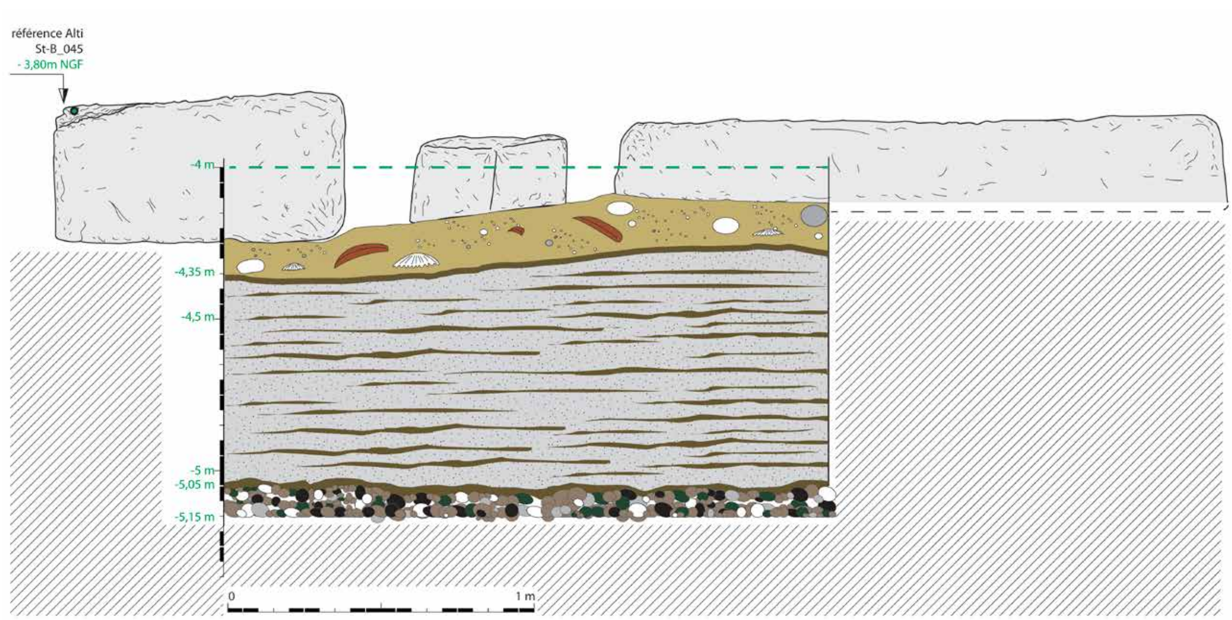

Figure 9. Stratigraphic section of Pillar 12 (east-west section of the south front of the pillar, Trench S-B2, campaign 2018) (Mourad El-Amouri, Ipso Facto).

Figure 10. Aureus (gold coin) found in the lowest anthropic layer in the trench at Pillar 3 of Structure B (Trench S-B1, 2016 campaign) (Loïc Damelet, CNRS-CCJ).

Figure 11. Roman fresco from Stabiae, probably representing Puteoli Harbour (ancient Pozzuoli). Museo Archeologico Nazionale of Naples (inv. 9514) (© Prisma Archivo/ Alamy).

Below this level, finer sand is largely mingled with dead posidonia and constitutes a sterile level without any anthropogenic elements (Fig. 9). As far as one can judge, no evidence excludes the pillars having been built with their foundations in water, nor any to exclude their construction on land. In the latter case, however, the function of this linear structure built on arches would be enigmatic.

The fairly abundant ceramic corpus found in the surface levels around the blocks of the pillars corresponds, in its composition, to the general facies of the harbour context of Fos-sur-Mer and was probably deposited by sea-currents when the structure was in operation or after its abandonment. It is composed mainly of amphorae dating to the 1st-3rd centuries CE.[6] In the Area PL3 trench, at the foundation level of the pillar, an *aureus* was found, bearing the effigy of Domitian (Fig. 10). This relatively rare coin (only ten are now listed) was minted in Rome during the reign of Titus, in honour of Domitian, between the beginning of the year 80 and the end of 81 (Suspène *et al.,* 2017). Given its position in the trench, this coin cannot have had a votive function; its presence is more likely the result of a loss when the structure was in operation.

Like many other buildings identified or studied in Saint-Gervais cove, most of the stones of Structure B have been robbed out, probably for recycling. It is easy to imagine that the well-made, non-submerged, ashlar blocks were systematically recovered for new constructions sooner or later following the abandonment of the site, whether this was prompted by a violent event or not. This state of affairs, where only the lowest levels of the structures are conserved, complicates the interpretation and understanding of the structures. Be that as it may, the particular morphology of Structure B leaves little ambiguity about the restitution of the pillars, which is comparable to those that figure notably on the villa Stabieae fresco that probably represents the port of Pozzuoli (Fig. 11) and its jetty: the Pillae. This assumes that the northern part of Fos Pillae is connected to a building on land. An archaeological exploration of the vast accumulation of blocks, extending over 160 m east-west and about 80 m north-south (Sector D, Fig. 2) will be conducted in the coming years to determine if such a building has been preserved.

6 Studied by Daniel Rodriguez, MoMArch Student, Aix-Marseille University.

Figure 12. Altar or statue base (Musée d'Istres, inv. 8894), at the time of its discovery in 1994 on the site of the so-called 'Submerged Necropolis', 300 m from the monumental complex in the centre of the cove (Bertrand Maillet, Archives of Ministry of Culture/DRASSM).

A port site on the scale of Saint-Gervais cove

The monumental complex comprising Structures A, B, and C that occupies the centre of Saint-Gervais cove and probably extended eastward with one or more buildings in Sector D, is part of a much larger archaeological area that occupies nearly 40 hectares in Saint-Gervais bay between the beach of Cavaou in the west, Saint-Gervais beach in the east, and Saint-Gervais rocky point in the southeast (Fig. 2).

Some 300 m southwest of Structure A, more than 50 funerary stones (*stelae*, altars, part of a sarcophagus) and architectural elements (cut blocks) are scattered over about 7000 sq m. Several *stelae* and altars discovered in the 1970s have been brought up from the sea and are currently being re-studied (Courrier *et al.*, forthcoming), particularly the unpublished inscriptions on four of them. Most of the funerary stones are stylistically dated from the late 1st to 2nd century CE. In 1994, about ten trenches were dug under the *stelae* and an altar still in place (Fig. 12), but no burial could be identified and the research team, led by Gassend, has concluded that an erosion phenomenon leached the burials and sediment leaving only the stone elements *in situ* (Gassend and Maillet, 1994; Gassend and Maillet, 2004). Although this hypothesis seems plausible, various characteristics still suggest ambiguity over the actual presence of a necropolis (see Marty *et al.*, 2019), for example, the significant scattering of the funerary stones; the strong presence of architectural blocks that are not specifically funerary; and the existence nearby (at the Marronède site, on the other side of Saint-Gervais point) of an ancient structure in which some funerary and architectural stones are re-used. Further *in situ* archaeological investigations will have to be carried out to map the distribution of funerary elements and non-funerary architectural blocks precisely. This being said, the recent confirmation of the terrestrial nature of the neighbouring monumental complex strengthens the possibility of another land site, funerary or not, in this area today submerged under 2-3 m of water.

Further northwest in the cove, along what is today Cavaou beach, two 'hangars' were identified in 1965, using aerial photography. Now buried under the sand, one of the two buildings was the subject of several excavation campaigns between 1989 and 1995 by a team led by Gassend (Gassend and Maillet, 2004). Until now, there is no consensus on their interpretation of the function of these buildings as *navalia* (shipsheds). Marie-Brigitte Carre and Kalliopi Baika are currently revisiting the archaeological and architectural data as part of the Fossae Marianae Project (Fontaine *et al.*, 2019, 30-31; Baika and Carre forthcoming).

To the east of the monumental complex, beyond Sector D, a very large area of ashlar blocks is visible on acoustic cartography and aerial photographs. This area, Sector H (Fig. 2), extends almost to Saint-Gervais beach. To this day only partially surveyed, this area is undoubtedly a space where one or more buildings were erected (Fig. 2 and Fig. 13). Several concentrations of large ashlar blocks are observable and, on the southern periphery, towards the sea and the rocky Saint-Gervais point, a succession of four to seven clusters of ashlar blocks has been identified (only the four most eastern ones have been seen *in situ* by the Fossae Marianae project team). Spaced at 10-20 m, they are arranged in a

Figure 13. Map of Saint-Gervais beach area: main building remains as seen on archive and recent aerial photography (GIS Fossae Marianae, Souen Fontaine, DRASSM).

circular arc to the south of Sector H. About 30 m further south, fragmentary columns were discovered in the 1949 and were brought up. In aerial photographs from the 1960s, Sector H connects with the submerged structures of Saint-Gervais beach. Many discoveries have been made close to the beach since 1948: thousands of complete and fragmentary amphorae, ceramics, and other objects, barrels, wood and bone *instrumentum*, etc. Several structures are also known, including a probable warehouse (Structure J) formed by alignments of stones, some with deep, carved quadrangular mortises intended to receive support pillars.

In this sector (Fig. 13), the fieldwork of the Fossae Marianae project has mainly focused, for the moment, on a set of wooden piles 300 m north of the warehouse mentioned above, which were recently cleared of sand by the movements of the sea. Surface-clearance, carried out between 2017 and 2019, of an area about 100 sqm around this structure (T), uncovered at least 397 wooden piles still in place and occupying 30 sqm (Fontaine *et al.*, 2019) (Figs 14-15).[7] The piles, planted very close together, straight or at an angle, draw the foundations of probable walls that were about 1 m wide. Although we have only cleaned a small area of the structure, there is little doubt that it has a pile-foundation system intended to support a substantial building, built in a humid environment. The structure comprises mainly softwood piles – mainly Aleppo pine (*Pinus halepensis*) and stone pine (*Pinus pinea*), probably of local origin – shaped in a rudimentary manner, still with bark and thus placed while still green. In two distinct parts of the main structure, the piles made of pines stand next to several rows of oak piles the shaping of which is very different. The oak piles have regular octagonal cross-sections. In a trench opened in 2018 (sondage S-T3), 30 m further north of the main trench, under a thick layer of sand, the same structure continues and nearly 80 piles have been cleared in an area of 10 sqm, all made of oak. A combination of radiocarbon dating of two of the piles gives a

7 Excavation and dendrological studies conducted by Sandra Greck in collaboration with Axel Eeckman, Ipso Facto Co-op.

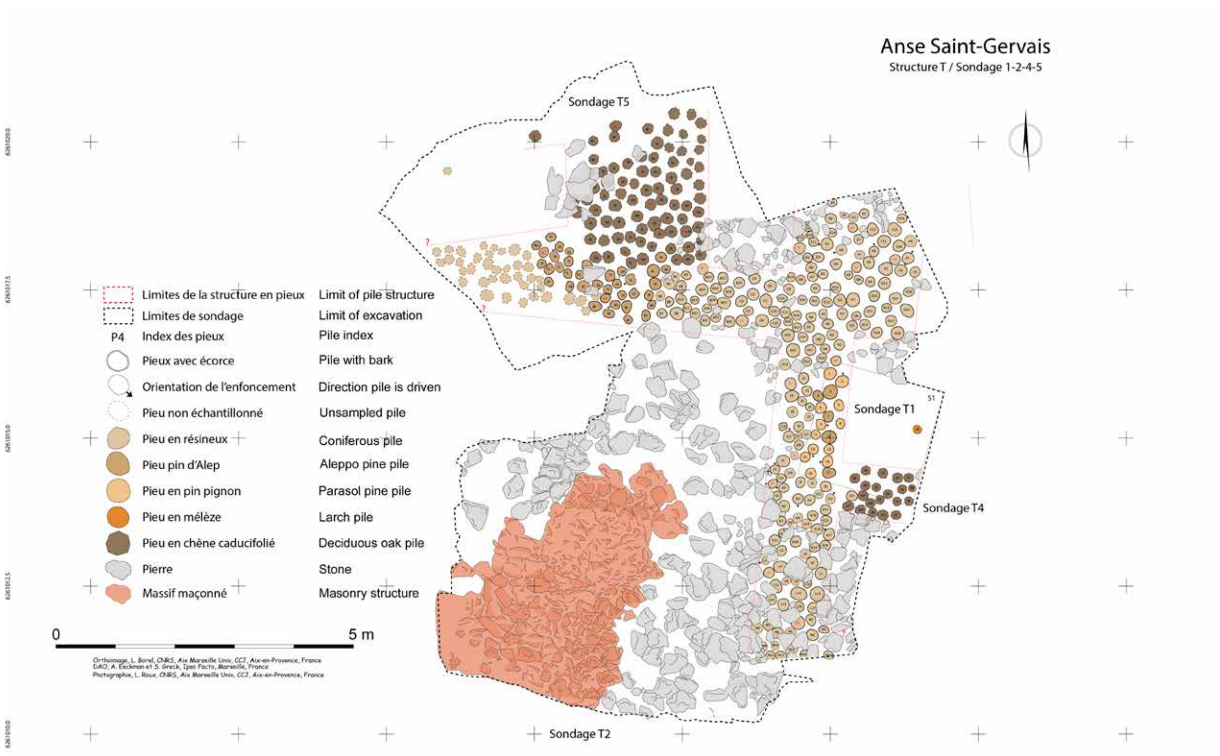

Figure 14. Excavation in progress on Structure T, a building with a pile-foundation system (Photography Loïc Damelet, CNRS-CCJ).

Figure 15. Map of the piles found in Trench S-T1, Structure T (Map Sandra Greck and Axel Eeckman, Ipso Facto Co-op).

date in the mid 1st century CE (Fontaine *et al.*, 2019). The stratigraphy observed in the deep trench (S-T1) shows a well-preserved succession of layers characterizing a humid environment, even a nearshore lagoon, with the presence of layers of dead posidonia. It also reveals that the area was sanitized before the piles were set in place, as evidenced by a thick layer of lime (200-500 mm). This important layer of lime is also found in the area of the neighbouring warehouse (Structure J) and on the wetland reclamation site (Estagnon) excavated, on land, a few hundred metres away (Fig. 13).

The use of a pile-foundation system is a common practice in Roman wetland construction, particularly in lagoonal contexts, and an excellent nearby parallel is provided by the example of the *circus* at Arles, built in the middle of the 2nd century CE in the humid context of the Rhone banks (Sintès, 2011). This considerable building has a pile-foundation system with characteristics almost identical to those of Fos. A majority of softwood piles, still green and roughly cut, is supplemented by octagonal oak piles in some strategic locations requiring more mechanical strength. This analogy between the two constructions, at Fos and Arles, is perhaps not fortuitous and one can legitimately contemplate whether they were carried out within the same construction programme, or at least by the same builders. Although it is not yet possible to assess the size of the Saint-Gervais Beach building, it is assumed, given the construction method, that it is a large building.

Conclusion

The work of the Fossae Marianae project on this very rich area on the edge of Saint-Gervais shore is just beginning. This space, now submerged by less than 1 m of water or covered by beach sand and by current houses on the seashore, was undoubtedly a terrestrial, humid space occupied by a set of functional installations linked to the activity of the port when the Roman harbour was in use. With all the reservations that the very incomplete state of our knowledge demands, the outline of the layout of the port facilities and probably of the associated city are gradually being drawn by our investigations. By corollary, a complex natural environment, still poorly understood, is also being defined: the emerged lands remained wet and one or more lagoons extended – probably deep – into the terrestrial space. The port basin has not yet been localized. In addition to the continuing synthetic study of old data and new archaeological fieldwork on the various sites, both in the port space and on the canal, two major research activities will be carried out in the coming years: the resumption and continuation of the geomorphological study and detailed geophysical mapping, including under the sediments, sectors in very shallow waters that are still technologically problematic (sub-bottom profiler), and on the beaches and the peninsula of Saint-Gervais (GPR and ERT). The objective is to be able to propose a reconstruction of the harbour facilities and the possibly associated city, to understand their chronology and their organization, the evolution of the complex natural space which surrounds them, and the reason for their abandonment and their current submersion.

A better understanding of these elements should enable us to assess more precisely the importance and chronology of the port and, consequently, to place this *statio*, permanently or for a period related to the Fossae Marianae, in the wider harbour system of the Rhone river delta in which Arles, Marseille, Fos and the mouths of the river (at Saintes-Maries-de-la-Mer) are necessarily connected.

Acknowledgements

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The First Marine Structures Reported from Roman/ Byzantine Ashkelon, Israel

Do they solve the enigma of the city's harbour?

Ehud Galili, Baruch Rosen**, Asaf Oron***, and Elisabetta Boaretto*****

The inland territories of ancient Ashkelon served as a productive and rich agricultural hinterland, giving the city commercial and strategic advantages. Archaeological finds and literary sources point to an intensive maritime activity and international trade, yet no harbour has been discovered there. The coastline of Ashkelon is straight, sandy, and lacking bays, and could not provide shelter for seagoing ships during winter storms. This contradiction has been noted but never resolved. During 2002 and 2004 two wooden piling installations were discovered some 130 m offshore and 5-7 m deep. Dated by radiocarbon analysis to the Late Roman-Byzantine periods, they are interpreted as an offshore mooring facility and artificial beaching installation respectively and are described and discussed.

Keywords: wooden pilings, wooden mole, mooring, harbour, anchorage.

Ancient Ashkelon is situated on the coast of the Judean plain, a productive and rich agricultural hinterland (Figs 1a-b). The city is located on the coast adjacent to the Via Maris, which connected Egypt with Syro-Canaanite coastal points to the north. Ashkelon also served as the sea terminus to the incense trade route, connecting the East with the Mediterranean coast (Avi-Yonah and Eph'al, 1975). This location gave it commercial and strategic advantages, which brought about its development as an important urban centre, beginning in the Middle Bronze Age (20th-17th century BCE). Its flourishing trade was terminated with the end of the Crusader period (late 13th century CE). The success of the city depended heavily on the sea and port facilities that were needed to maintain such extensive maritime trade. The existence of a landing place is inferred from the archaeological evidence of continuous sea trade found in the city. However, no built harbour facilities have been discovered there.

A diversity of imported goods has been recovered in archaeological excavations at Tel Ashkelon. There is historical evidence for trade in oil, wine, and other agricultural products, which were distributed all over the Mediterranean (Stager, 1992; Devorjetski, 2001: 121-127; Stager and Schloen, 2008). This evidence points to widespread maritime ties between Ashkelon and the large trading centres of the Mediterranean basin.

Evidence of the role of Ashkelon can be found also in historical records. In Pseudo-Scylax's guide for seafarers from the 4th century BCE, Ashkelon appears as a

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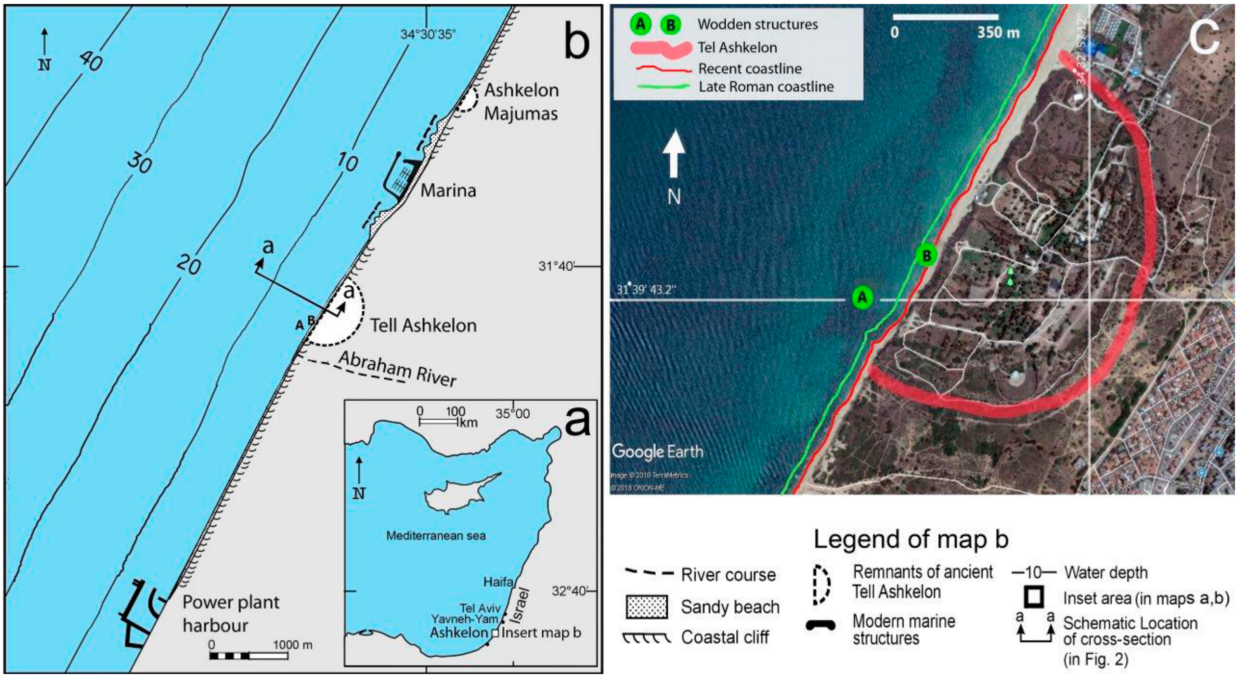

Figure 1. Location map: a) the eastern Mediterranean and the Israeli coast (E. Galili); b) Ashkelon coast, including the location of the cross-section a-a (see Fig. 2) (E. Galili); c) Tel Ashkelon, the location of the two wooden installations (A, B), the location of the coastline during the Late Roman period (green line) and at present (thin red line) (Modified by E. Galili after Google Earth: Image ©2018 TerraMetrics; © 2018 ORION-ME; © 2018 Google; Image © 2018 Digital Globe).

coastal city (Stern, 1974: 3: 8-10). William, Archbishop of Tyre, visiting Ashkelon in 1153, after the Crusader conquest, wrote:

> Ascalon derives no advantage from being situated on the seacoast, for it offers no port or safe harbour for ships. It has a mere sandy beach and the violent winds make the sea around the city exceedingly choppy so that, unless the sea be calm, those who come there are very suspicious of it. (Babcock, 1943; Brundage, 1962: 126-136)

The Arab historians Ibn Shaddâd and Abu al-Fidâ, citing earlier sources, stated that Ashkelon did not have a harbour in which ships could anchor (Sharon, 1995: 65). Victor Guerin, who surveyed Ashkelon's ruins between 1854 and 1863, echoed his predecessors:

> The pattern of the Ashkelon coast is not at all suited for giving shelter to ships, therefore Ashkelon never had a port or anchorage that could provide safe haven for ships, but only a dangerous sandy beach. (Ben-Amram, 1982: 100, 109-110)

Despite the intensive surveys and excavations carried out to date, no remains of a built port have ever been found in Ashkelon. No historical description suggests that the city had a port, while some categorically deny its existence. The coast of Ashkelon is straight, sandy, and lacks bays and islets that could provide shelter for seagoing ships during storms. The nearest temporary shelters for ships are Tel Ridan anchorage, 40 km to the south (Raban and Galili, 1985), and Yavneh-Yam anchorage, 35 km to the north (Galili and Sharvit, 1991; 1996; Galili *et al.,* 2002), and these could not be used in winter. Thus, Ashkelon is situated at the centre of a 75 km-long coastal strip that lacks havens for ships during storms and certainly does not enable safe loading and unloading of goods in a stormy sea.

This article reports the discovery of two marine-associated installations made of wood at Ashkelon. The finds constitute the first known mooring facility and marine approaches in Ashkelon. The structures, interpreted as an offshore mooring facility and a shore installation, are described and discussed below.

The finds

Underwater and coastal surveys at Ashkelon were carried out by the Israel Antiquities Authority (IAA). The underwater archaeological remains opposite Tel Ashkelon (Figs 1a-1c) are usually covered by a protective layer of sand. Changes in the amount of the sand-cover in the shallows, caused by natural or human interventions,

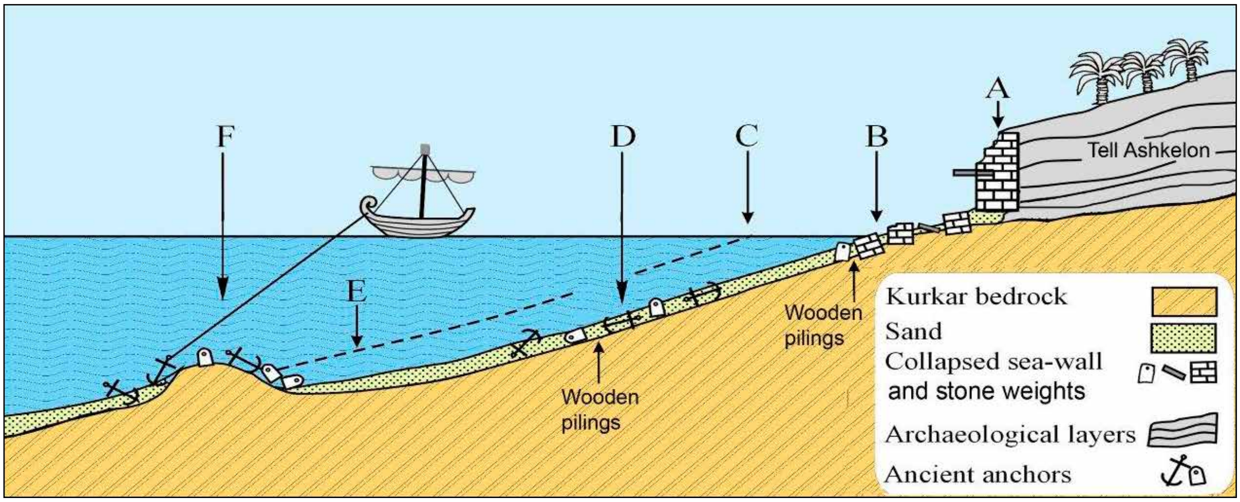

Figure 2. Schematic possible reconstruction of the cross-section of Tel Ashkelon coast during the Late Roman-Byzantine periods (for the location of the section, see line a-a in Fig. 1b): A) ancient seawall with granite columns in secondary use; B) remnants of the seawall and ancient settlement that collapsed into the sea, and stone weights (depth 0-1 m); C) ancient coastline; D) remnants of wrecked watercraft (depth 2.5-4.5 m); E) ancient level of sand; F) offshore anchor hold on a submerged kurkar ridge (after Galili et al., 2001).

periodically expose these remains (Galili *et al.*, 2001). The finds on the sea-bottom have included:

1. artefacts and architectural elements derived from the ancient city site, which is subjected to marine erosion found scattered in the shallows, 1-30 m offshore at 0-1 m depth (Fig. 2 B);

2. artefacts originating from shipwreck assemblages, located in the breakers zone, some 70-130 m offshore at 2.5-4.5 m depth) (Fig. 2 D);

3. and concentrations of lost anchors scattered on or near submerged *kurkar* reefs some 200-600 m offshore, at depths of 6-10 m (Fig. 2 F). These have been interpreted as offshore anchor holds.

In addition, indirect evidence for artificial beaching facilities has been recovered in the shallows, some 5-25 m offshore, at water depths 0.5-1 m including clusters of biconical millstones made of basalt (weighing 100-180 kg each), some of which were filled with lime plaster, and perforated olive-press stone weights made of limestone (200-300 kg each) (Fig. 3). Given that these stones were found in very shallow water, they could not have been part of a lost ship's cargo: on the Israeli coast, heavy objects originating from shipwrecks are usually found in the breaker zone in water 3-4 m deep, some 100-120 m off the present coastline. It is assumed that these stone weights were being re-used to stabilize capstans and movable slipways (Galili *et al.*, 2001). Such wooden capstans were used in the region for hauling ships until the beginning of the 20th century (Hornell, 1934: 105, fig. 12).

Figure 3. Secondary-use millstones and perforated olive-press stone weights made of basalt and limestone respectively discovered in the shallows opposite Tel Ashkelon. They were probably used for stabilizing capstans and movable slipways (E. Galili).

The recent finds of lines of wooden pilings on the seabed off Ashkelon are the first evidence of marine facilities built in an attempt to improve the connections between this city and the sea. The pilings were recorded under water by divers using measuring tapes, an underwater camera, and a water-resistant drawing board. They have been deliberately left at sea for future studies. The remains of these wooden pilings will stay where they were found until a comprehensive study of the site is completed. They will be retrieved after such study and when their long-term preservation is assured.

The offshore wooden installation (Structure A)

The offshore installation is located 130 m off Tel Ashkelon, at a depth of 4.6 m, on a rocky seabed with sandy patches interspaced by pebbles (N 31º 39´ 43.19´´; E 34 º 32´ 27.74´´) (Galili, 2004). Here, the shore is straight and sandy, offering no sheltered anchorage (Figs 1b and 1c). The remains of six upright wooden pilings were recorded. When recorded, they protruded some 50 mm vertically above the sea-bottom (Figs 4, 5, 6a). No excavation was conducted to prevent damage to the delicate, waterlogged, wooden remains. Of the six, three were semi-circular in section (300-400 mm in diameter), one was rectangular (360 x 240 mm) and one was an approximate quarter circle in section (280 x 260 mm). The pilings were driven in a line (7.2 m long) parallel to the coast at an angle of 40º east. The distances between the pilings range 1-2.1 m. Because the areas north and south of the pilings are presently covered by shifting sediments, it is unknown whether the wooden piling line continues in either direction. The area between the installation and the present-day coastline was surveyed for several years when exposed, and no sign of any connection to the coast

Figure 4. A diver checking a wooden piling in Structure A (E. Galili).

Figure 5. Detail of the wooden piling of Structure A (E. Galili).

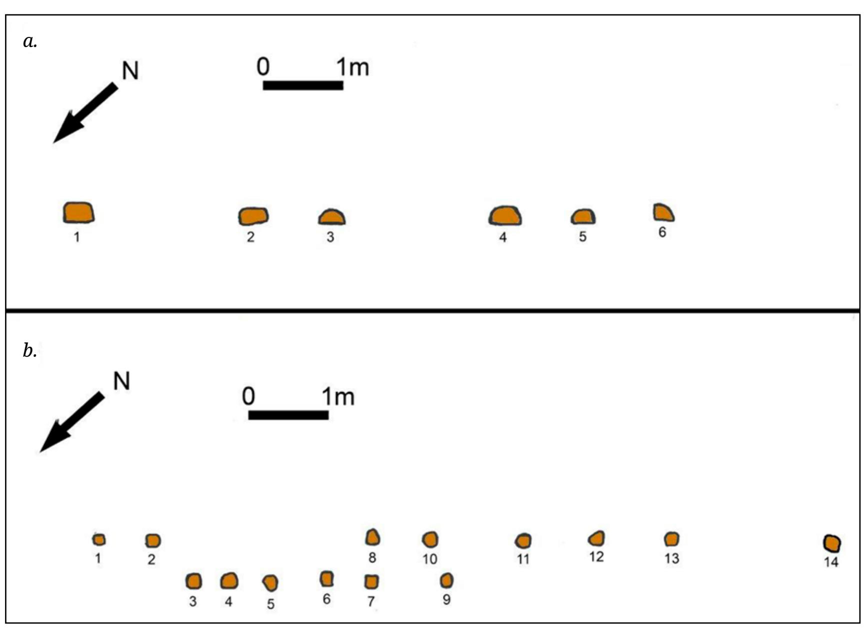

Figure 6. Plans of the wooden structures: a) Structure A (E. Galili); b) Structure B (E. Galili after J. Sharvit).

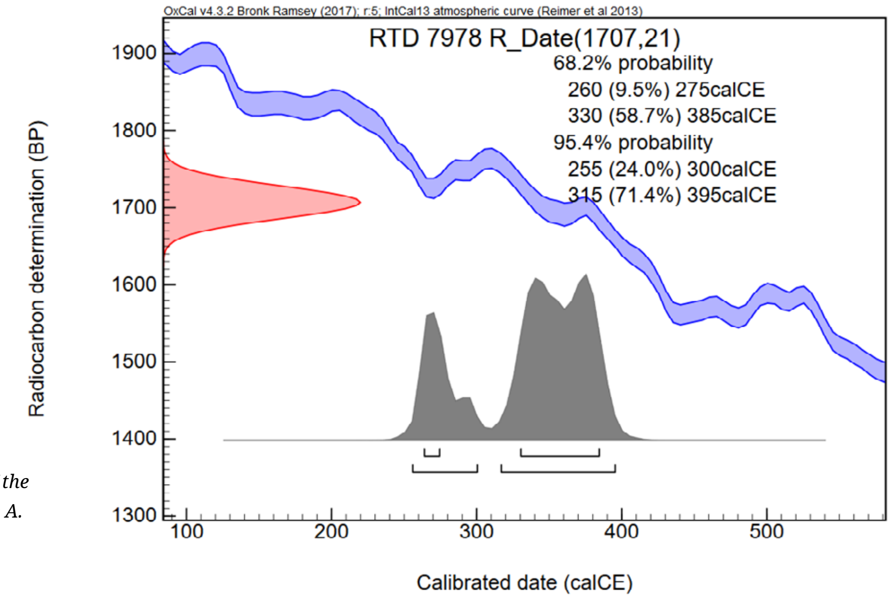

Figure 7. The probability distribution of the calibrated range of RTD 7978, Structure A.

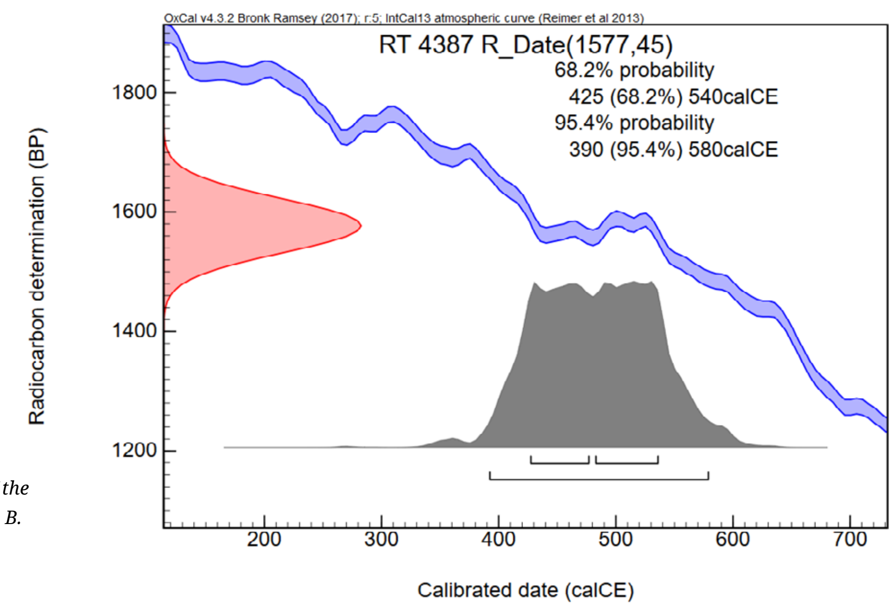

Figure 8. The probability distribution of the calibrated range of RTD 7978, Structure B.

was found. Three of the pilings were sampled (Nos 1, 4, 6) for future wood identification. One of the pilings (No. 1) was dated by radiocarbon. The sample RTD 7978, was pre-treated to eliminate the environmental contamination and measured by Accelerator Mass spectrometry technique (AMS) based on the Dangoor Research Accelerator Mass Spectrometer at the Weizmann Institute (Regev *et al.*, 2017). The calculated ^{14}C age of the multiple rings considered is 1707 ± 21 years ^{14}C BP. The calibrated range for this sample is 260 CE (9.5%) 275 CE; 330 CE (58.7%) 385 CE (for the ±1 σ, σ = standard deviation) or 255 CE (24.0%) 300 CE; 315 CE (71.4%) 395 CE (for ±2σ). The calibration was obtained using Oxcal v.4.3.2 ©Bronk Ramsey (2017) based on Bronk Ramsey (2001), based on the calibration tables of Reimer *et al.* (2013). The calibrated range, which covers the second half of the 3rd and the whole 4th century CE should be considered as a *terminus post quem* for the construction of the structure, which could, therefore, be attributed to the Late Roman or Byzantine period (Fig. 7).

The coastal wooden installation (Structure B)

This wooden installation (9.8 m long) is located in the shallows opposite Tel Ashkelon (N 31º 39´ 47.14´´; E 34 º 32´ 36.6´´) (Sharvit 2002). Thirteen wooden pilings were discovered on a sandy seabed rich with pebbles. The pilings were arranged in two parallel lines (500 mm apart, at an angle of 42º east), at a depth of 1 m, 5 m from the present coastline at the north end of the structure and 7 m at its south end (Fig. 6b). The rectangular pilings were inserted vertically in the sea-bottom, protruding some 200-300 mm above it. Some of them have preserved their original rectangular section (150 x 200 mm) while others have been eroded. South of the pilings structure and adjacent to it, three basalt millstones were found. One of the pilings was radiocarbon dated. Sample RT 4387 was measured by Liquid Scintillation Method at the Weizmann Institute (Boaretto, 2004). The calculated ^{14}C age of a large number of rings is 1577 ± 45 years ^{14}C BP. The calibrated range for this sample is 425 (68.2%) 540 (for ± 1 σ), and 390 (95.4%) 580 CE (for ± 2 σ). The calibration was obtained as for sample RTD 7978 above. The calibrated range, which covers the 4th and the large part of the 5th century CE should be considered as a *terminus post quem* for the construction of the structure, which could be therefore attributed to the Byzantine or a later period (Fig. 8).

Discussion

Ashkelon's role as a sea gate

Underwater archaeological finds and literary sources point to intensive maritime activity and international trade in ancient and medieval Ashkelon. It served as an active sea gate from the Late Bronze Age (~1500 BCE) to the end of the Crusader Period at the end of the 13th century. During these periods it played an important social, economic, and political role in the history of the southeast coast of the Mediterranean. However, all information sources suggest that the city never had a sheltered, built harbour. Judging by the archaeological finds and the historical records, it seems that in Ashkelon ships anchored a few hundred metres offshore where they found submerged *kurkar* ridges that were used as anchor holds (Fig. 2 F). Cargoes and passengers could have been transported between shore and ship by lighters (Galili and Sharvit, 1996; 2000; Galili *et al.*, 2000; 2001).

Classification of ancient shore-sea approaches along the coast of Israel

To search for harbour facilities in Ashkelon, one has to look at similar structures that have developed since the start of navigation along the Israeli coast. In addition to built harbours, there are several types of anchorages, moorings, and artificial beaching facilities along the coast that are based on natural morphological features. Using archaeological findings, one may draw a tentative typology for harbours, anchorages, and mooring facilities on the Israeli coast. The following is a revised, updated version of the typology set out by Galili and Sharvit (1994):

1. Built harbours: facilities, such as quays, breakwaters, jetties, etc. were usually constructed by governments starting during the Iron Age or Persian period. Such facilities were identified at Akko, Atlit and Caesarea (Raban, 1985: passim; 1993; 2009; Galili, 2009; 2017b; Galili *et al.*, 2018).

2. Proto-harbours based on natural features (3-7 m water depth): a sheltered area on the lee side of a partly submerged *kurkar* ridge, having some manmade improvements. These were located about 70-200 m offshore. They were used from the Middle Bronze Age by seagoing vessels for overnight anchoring and while waiting for favourable winds. Such features were identified at Caesarea (Galili *et al.*, 1993; 2011; Galili, 2017a; Ratzlaff *et al.*, 2017), at Apollonia (Grossmann, 1997; Galili *et al.*, 2018), at Yavneh-Yam (Galili and Sharvit, 2005; Golani and Galili, 2015), and at Tel Ridan (Raban and Galili, 1985).

3. Isolated stone-built piers: three such features were recorded in Caesarea: a Crusader pier made of re-used Roman columns on the city seafront and two ashlar-built piers in the southern anchorages: the northern one was destroyed by the construction of a modern pier and the southern one was made of pierced ashlars, probably the base for a vanished wooden pier (Galili, 2017b).

4. Isolated wooden marine installations: remains of ancient wood pilings associated with marine installations have been discovered underwater in Akko and Atlit. Two such previously unpublished structures discovered near Tel Ashkelon are the focus of this article.

5. Isolated slipways: three such slipways, dated to the Hellenistic period, were discovered in the northwest section of Tel Dor (Raban, 1981).

6. Rock-cut mooring facilities: rock-cut bollards have been recorded south of Tel Shiqmona and south of Tel Akhziv, while mooring holes have been found south of Tel Dor (Galili *et al.*, 2018).

7. Shallow-water natural anchorage (3-7 m water depth): this type is similar to the Type 2 proto-harbours mentioned above, but without any manmade improvements. Such anchorages have been found at Akhziv, Shavey-Zion, at Atlit north and south bays (Galili and Sharvit, 1999), Neve-Yam, Dor (Kingsley

Figure 9. Schematic possible reconstruction of a mooring facility made of wooden pilings off Tel Ashkelon, and a movable artificial beaching facility (E. Galili).

and Raveh, 1996), Ma'agan-Michael, Tel-Taninim (Zarka), Caesarea, Michmoret, and Jaffa (Galili *et al.*, 2018).

8. Very shallow-water natural anchorages (1-3 m water depth): a shelter created by small natural features close to the coastline. This type of anchorage usually uses minor bays and abrasion platforms for anchoring fishing boats and lighters. Traditional fishermen currently use similar features at Zarka, Shiqmona (south of Haifa), north of Acre, and south of Akhziv.

9. Natural offshore anchor hold: a submerged *kurkar* ridge, located some 200-600 m offshore, with its peak lying at 4-12 m below sea-level. Features such as this provided an optimal holding ground for anchors. Ancient vessels chose such places for anchorage in areas where no shelters or port facilities were available and where the sea-bottom was generally silty or sandy. Two anchorages of this type have been found off the coast at Ashkelon and one off Mikhmoret in central Israel (Galili *et al.*, 2018).

10. Harbours at the outlet (estuary) of a coastal river: it was suggested that Israeli coastal river channels could have served as inland harbours for seagoing vessels during the Bronze Age (Raban, 1985). However, no archaeological evidence confirming the existence of such an inland harbour has yet been found.

Building wooden marine construction in Israel in antiquity

Substantial wooden marine constructions are extremely rare on the Israeli coast due to lack of local sources of raw timber and an ensuing lack of proper technical proficiency (Liphschitz and Biger, 1995; Rosen *et al.*, 2004). The technologies of marine constructions using wood are more typical of Atlantic Europe and northern shores of the Mediterranean, where suitable wood is abundant (Liphschitz and Biger, 1995).

Function

The Structure A pilings, found 130 m from the present coastline, were probably intended to support a permanent structure that was stabilized by being driven into the sea-bottom. The now-vanished upper structure probably protruded above the sea surface. It seems reasonable to assume that it served as a facility associated with marine activity. As only one line of well-founded pilings was located, the possibility that any kind of stable working platform existed above the water is reduced. The piles could have been used for mooring watercraft offshore (Fig. 9). The facility would have enabled the mooring of lighters or small to medium-sized vessels by tying one end to a piling and casting an anchor at the other end.

The Mediterranean Sea is characterized by a micro tidal range, so watercraft cannot be beached and maintained using the tide. In antiquity, Mediterranean watercraft were artificially beached on open, bare beaches lacking any long-lasting artificial beaching facilities (Votruba, 2017). Structure B discovered in the

Figure 10. Launching a boat with a movable slipway on Anfushi beach, Alexandria (Photo E. Galili 17.6.1996).

shallows off Tel Ashkelon was probably on the sandy shore or the beach when it functioned. Coastal erosion shifted the coastline eastward and today the exposed structure foundations are observed at 1 m depth. Given its location, this structure was associated with the sea, but could not have served as a mole or a dock. However, it could have been used like bollards, for tying up lighters, or might have served as a part of wooden slipway or artificial beaching facility. The existence of movable slipways and capstans on the beach opposite Tel Ashkelon has been previously proposed and was based on the discovery of clusters of biconical mill-stones and perforated oil-press weights in the shallows adjacent to the wooden structure. It was suggested that these stones in secondary use were intended for holding movable slipways (Galili *et al.*, 2001) (Figs 9-10). The existence of such facilities was associated with the term *Nadiraya de Ashkelon* mentioned in the Talmud (Sperber, 1993: 163-166). Similar wooden slipways were seen in use in contemporary Alexandria (Fig. 10). Wooden capstans were used in the early 20th century in Haifa bay (Hornell 1935: 105, fig. 12). The shoreline wooden pilings reported above may have been part of the artificial beaching facilities on the Ashkelon coast.

Conclusions

The reasons for the development of Ashkelon as a major marine trading centre stemmed mainly from considerations such as connections with the hinterland, accessibility to inland trade-routes, and the geopolitical situation, and not because of coastal characteristics and easy approach. Ships arriving at Ashkelon would have by necessity anchored in the open sea, hundreds of metres offshore, using *kurkar* sandbanks and underwater rocks to ensure an anchor hold. Coastal lighters probably transferred goods and passengers between the coast and the anchored ships. The indirect evidence for artificial beaching facilities on the coast suggests that small boats were hauled ashore for repairs and protection from winter storms. The offshore Structure A may be considered as the first manmade mooring facility discovered off Ashkelon. It enabled small to medium-sized ships to moor some 100 m off the city coast during calm seas. Structure B, now situated in the shallows could have been used for mooring (like bollards) or as a part of an artificial beaching facility.

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Fortified Crusader Harbours of the Syro-Lebanese-Palestinian Coast

*Patricia Antaki-Masson**

The Crusaders owned several harbours along the Levantine shore, which were necessary for the landing of goods, pilgrims, merchants, and fleets. Most were fortified to counter possible enemy attacks and thus had multiple defensive structures and protective measures. This paper discusses these fortified elements, which included seawalls, towers, fortresses, entrance chains, and the use of massive masonry. Literary and iconographic documentation is used to give an overview of the fortified harbours, complemented by the surviving archaeological evidence that has been studied in recent years.

Keywords: ports, harbours, Crusades, fortifications, Syria, Lebanon, Palestine.

During their two-century stay in the Holy Land, for obvious security reasons, the Crusaders gave utmost attention to the defence of their settlements. The fortifications they erected consisted primarily of fortresses, towers, city walls and, last but not least, fortified ports. These havens were vital since it was in these ports that most merchandise and people were landed – hence the need for them to be safe strongholds, even more so in times of trouble when the enemy (mainly the Fatimids, and later the Ayyubids or the Mamluks) might attempt to storm a town with their fleet.

However, it is important to point out that by the time the Franks arrived in the Levant at the very end of the 11th century, these harbours had already existed since very remote times and some had been fortified since the Phoenician Period, the Hellenistic period, or Romano-Byzantine times (Carayon, 2008); for example, the harbour of Caesarea built by King Herod the Great at the end of the 1st century BCE.

In addition, during the Medieval period which preceded the arrival of the Franks, the Muslims – namely the Umayyads, the Abbasids and the Fatimids – who had to face Byzantine naval raids, had also engaged in the construction of strong defences in several harbours, such as at Tyre or at Acre (Akko) (Borrut, 2001; Bramoullé, 2007: 96-104). As a consequence, Frankish harbour-works sometimes built over or incorporated older infrastructures. A good illustration of this point is revealed by the historian William of Tyre who describes the amazement of the Crusader army when entering the city of Tyre in 1124 after its capture: 'They admired the fortifications of the city, the strength of the buildings, the massive walls and lofty towers, the noble harbour so difficult of access' (William of Tyre, 1986: 21).

After a general presentation of the Crusader harbours in the Levant, this paper will examine the main defensive features of these particular places in an attempt to give

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a clear picture, as accurate as possible, of the defensive character of the coast as it appeared at that period (see Deschamps, 1934: 73-76).

General overview

The anchoring places to be found along the Levantine shore, from the Gulf of Alexandretta in the north to the Egyptian boundary in the south, were numerous. However, very few were considered to be potentially good ports (Mollat, 1967: 356) and even those that ranked among the best, such as Acre, couldn't accommodate large ships because of an inadequate depth of water (Gertwagen, 1996: 570). Only the main ports will be listed here – or, at least, those which are known to have displayed defensive works – although one can assume there were countless small, sheltered havens which could also provide safe anchorage for small crafts (Hijāzī, 1992) (Fig. 1).

In the northernmost coastal Frankish state, the Principality of Antioch, which corresponds today to the southern littoral of Turkey and part of northern Syria, a series of small harbours seems to have been used mainly for the export of pinewood from the nearby Amanus mountains (Rey, 1884: 332-333; Cahen, 1940; Deschamps, 1973: 70; Bronstein, 2005: 51). Besides the port-town of Calamella (modern-day Tinet), which was located on the Gulf of Alexandretta and was part of the Armenian kingdom of Cilicia, there were similar places such as Payas (or Baiesses), the frontier town between the Armenian kingdom and the Principality, Alexandretta (Iskenderun) port which proved to be useful for the siege of Antioch, and Port Bonnel (in Arabic, Arsouz) which was in the hands of the Templars. The last major port on the Turkish coast, the famous port of Al-Mina or le Soudin (or Sweydyya), served the city of Antioch: it was located about 27 km from Antioch and 1 km inland from the mouth of the River Orontes (Deschamps, 1973: 53). Unfortunately, very little is known or remains today of any of these harbours, even of Al-Mina (Vorderstrasse, 2005).[1] Further south, ships could find shelter in the ports of what is now the Syrian coast. The chief port of the region was the flourishing city of La Liche (Latakia).[2] Other known anchorage places of some relative local value were those of Gibellum Major (Jableh), Balda, which served as an outlet for the products of the surrounding fertile plains, and Banyas, which marked the frontier with the southern county of Tripoli. Moving

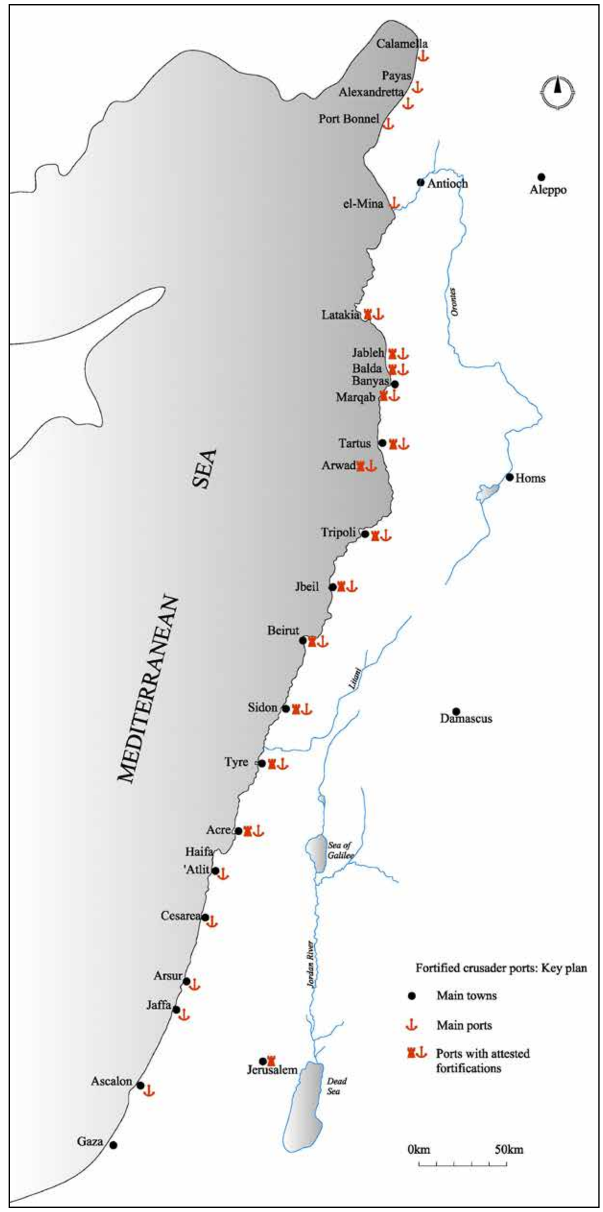


Figure 1. Location of the main Levantine medieval harbours (P. Antaki-Masson, drawn by H. Kahwaji-Janho).

to this other Latin state we find Marbaṭ al-Marqab, the harbour of Marqab castle, Maraclea or Maraqiyya (Major, 2016: 118-120), and Tortosa (Tartous), which housed the headquarters of the Templar order in Syria.[3] This city possessed a harbour recently identified 2 km to the north and which had its own suburb (Major, 2016: 117) and another located in the facing island of Arwad. The next major harbour was located

1 For a geographical description of this region in Crusader times, see Cahen, 1940: 109-176.

2 On a possible fortified port in the bay of Ibn Hani, 6 km north of Latakia (Rey, 1884: 335 and Major, 2016: 120).

3 There existed also a smaller port called al-Qantara (al-Qunaytra), located 8 km north of Maraqiyya, possibly endowed with a tower (Major, 2016: 119).

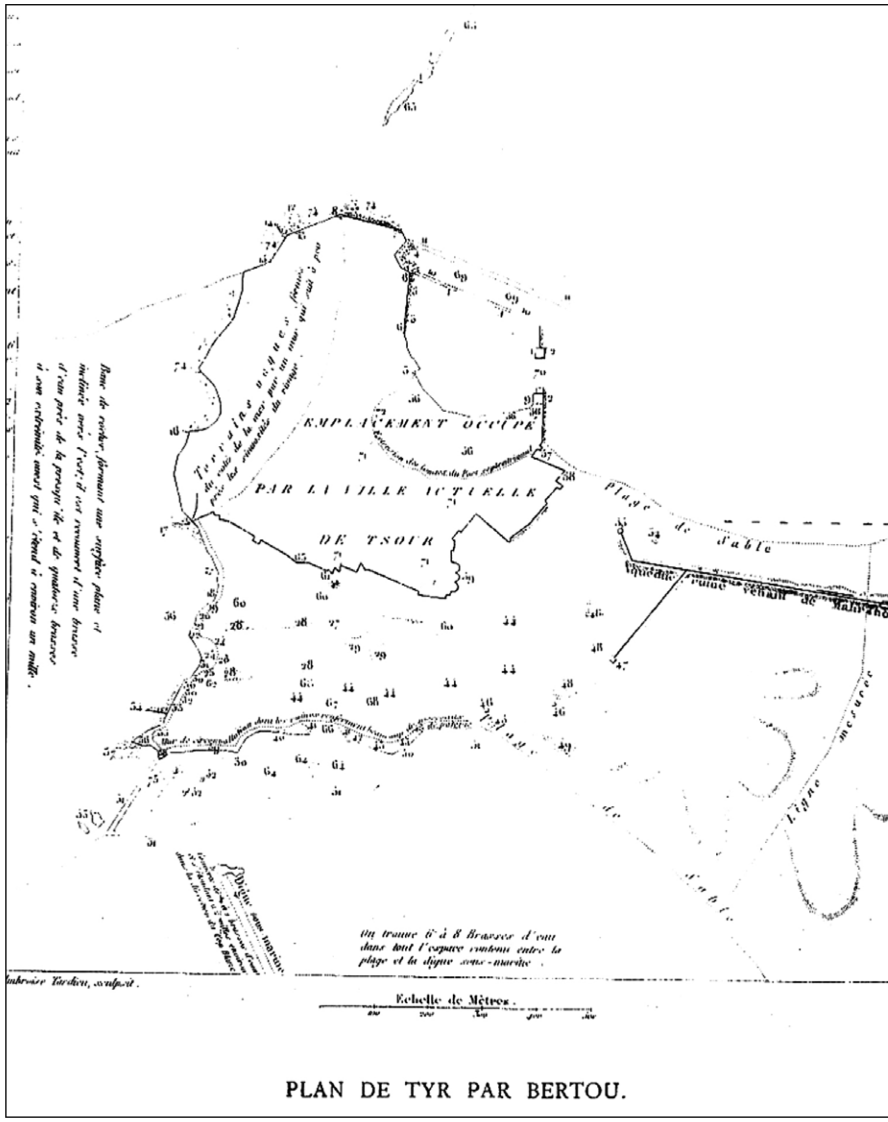


Figure 2. The layout of the harbour of Tyre in the 19th century (Map P. Du Bossay, 1861).

in today's Lebanon – the northernmost city and eponymous capital of the Crusader county, Tripoli. The port must have stood near the closest island that the city possessed since it is there that some old harbour-works have been identified close to the modern jetty (Viret, 2000: 127-130). Sailing further south, one would encounter the minor port of Jbeil, or Gibelet as it was called by the Genoese who ruled the city. Once in the heart of the Latin settlement, the kingdom of Jerusalem, vessels could anchor at the major ports of Beirut and Sidon, which were also the nearest to the important city of Damascus. The next two harbours are the most important of the whole coast and belonged, not surprisingly, to two major thriving Frankish cities: Tyre (Sour) (Antaki-Masson, 2016: 5-6) and Saint John of Acre (Akko).

On the Palestinian coast, closer to the Holy City, as one might expect, several more ports are to be found. However, quite unexpectedly, most of them were not very convenient for a safe landing, if at all, as reflected in the historical and archaeological record. These were the ports of Château Pèlerin ('Atlit), Caesarea (Qaysaryyeh), Arsur (Arsuf),[4] and Jaffa, which was the closest to Jerusalem and which was recorded in the Islamic period to have been excellent (Borrut, 2001: 29), although it seems it had lost its importance by the Crusader period (Pringle, 2008: 62).

4 There is still a debate among scholars on whether it was a real harbour or simply a mooring basin for small vessels (Mirkin, D. *et al.*, 2016).

Natural defences

Before analysing the manmade fortified works of these harbours, a close look at their natural defences should first be considered since these also played a protective role as natural breakwaters. These geological features consisted primarily of natural promontories, islands, and offshore reefs. The port of Beirut, for example, was protected on the west side by the spur of land of Ras el-Chamiyeh and on the east side by a promontory and its castle, both projecting into the sea. Opposite Tartous was the island of Arwad, which became the last Crusader outpost in the Holy Land when a Templar garrison was able to maintain its presence there until 1303. Tripoli had several islands; among these, the closest to the city, al-Baqar, is known to have been the place where Crusaders sought refuge when Mamluks captured the city (Viret, 2000: 127-136). Sidon has two islands; one on which its sea castle was erected, and al-Zire island. As for reefs, which usually protected outer harbours such as that of Tyre, they were found in places such as Tripoli, where they extend for about 7 km or in Tyre, where the discovery of several medieval anchors and cargo is clear evidence of the use of this spot as a mooring place (Frost, 1971: 107) (Fig. 2). In Jaffa, the main features of the harbour consist only of reefs, among which is the rock to which Andromeda was supposedly chained (Pringle, 2008: 261).

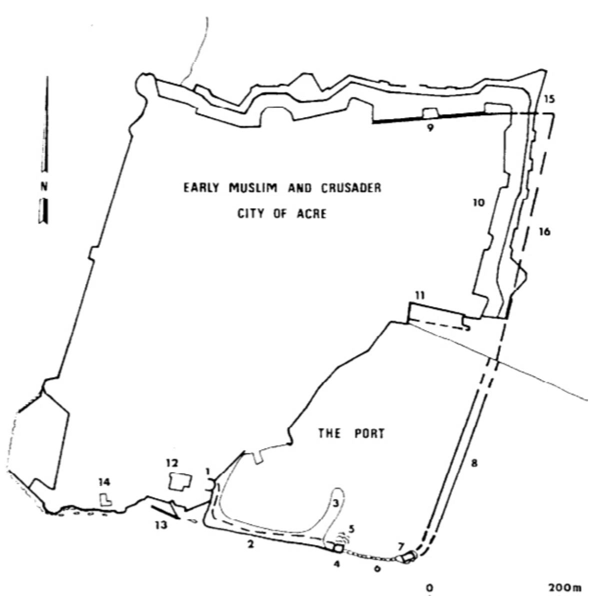


Figure 3. Reconstitution of the Crusader harbour of Acre (Map R. Gertwagen, 1996).

Defensive and guard towers

Among the defensive measures and the most prominent features of the ports set in place by Frankish engineers were the towers. These were built in most cases at harbour entrances to oversee entries and exits, and to shelter the garrison. They were also used, very likely, as visual navigational aids, as was probably the case, for instance, of the Tower of Flies, which stands today isolated in the middle of Acre harbour (Jacoby, 1979: 10-11) (Fig. 3). Here, a common configuration was the presence of one tower on each side of the entrance. Acre's Tower of Flies originally faced another that today lies under water (Linder and Raban, 1965: 183).

In the port of Jbeil only a northern tower is still standing, but a group of scattered columns lying to the south, below water, not long ago, indicated the location of its pair (Renan, 1864: 160) (Fig. 4). In Beirut, 19th-century engravings and visitor's accounts depict two towers, which were originally part of a single structure, the opposite tower is probably located on the wharf (Rey, 1871: 173-174; Davie, 1987: 157) (Fig. 5). In Tyre, the northern tower, which has disappeared today, seems to be observable on a 19th-century painting (Wilson, 1883). In Jableh, Rey describes the foundations of a massive tower on the northern side of the port entrance in the 19th century. According to him, it was further separated from the land by a ditch (Rey, 1871: 175-176; Major, 2016: 120). In Latakia a huge tower, built sometime around 1261, the foundation of which is still visible under the modern lighthouse, was still standing in the 19th century as attested by old engravings (Fig. 6). This tower is mentioned in the sources as being a substantial defensive feature which also served as a pigeon tower and as a lighthouse (Rey, 1871: 178; Hijāzī, 1992: 217-224; Major, 2016: 74-75, 117). Indeed, it was only following the tower's destruction by an earthquake that the Mamluks were able to seize the city in 1287. As far as the strategic importance of some towers is concerned, the Tower of Flies of Acre harbour can be mentioned again: it was taken twice by the Genoese to block the entrance to the inner basin (Jacoby, 1979: 10). These towers were usually connected to the city by the means of moles but some stood directly on land, as was probably the case in Beirut.

Sometimes, in addition to the entrance towers, there were others on the moles and wharfs nearby or integrated into city walls. We know from historical sources that the port of Tyre, for example, could claim at least three. Rey saw the remains of two towers in this harbour, one on the eastern mole and one at the tip of the northern mole (Rey, 1871: 167-168). These were also recorded by Poulain de Bossay (Fig. 2). In Banyas, Enlart saw the ruins of a tower on the shore (Enlart, 1928: 441; Major, 2016: 119). In Jbeil, foundations of towers on the mainland were still visible half a century ago as recorded by

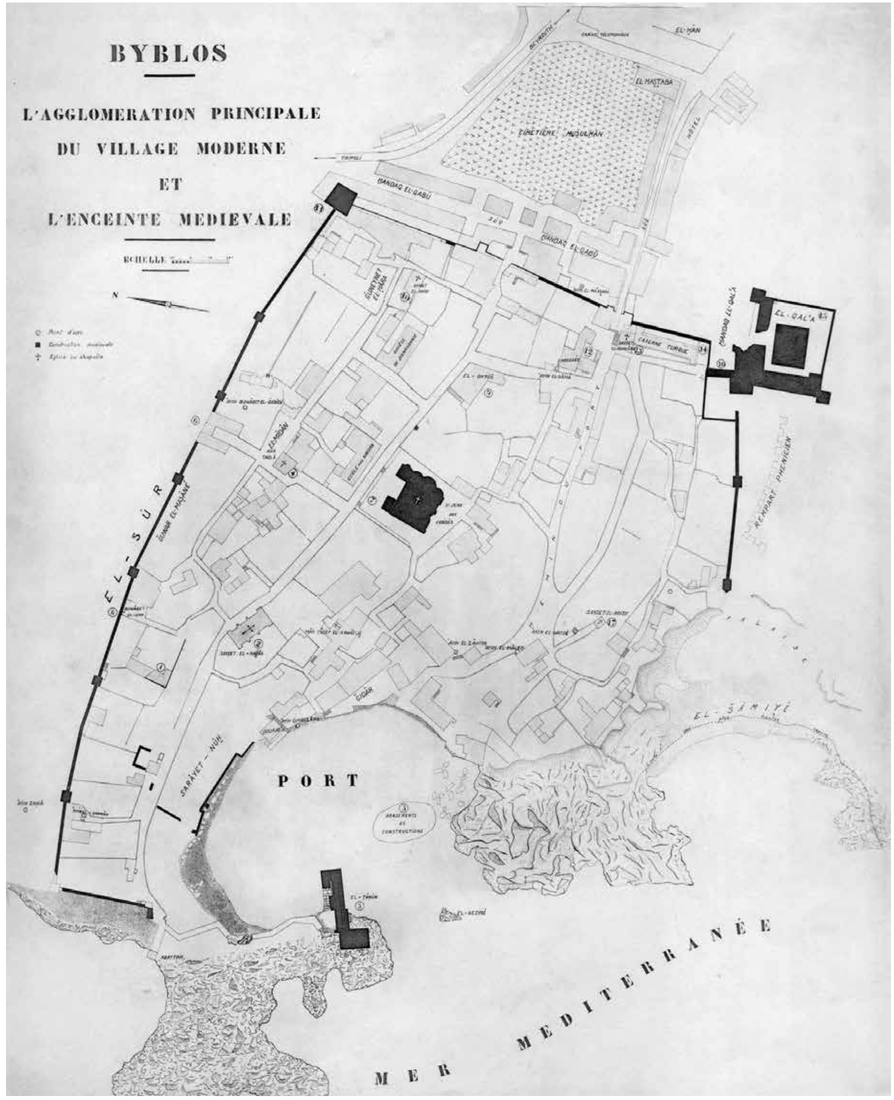


Figure 4. The layout of the harbour of Jbeil showing the remains of seawalls and towers (Map M. Dunand, 1939).

visitors, on old plans and in photographs (Renan, 1864: 159; Condé, 1964: 67-69).

These defensive buildings were usually square or rectangular and of various dimensions – the tower of Maraclea (Hijāzī, 1992: 129), for example, measured 16 m along one side. In Arsur, there is evidence for circular towers located at the corners of the western seawall (Mirkin *et al.*, 2016: 296) (Fig. 7). Another example of a round defensive tower might be a structure with foundations identified under the modern northern mole of Tyre harbour (Noureddine and El-Helou, 2005: 121-122) (Fig. 8). In Jbeil, two round towers were still visible half a century ago at either end of the port (Condé, 1964: 68-69). Acre boasted a round tower (Jacoby, 1979: 17). Some towers had a cistern which could have proved helpful in case of a long blockade, like that observed in the tower at Beirut or in Maraclea by Guillaume Rey in the 19th century (Rey, 1871: 174, 160).

The only two complete and original towers still standing today are those of Acre and Jbeil, all others having disappeared or being preserved only at foundation level. Sometimes, texts provide the name of some of the towers: the Tower of Flies at Acre, and the Tower of the Chain and Tower of Saint Catherine at Tyre (Templier de Tyr, 1906: 757; Antaki-Masson, 2012: 209). Rey speaks of the Genoese towers of Beirut without providing any evidence to support his statement (Rey, 1871: 173).

Protective chains

Another security measure employed for the protection of harbour entrances was the use of a chain, usually stretched between two towers. When this device was raised, unwanted vessels could not enter the basin. It is interesting to mention a case where the chain was

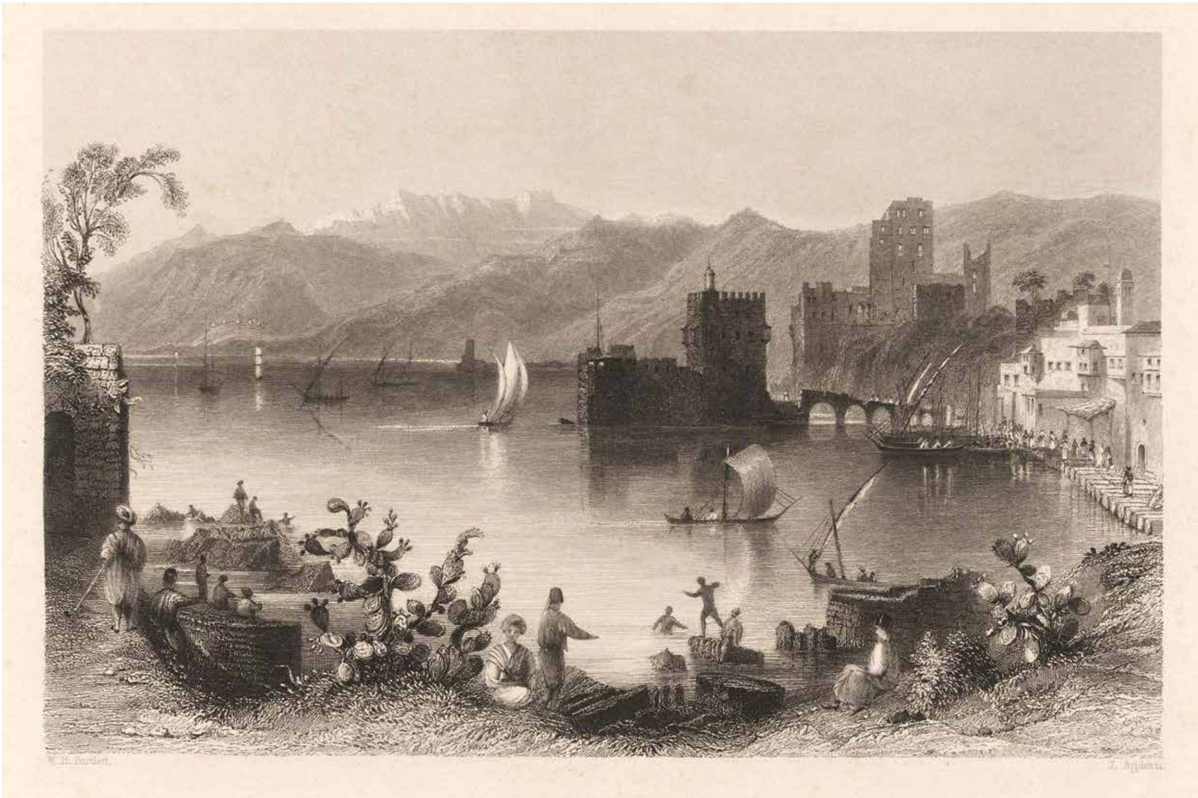
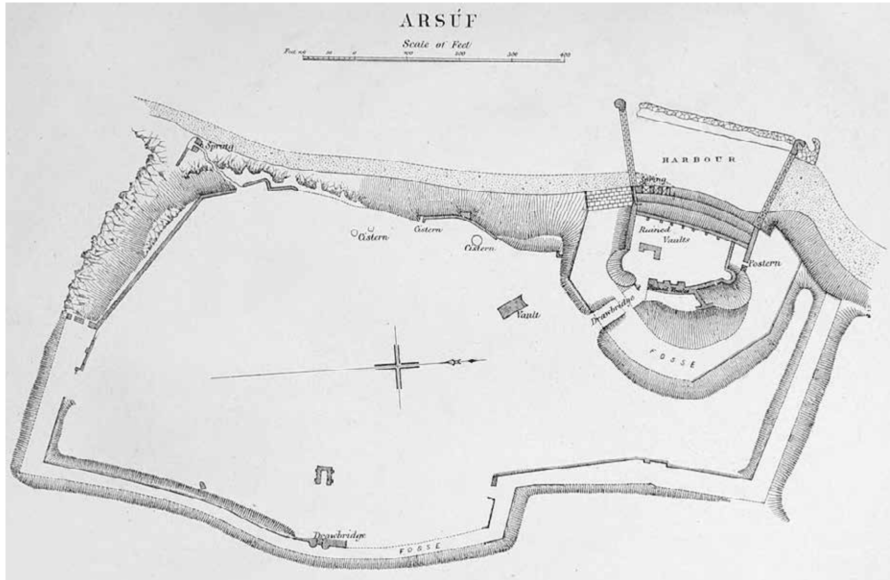


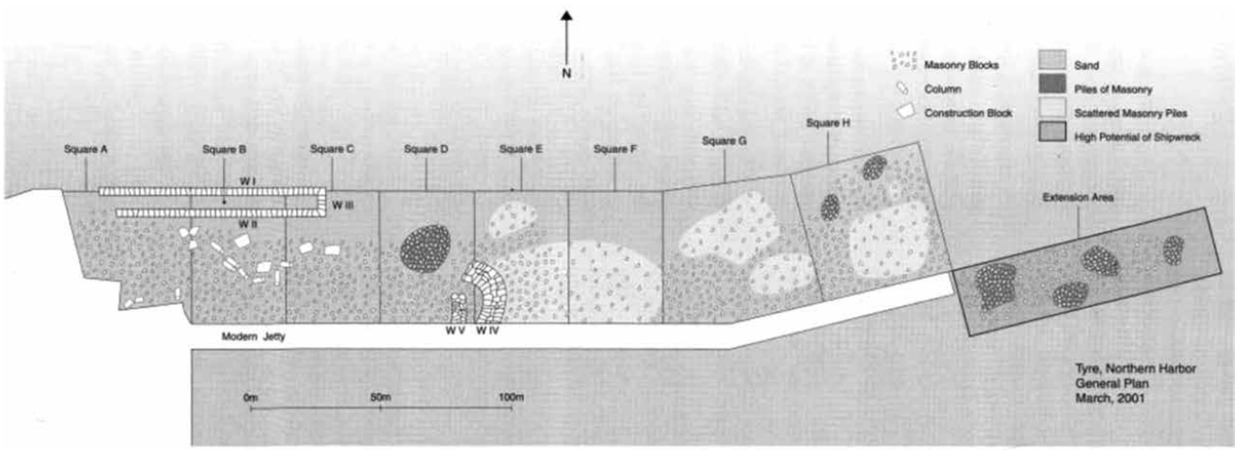
Figure 5 (opposite page, top). Sea towers and citadel of Beirut on a 19th-century engraving (W. H. Bartlett, 1847).

Figure 6 (opposite page, bottom). Engraving of the tower of Latakia in the 19th century (L. Mayer, 1810).

Figure 7 (right). The layout of the harbour of Arsur (Plan Conder and Kitchener, 1882).

Figure 8 (below). The medieval mole of Tyre and possible circular tower (Plan I. Noureddine and M. El-Helou, 2005).





cunningly used, not to prevent entry, but rather to keep the enemy inside. This episode happened in the harbour of Tyre in 1187 while Saladin was trying to gain control over the city. The lord of Tyre, Conrad of Montferrat, lowered the chain to let in five enemy galleys which, once trapped inside, were captured by troops hiding in the Chain towers (Ernoul, 1871: 241-242).

The chain was used in this way from Antiquity in many harbours such as Byzantium or Carthage (Kedar, 2012: 4). Chains were, equally, rather common in the Islamic period. They are attested for example in Tyre harbour from the 9th century (Nāṣir-i Hosraw, 1881: 49; Al-Muqaddasī, 1963: 182-183; Borrut, 2001: 25-26), as well as in Acre (Nāṣir-i Hosraw, 1881; 49; Al-Muqaddasī, 1963: 182; Jacoby, 1979: 13; Borrut, 2001: 24-25), and in the Egyptian harbour of Damietta (Kedar, 2012: 6-7).[5] In the Crusader realm, historical accounts mention only three. One was observed in the harbour of Beirut by a Greek pilgrim, John Phocas (Joannes Phocas, 1875: 531). Another one is accounted for at Tyre harbour by several visitors such as Theodericus (Theodericus, 1980: 384), Ibn Jubeyr (Ibn Jubayr, 1949-1965: 357), or Benjamin of Tudela (1734: 72) who mentions several iron chains (Antaki-Masson, 2012: 379). A third, the location of which is still debated among scholars, was in Acre harbour (Jacoby, 1979: 13-14; Gertwagen, 1996: 564-568).[6] The most famous chain, however, although located outside our field of

5 It is this river chain that came to play a major role twice when the city was later attacked by the Franks (Kedar, 2012: 6-7).

6 About the controversy concerning the chain position and the double harbour location in Acre (Benvenisti, 1970: 95-97; Jacoby, 1979: 13, and Gertwagen 1996: 562-568).

study, was the famous 750 m Golden Horn chain in Constantinople that floated on baulks of tree trunks and that the Crusaders succeeded in breaking during their attack on the city in 1203 (Pryor, 2007). Following their success, the victorious forces sent a section of the chain to Acre where it was used to provide further protection for the harbour (Jacoby, 1979: 13-14). We know of a case where another type of chain, this time made of floating thick wooden beams, was installed at the entrance of Acre harbour by the Genoese to prevent the Venetians from receiving supplies (Jacoby, 1979: 10). In later periods, in the 16th century, chains were still in use in some ports: they appear, for instance, on drawings executed at this period by the Ottoman sea captain and cartographer Piri Reis (Piri Reis, 1935). These chains, as one might expect, have completely disappeared, although one displayed in the Istanbul museum dates back to the 15th century. However, it's interesting to notice that an iron ring was still attached to the base of Lattakia tower at the end of the 19th century (Rey, 1871: 178).

Let's add that the chain was such an important feature of these harbours that it sometimes gave its name to urban features associated with the port. In Acre, for example, the *chaene* was the name given to the harbour quarter as well as to the maritime customs-house (Jacoby, 2005: 88-104), while the *ruga cathene* (from the Latin '*catena*', for chain) designated the main street in the harbour area (Jacoby, 1979: 15-16). In Tyre, according to various documents, the maritime customs were also named *cathena* (Müller, 1879: 27, 37; Berggötz, 1991: 166-167).

Seawalls enclosing the harbours

Harbours could also be protected by seawalls built on moles and quays to make it difficult for the enemy to enter the city if they had succeeded in seizing the port. Although these structures were part of the city defences, rather than the harbour defences, they were nonetheless undoubtedly part of the military landscape of most of the ports. Although they have almost completely disappeared today, some are recorded by eyewitnesses, such as those at Tyre by Ibn Jubayr (Ibn Jubayr, 1949-1965: 357; Antaki-Masson, 2011: 196-197). Traces of others can still be observed on engravings and pictures. Remnants of these structures are still visible in some places such as on the western mole of Acre, which bears traces of Crusader masonry (Jacoby, 1979: 8; Gertwagen, 1996: 559), or at the port of Jbeil, also recorded by several visitors (Condé, 1964: 68-69).

Furthermore, these enclosures had fortified gates with names sometimes related to their association to the sea, such as the gate of Ascalon designated as *Porta Maris* (Pringle, 2008: 62). In Acre the gate was called the *Porta Ferrea* or Iron Gate, as depicted on maps from the 16th century (Jacoby, 1979: 17-18). Sometimes there was more than one gate, as in Tyre, where people entered either through the *Porta Magistra* (Tafel and Thomas, 1856: 140-141; Antaki-Masson, 2012: 379) or through another gate on top of which stood a church dedicated to Saint Peter (Berggötz, 1991: 167; Antaki-Masson, 2012: 379).

Fortresses and towers overlooking the harbours

Besides sea towers, fortresses that stood in the harbour area (usually on land), although not intended primarily to protect the harbour but rather to serve as an ultimate stronghold for defenders, could also prove to be very helpful in the defence of the harbour. With the exception of Sidon Sea Castle, which was built on an islet, such fortresses dominated the harbour as at Tartus, Beirut (Fig. 5), 'Atlit, Cesarea, and Arsur (Fig. 7). A few towers, such as the tower of Burj al-Sabi, which overlooked Marqab port, or the tower at the mouth of the river Nahr al-Sinn in Kharab Balda, must have also played a similar role (Major, 2016: 119-120).

Building techniques

The masonry of such defensive constructions – walls, towers, and fortresses – had several common characteristics. They were usually erected on the natural bedrock, which provided a solid base. Therefore, the sites chosen were islets as at Sidon Sea Castle, promontories as at Beirut land castle, natural promontories (most seawalls), natural reefs such as Arsur western seawall (without the angle towers, though) (Mirkin *et al.*, 2016: 305-306), or even quarry walls such as the northern seawall in Jbeil (Viret, 2005: 18).

Quite often, as already stated, the fortifications were constructed on top of older structures as was the case, for example, of the Tower of Flies, which integrated Hellenistic and Islamic remains (Gertwagen, 1996: 559; Jacoby, 1979: 9). The walls were massive, solid, high, and thick. One of the towers of Beirut, for example, had walls which were 6 m thick and the recently detected Tyre jetty was 9 m wide (Noureddine and El-Helou, 2005: 121). The blocks used were large ashlars with drafted margins and bossed centres, as can still be seen on nearly all the surviving examples (Fig. 9).

In addition, iron cramps coated with lead were sometimes used to fasten ashlars firmly together.[7] These are attested in several places: in the sea tower of Maraclea on the Syrian coast, as stated by Mamluk sources (Rey,

7 This device is recorded since Persian times in maritime constructions (Carayon, 2008: 653).

Figure 9. Columns embedded in the walls of the sea castle of Sidon (Photo P. Antaki-Masson).

Figure 10. Iron tenons in Beirut citadel (Photo L. Sheikho).

1871: 161; Gabrieli, 1969: 240-241) and seen recently by Balazs Major (Major, 2016: 188, pict. 106). In Jbeil, the seawall connected to the northern tower shows traces of such tenons on its external facing. The outer wall of the Sidonian sea castle still retains large grooves for dovetail clamps (Rey, 1871: 156). In Acre, the ashlars in the Tower of Flies are linked by C-shaped iron clamps, although these could be of Muslim origin (Gertwagen, 1996: 559; Jacoby, 1979: 17). Finally, the recently uncovered masonry of the citadel of Beirut also bears such bondings (Fig. 10). It is noteworthy to mention that these are attested in 1212 by a German pilgrim, Wilbrand of Oldenbourg, who saw the castle being erected (Wilbrand d'Oldenbourg, 1999-2003: 306; Antaki, 2002: 338).

The re-use of *spolia* – that is, antique architectural elements – wasn't uncommon. These elements were employed to strengthen walls and, especially, foundations. They were usually column drums of marble or granite that had been imported and used by the Romans in their constructions, which the Crusaders later found, literally, under their feet. Frankish builders incorporated them as headers in the harbour walls as at Latakia (Major, 2016: 117), in the tower and the maritime walls of Jbeil (Condé, 1964: 69), in the sea castle of Sidon (Fig. 9), as well as at Acre, Caesarea, and Jaffa. Other antique elements such as sculpted blocks were employed, such as a fragment of a sarcophagus still visible in Jbeil's northern tower (Renan, 1864: 159), or other, more antique elements, such as in Tyre's recently uncovered maritime tower (Noureddine and El-Helou, 2005: 121).

The written evidence

Literary sources mentioning the erection of harbour fortifications are very rare. The construction of the citadel of Jaffa to defend its port with the help of the Pisans in 1099 against Egyptian naval raids is one of the few examples (Prawer, 2007: 258). Nonetheless, such achievements are usually implicit in the texts. When chroniclers report, for example, that Conrad of Montferrat refortified the city of Tyre to be able to resist Saladin attacks in 1187 (Ibn al-Aṯīr, 1872: 707; Abū Šāma, 1884: 34; Antaki-Masson, 2011: 192-193), it can be reasonably assumed that these works also encompassed the harbour defensive infrastructure. Besides such accounts from various pilgrims and historians, evidence pointing to the existence of such constructions can, ironically, be derived also from mentions of their dismantling. The best-known example is the vast operation of the destruction of fortified infrastructure ordered by Saladin after his victory in Hattin and his subsequent capture of several coastal cities such as Caesarea, Arsuf, and Jaffa – to prevent any possible re-use by the Crusaders. Events proved him right since one of the reasons why the Crusaders were able to re-establish themselves in Acre in 1191 was that Saladin had kept Acre port fortified (Hillenbrand, 2000: 569-570).

Conclusion

To sum up, it should be stressed that among the numerous harbours that were held by the Franks all along the 700 km Levantine coastline, only a few are attested by historical sources or archaeological evidence to have been equipped with defensive features – mainly seawalls, towers and castles, and well-defended entrances endowed with chains. The major fortified maritime bases of the kingdom were Acre, Tyre, Beirut, and Sidon. Those of the county of Tripoli were Tripoli, Tartous, and Jbeil and the only well-fortified port of the Principality of Antioch was that at Latakia. If texts reveal that these features reached their goal in ensuring security and protecting the towns from enemy attack most of the time, at other periods they couldn't resist the assaults and finally fell under the Mamluks' final blow. Following the forced departure of the Franks, the ports were systematically razed to the ground one after another by the Mamluks, who feared any possible return of Latin troops and a subsequent re-occupation of these strongholds (Fuess, 2001; Pryor, 1988: 132-134). Over time, their basins progressively silted up and greatly diminished in size, as has been proven by recent geophysical studies conducted mainly in the Lebanese harbours (Marriner, 2007). Today, only a handful of the primitive maritime fortified structures still survive, bearing testimony to these ports, which can be considered among the most substantial building achievements undertaken by the Franks.

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The Port of Ishbiliyya and its Shipsheds

Islamic-period transformations of the Guadalquivir River, the port of Seville and the 12th-century Almohad dockyard

Carlos Cabrera Tejedor and Fernando Amores Carredano***

During the Islamic period of Seville (712-1248) the River Guadalquivir (Islamic *al-wādi al-kabīr*) went through severe geomorphological and hydrological transformations. These led to the disappearance of the ancient river channel (the Roman River Baetis) resulting in the abandonment of the ancient port of Seville, and its relocation. As a result, the Islamic medina at Ishbiliyya underwent profound urban transformations and saw the construction of new military riverine defences during the 12th and 13th centuries. These included the erection of an Almohad dockyard equipped with shipsheds. This article discusses these fluvial transformations and their repercussions in the urban and defensive organization of Seville.

Keywords: Port of Seville, Guadalquivir River, Atarazanas, Islamic shipsheds, al-Andalus, Islamic period.

From the ancient descriptions of navigation in the Baetis (the Roman Guadalquivir) and the tides at Hispalis (Roman Seville) (Strabo, 3.2.4) the port of Seville is defined as being part of the maritime façade of the Atlantic coast. However, since ancient times, this Atlantic port paradoxically played a key role in broader Mediterranean maritime networks. Its unique geographical location was an important factor that allowed the port of Hispalis to become a major commercial hub (*emporium*) within western Mediterranean maritime networks.

The geomorphology and hydrology of the River Baetis also contributed to this: its features were similar to those of central- and northern-European rivers as defined by François Beaudouin in 1994. It has been recently noted (García Vargas *et al.*, 2017: 248-250; Cabrera Tejedor, 2019: 23-26) that Seville is strategically located at the transit point between the River Guadalquivir's fluvio-maritime transport zone and its fluvial zone (Beaudouin, 1994; Rieth, 1998), so navigation upstream was aided by the force of the daily tides as described by Strabo (3.2.4). These were certainly among the reasons why the original settlement was established there (Cabrera Tejedor, 2019: 35), and why Roman Hispalis became one of the most important commercial ports connecting with western Mediterranean networks during the Roman Era (Keay, 2016: 316).

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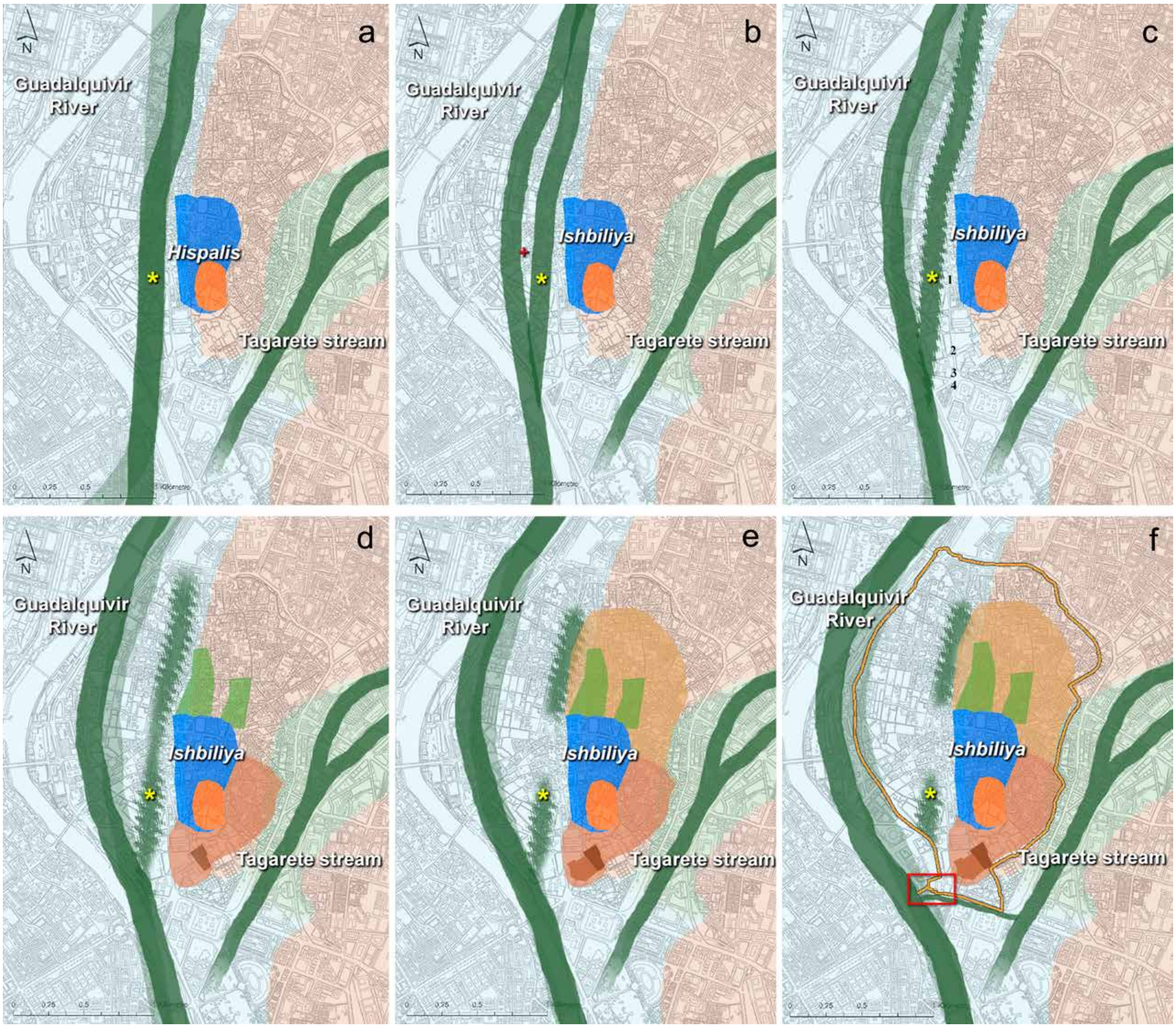

Figure 1. Approximate positions of the Guadalquivir River, intramural area of Republican Hispalis (orange), intramural area of Imperial Hispalis (blue) (after González Acuña, 2011: figs 25 and 27). The asterisk marks the Plaza Nueva. The shaded areas along the river correspond to the position of the meanders during the previous phase: a) 6th and 8th centuries (after Cabrera Tejedor, 2016: fig. 98); b) after avulsion during the 9th century. The red cross marks the site of the Galerías Preciados excavations (1969); c) after avulsion of the 10th century. Note that the Roman channel starts to disappear while the new Islamic riverbed begins to migrate westwards; archaeological sites where potters' kilns or/and workshops have been unearthed: 1. Plaza de San Francisco; 2. Zanja de la Avenida; 3. Puerta de Jeréz; 4. Avenida de Roma; d) 11th century. Note the Roman channel had silted up. The Islamic riverbed continued to migrate westwards and new quarters emerge north and south of the city (green and light brown) (after Valor Piechotta, 2008: 180) and the Alcázar (dark brown) (after Tabales Rodríguez, 2013: fig. 5); e) 12th century. Only two lagoons remain from the Roman channel. The Islamic riverbed continues its migration westwards. The north quarter of the city expands (beige) (after Valor Piechotta, 2008: 180) as well as the Alcázar (dark brown) (after Tabales Rodríguez, 2013: fig. 6); f) 13th century. The Islamic riverbed continues to migrate westwards and the city has a new wall. Note the canal excavated to connect the Tagarete stream with the River and serve as a defensive moat for the southern city wall and of the dockyard (red rectangle) (©Carlos Cabrera).

Despite its importance in antiquity, little is known about the port's exact position, layout, or facilities. Equally, the developments or transformations that the port underwent over time are undetermined. In this regard, a detailed study conducted by Cabrera has contributed to determining the position of the river during different historical periods and has established the exact chronologies, as well as some morphological characteristics, of the ancient riverbed and the port (Cabrera Tejedor, 2019).

From the 9th to the early 20th century, the Guadalquivir River underwent important changes that

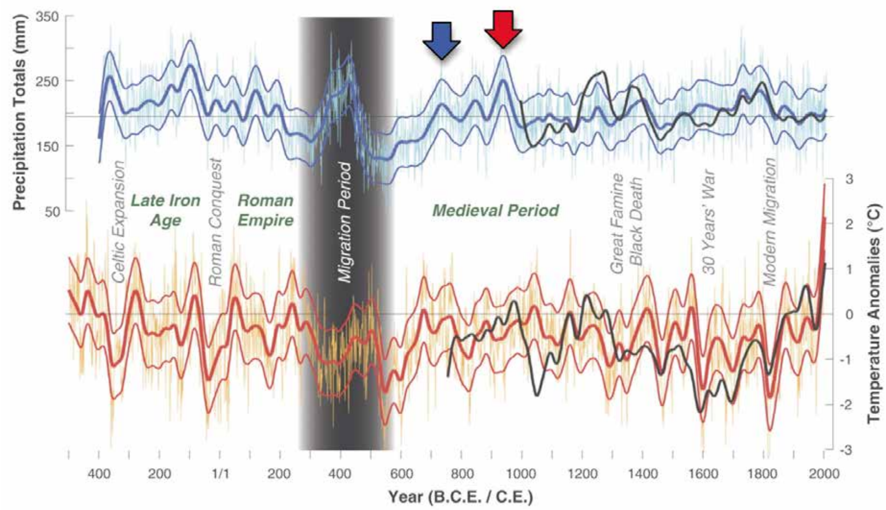

Figure 2. Reconstructed precipitation totals (top) and temperature anomalies (bottom). Bold lines are 60-year low-pass filters. Periods of demographic expansion, economic prosperity, and societal stability are noted, as are periods of political turmoil, cultural change, and population instability (after Büntgen et al., 2011: fig. 4). The blue arrow marks the beginning of a humid period; the red arrow marks a significant increase in precipitation around the middle of the 10th century.

greatly affected both its geomorphology and hydrology. The estuary of the river endured a 'general process of continentalization' in which the Lacus Ligustinus – the maritime marshes at the Guadalquivir River mouth – were transformed, by a lengthy process of siltation, into an 'interior delta' (Vanney, 1970). Both the geomorphology and the hydrology of the river, as well as the position of the riverbed in Seville, were very different during different historical periods. The ancient Roman channel of the River Baetis and the antique port of Hispalis ceased to exist at some point before the 13th century. Any preserved remains of the ancient port currently lie 7 m beneath the tell of the city centre. The significant displacement of the riverbed ultimately led to the assimilation of the ancient port area into the emergent Islamic medina of Ishbiliyya.

The first half of this article investigates the disappearance of the ancient port of Seville. Focusing on the Early Middle Ages (9th-13th centuries CE), it attempts to explain exactly when, how, and why dramatic changes occurred in the channel of the river then named in Arabic *al-wādi al-kabīr* (from which its name in Spanish '*Guadalquivir*' derives). The second half of this article focuses on the port facilities of Ishbiliyya and its Islamic shipsheds, with particular attention to the 12th-century Almohad dockyard and its shipsheds, details of which are presented here for the first time.[1]

Deciphering the disappearance of the ancient port of Seville

In light of archaeological evidence, it seems that the ancient riverbed, which throughout Antiquity and the Early Middle Ages flowed close to the city and accommodated the ancient port on its east bank, gradually silted up until it was no longer navigable. The existence in the year 1022 CE of a necropolis in the Plaza Nueva area (Lévi-Provençal, 1931: 43-46) provides a *terminus ante quem* for the existence of the ancient riverbed of the Guadalquivir. The ancient riverbed must have disappeared prior to the 11th century, along with the port on its east bank. The riverbed seems to have changed its position and morphology no later than the early 11th century.

Historical chronicles, archaeological remains, the geomorphological information on the river, and palaeoclimatological studies, have been used to propose a hypothesis for when and how the transformation took place (Cabrera Tejedor, 2019).

Geomorphological information on the River Guadalquivir suggests that between the 6th and 8th centuries there was a period characterized by a degree of stability in the hydrology of the river (Borja Barrera, 2014: 293) (Fig. 1a). Then, around 800 CE, the River Guadalquivir started to progressively divide into two channels or riverbeds. This occurred through a process of avulsion that progressively silted up the main riverbed with alluvium transported by the river (Borja Barrera, 2014: 298-299). Geology and palaeoclimatological studies seem to indicate that this process of avulsion was triggered by a combination of a higher mean sea-level and climatological factors such as changes in mean temperature and precipitation totals (Cabrera Tejedor, 2019: 167-172). These combined factors produced a period of high-energy events causing floods in the river and the ancient Roman riverbed to silt up. Historical chronicles also documented a series of high-energy events starting around the beginning of the 9th century: these were exceptionally frequent and violent during the 10th century, which saw a dramatic peak in precipitation totals (Fig. 2).

1 We have included only the information necessary to allow us to present the general outline of the question.

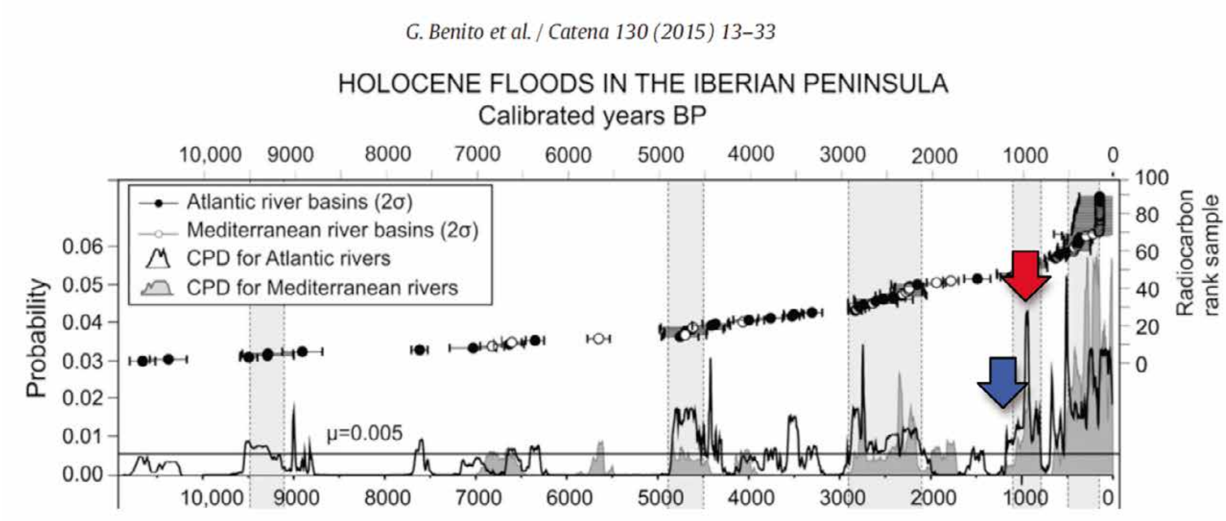

Figure 3. Cumulative probability density plots of radiocarbon dates from floods and extreme fluvial event units of the Iberian Peninsula. The horizontal line indicates the mean probability above which a period of major flooding is inferred. Shaded vertical bars show periods of enhanced flood/fluvial activity above the mean and with at least three radiocarbon dates in 200 years. Black and white dots are radiocarbon aged samples (after Benito et al., 2015: fig. 3). The blue arrow marks the beginning of a period of increasing flooding around 800 CE; the red arrow marks a significant increase in the probability of flooding at around 1100 CE.

Additionally, recent studies of palaeofloods in the Iberian Peninsula during the Holocene (Benito *et al.*, 2015) show how a major change in increasing fluvial activity and vertical alluviation rates occurred from the 10th century onwards, which coincided with higher flood frequency (Fig. 3). The newly formed channel slowly became the main one, and its meander was displaced westwards, leaving point bar deposits: meanwhile, the ancient Roman channel became secondary (Borja Barrera, 2014: 298-299). The process of avulsion, and the complete sedimentation of the ancient Roman channel, took approximately two centuries, roughly 800-1000 CE given that the existence of the necropolis in the Plaza Nueva area in 1022 (Lévi-Provençal, 1931: 43-46). Thus, during the 9th and 10th centuries, the Guadalquivir probably had two navigable channels (Fig. 1b).

These two channels of the river were approximately 100 m apart. On the strip of land established between the two channels, any existing archaeological vestiges could, potentially, remain well preserved (Fig. 1b). This could explain the funerary remains found in 1969 during the construction of the retail store Galerías Preciados: first, a fragment of a Roman statue (of a toga-attired male) and a fragment of a Roman funerary inscription which, according to Carriazo, both dated to the early 2nd century CE (*ABC Sevilla* newspaper, 1969); second, 'a funerary monument with several funerary urns' as reported by Corzo Sánchez (1997: 198, footnote 10). These archaeological funerary remains may have come from a Roman necropolis located on the west bank of the River Baetis, as proposed by Collantes de Terán Delorme (1977: 78-79).

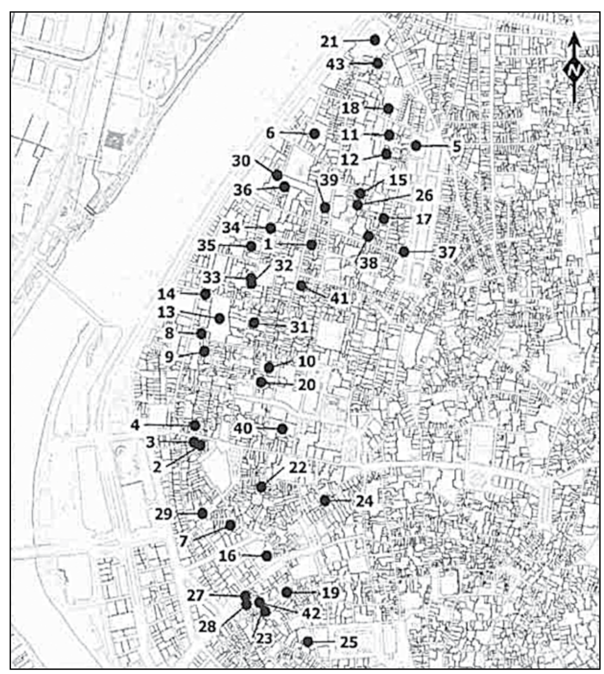

Figure 4. Excavations where no material predating the 11th century has been found in the archaeological record (after Jiménez Maqueda, 2011: fig. 40).

In the area occupied by the new channel, the force of the river current probably destroyed any archaeological remains that had once existed there. The subsequent and progressive migration of the newly formed channel westwards would, in a similar fashion, potentially have damaged or destroyed most of any archaeological remains. That would explain why none of the archaeological excavations conducted in the area has found remains from before the 11th century (Jiménez Maqueda, 2011: fig. 40) (Fig. 4).

It is estimated that the westward displacement of the newly formed channel of the River Guadalquivir took place across about three-and-a-half centuries (Cabrera Tejedor, 2019: 167-170). Since the channel moved westwards about 350 m over approximately 350 years, the lateral displacement of the river was about 1 m per year (Cabrera Tejedor, 2019: 170): this estimate is consistent with contemporary values of lateral migration rates documented in a palaeo-geomorphological study by Uribelarrea and Benito (2008: 29) of the same river at Córdoba.

The time that this process took is very brief in geological terms but would have been very gradual to the human eye. This explains why there are no historical chronicles describing a sudden change in the river. However, the existence of two navigable channels in the River Guadalquivir during the 9th and 10th centuries (Figs 1b, 1c), could explain some details of a particular historical account. The chronicle of al-Udri describing the Viking attack on Ishbiliyya in 844 CE attested that:

> *...at dawn they arrived in front of the city in an area that is known as the place of potters ... After that, the Normans advanced with their ships until positioning them in the middle of the city of Ishbiliyya. (Valencia, 1986: 123)*

Valencia (1986, 123-124, footnote 73) identified the area 'known as the place of potters', through which the Vikings arrived at Ishbiliyya, in the southwest corner of the city. Archaeological excavations in that area (on Avenida de Roma) that indicated the existence of potters' kilns (Gamarra and Camiña, 2006: 494-498) supported this hypothesis (Fig. 1c). The present reconstruction of the River Guadalquivir during the 9th and 10th centuries, with two probable navigable channels, could explain al-Udri's statement that the Normans were able to position their ships in the centre of the city (Valencia, 1986: 123).

The remains of a boat were discovered at Plaza Nueva in 1981, found with its oars in place within sediment consisting of fine silt, suggesting that its loss was an accidental product of a violent flood (Cabrera Tejedor, 2014; 2016; 2019). It is possible, therefore, to propose that the incident in which the boat was lost was one of the flood episodes that recent palaeo-geomorphology studies have shown were part of the avulsion process of the ancient Roman riverbed. The radiocarbon dating of the boat suggests that it belongs to the period of the Caliphate of Córdoba (929-1031 CE). This chronology respects the *terminus ante quem* derived from the presence of a necropolis in 1023 CE and coincides with exceptionally frequent and violent period of floods documented by chronicles in the 10th century. Considering all of the above, it is possible to conclude that the Plaza Nueva boat was lost in one of the exceptionally violent floods that occurred in the second half of the 10th century (Cabrera Tejedor, 2014; 2016; 2019).

By the 11th century, the morphological changes in the river had created a wide corridor through which the ancient Roman riverbed ran but was no longer navigable and, with its extensive port, had become a large barren area (Fig. 1d). Floodplains, ponds, and sloughs made up this area, with fluctuating water levels caused by the Atlantic Ocean tides. At the same time, several archaeological excavations attest to the city's expansion in this period, with new districts emerging on both its south and the north sides.

In fact, two lagoons remained in the north and south areas that the ancient Roman channel had occupied (Fig. 1e). From a geological point of view, these are oxbow lakes, made when a wide meander from the main stem of a river is cut off forming a U-shaped body of water. The two lagoons remained during the Christian era and were known as the Laguna de la Feria, in the north area, and Laguna de la Pajarería, in the southwest area of the city. The Laguna de la Feria was drained at the end of the 16th century and transformed into the Alameda de Hércules, which still exists (Fig. 5). The Laguna de la Pajarería was not drained until the end of the 19th century (Collantes de Terán Delorme, 1977: 33).

The areas around the lagoons would have had limited use, although the city's potters would have found them convenient since they provided unlimited supplies of quality raw material (fine clay) for the pursuit of their craft (Fig. 1e). In fact, as we have seen, at the beginning of the 12th century, Ibn ʿAbdūn described the presence of a potters' neighbourhood with a mosque (Ibn ʿAbdūn, García Gómez and Lévi-Provençal, 1981: 95). Archaeological excavations in the southwest area of the city have provided direct evidence of the presence of potters' kilns, workshops, and production waste located on the ancient east bank of the river towards the south of the city (Fig. 1c): at Plaza Nueva (see above), Zanja de la Avenida (Carriazo Arroquia, 1974-1975: 95-96), Puerta de Jerez (Martínez López and Pozo, 2007: 156, 157, 181 and 213), and Avenida de Roma (Gamarra and Camiña 2006: 494-498).

Additionally, Islamic toponymy of the city provides indirect evidence for the presence of a potters' quarter in this area. The Islamic chronicler Ibn Ṣāḥib al-Ṣalāh attested the existence of a city gate in the 12th century

Figure 5. Alameda de Hércules (former Laguna de la Feria) inundated during the flood of 9 December 1876 (after Menantéau, 2008: 60).

that had the name of 'bab al-Kuhl' or 'Gate of the Alcohol', which was located in the south of the city (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 65, 188, 200). Carriazo Arroquia (1975: 95-96) found a large deposit of ceramic production waste in that area. He proposed, following the suggestion of Felix Hernandez, the hypothesis that the toponym Gate of the Alcohol comes from the lead sulphur that potters use to glaze pottery (Carriazo Arroquia, 1974-1975: 96). Carriazo Arroquia also suggested that the potters' quarter was located outside the Gate of the Alcohol until the end of the 12th century when the Almohad citadel was built, which forced the potters to move to the west bank of the river, to the Triana area.

The area vacated by the river would also have been suitable for use as graveyards. We have seen that Plaza Nueva had been used as a graveyard at some point during the 11th century. It has been hypothesized that the Islamic necropolis at Plaza Nueva is the graveyard of the potters described by Ibn ʿAbdūn (Valor Piechotta, 1989: 331). This graveyard seems to have extended 200 m south from Plaza Nueva, attested by the dozens of graves found at the intersection of the Avenida de la Constitución and Calle Alemanes (Hunt, 2008). Another graveyard located further south of the ancient east bank of the River Guadalquivir was documented at Avenida de Roma (Gamarra and Camiña, 2006: 494-498).

Although these floodplains were useful to the potters and for burying the deceased, the rest of the inhabitants of the medina Ishbiliyya probably thought this area was dangerous and insalubrious. In fact, documents from the late 15th century attest how nuns from a convent located next to the Laguna de la Pajarería, in the southwest area of the city, complained about the insalubrity of this swamp area (Collantes de Terán Delorme, 1977: 33, footnote 6). Both the Laguna de la Feria and the Laguna de la Pajarería were inundated at every major flood of the Guadalquivir until the 20th century (Fig. 5).

The emergence of this large new area in the western part of the city certainly posed urban and administrative challenges for the Islamic rulers of Ishbiliyya. This area of the floodplain with its two lagoons separated the medina from the new position of the vital river and its port. People were forced to constantly cross it. The westward migration of the river, with the subsequent emergence of this new large area in the western part of the city, led to the major urban transformations that Ishbiliyya underwent during the 12th and 13th centuries. In particular, the construction of a new city wall (Fig. 1f) was initiated by the Almoravids (Torres Balbás, 1951: 465; Collantes de Terán Delorme, 1957: 18-21, 24; Almagro Gorbea, 1987: 427-428; Jiménez Maqueda, 2011: 386) and the greatest period of urban renewal and expansion of the city occurred during the Almohad Caliphate (Valor Piechotta and Tahiri, 1999; Jiménez Sancho, 2007; Valor Piechotta, 2008).

The port facilities of Ishbiliyya and its Islamic shipsheds

There is no direct archaeological information on the port of Seville during the Islamic period. There is, however, indirect evidence derived from the historical chronicles, although this predominantly describes events or activities which occurred in the new port after the avulsion of the old riverbed.

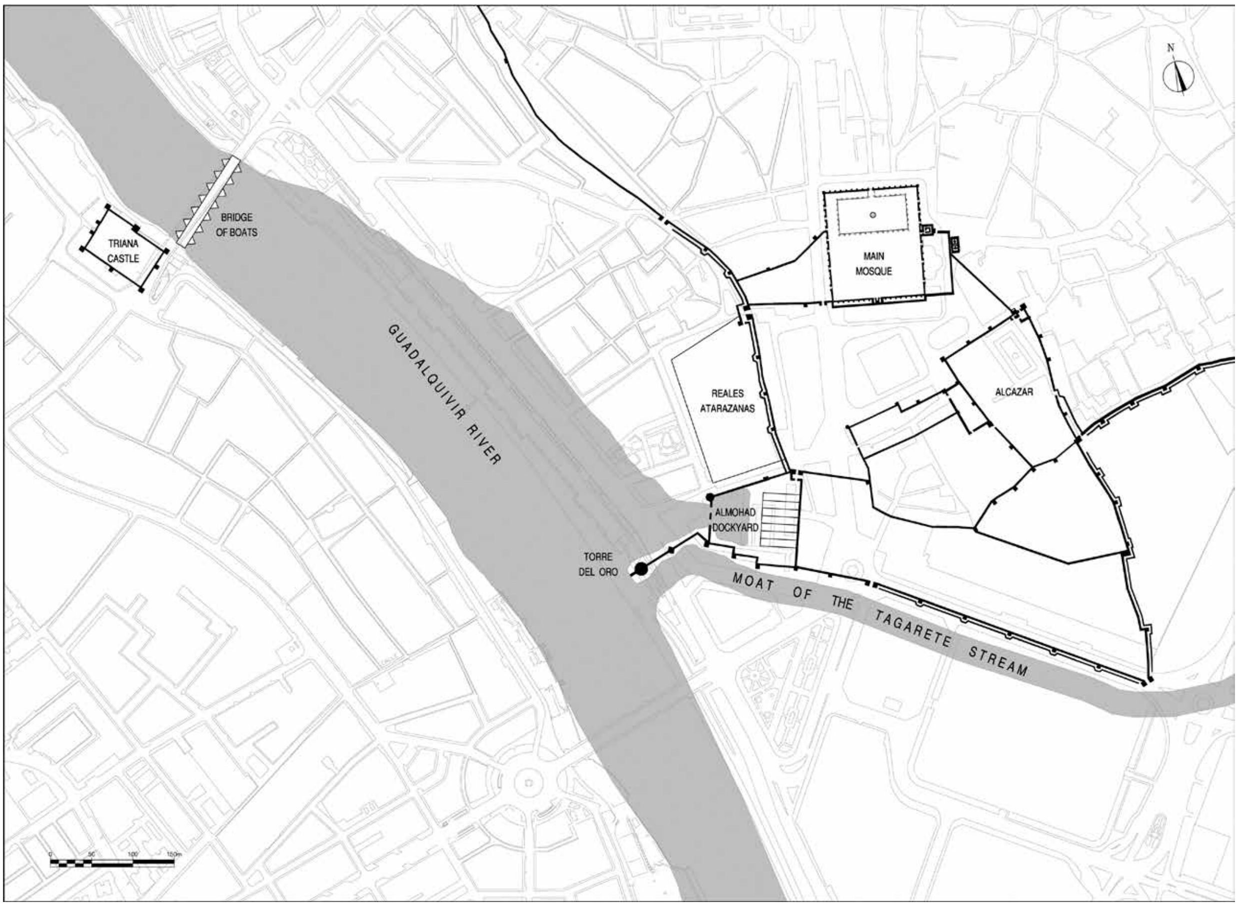

Figure 6. Location of the 12th-century Almohad dockyard of Ishbiliyya and its shipsheds and position and extension of the 13th-century Reales Atarazanas, Royal shipsheds of King Alfonso X (© Fernando Amores).

The Viking attack of 844 CE showed a weakness in the maritime defences of the Emirate, as well as in the defences of Ishbiliyya. Consequently, emir Abd al-Rahman II (822-852 CE) ordered the erection of a city wall in Ishbiliyya; the emir also ordered the construction of a fleet to be stationed in Ishbiliyya, the ships of which were equipped with apparatus to throw burning *nafta* (Greek fire).[2] For the purpose of housing the fleet, Abd al-Rahman II also ordered the construction of shipsheds (Lévi-Provençal and García Gómez, 1950: 144-150; Bosch Vilá, 1984: 35-50). These measures seem to represent a premeditated naval policy developed by Abd al-Rahman II (Lirola Delgado, 1993: 122-123). According to the chronicler Ibn al-Qūṭiyya, they were a great success, since the fleet from Ishbiliyya completely repelled a second attack by Viking raiders, which occurred in 858 CE (244 AH), burning some of the Viking ships (Ibn al-Qūṭiyya, ed. Ribera, 1926: 53).

Ibn al-Qūṭiyya specified that in order to build the fleet, Abd al-Rahman II hired 'seamen' from all the shores of al-Andalus and paid them generously (Ibn al-Qūṭiyya, ed. Rivera, 1926: 53). Naval shipyards are required for the construction of war galleys, and Seville had these from at least the time of the Roman Republic (Caesar, *Bell. Civ.*: 2.18; *Bell. Alex.*: 51, 56; Cabrera Tejedor, 2019: 88). The Arabic word to designate a shipyard is *dar al-sina'a* or *dar al-san'a* and occasionally *al-sina'a* from which the Spanish words *dársena*, *atarazana*, and *arsenal* derive (Lirola Delgado, 1993: 344; Blackman, forthcoming). During the 10th century, the Caliph Abd al-Rahman III (912-961 CE) developed a comprehensive naval policy. It included the construction of war galleys and shipsheds, with the objective of protecting al-Andalus from Viking attacks as well as attacks from the Fatimid Caliphate and the Christian kingdoms (Torres Balbás, 1946: 178).

During the 11th century, it seems that Ishbiliyya had an operational naval shipyard. According to the chronicle *Rawḍ al-Qirṭās* by Ibn Abī Zarʿ al-Fāsī, al-Mutamid (1069-1091 CE) ordered the construction there of

2 Greek fire, a combustible composition for setting fire to an enemy's ships, works, etc.; so called from being first used by the Greeks of Constantinople (Oxford English Dictionary).

an extraordinarily large ship, able to withstand storms, and it was sent to Tangier on a trade mission (Ibn Abī Zarʿ al-Fāsī, *Rawḍ al-Qirṭās*, ed. Huici Miranda, 1964: 527).

In the 12th century, the chronicle of Ibn Ṣāḥib al-Ṣalāh recounts the numerous and ambitious urban developments undertaken by Caliph Abu Ya'qub (reign 1163-1184 CE) in Ishbiliyya. He ordered the construction of a bridge of boats (which was in operation until the end of the 19th century), an impressive Aljama Mosque (later transformed into a cathedral), a new palace citadel, new city walls (equipped with a moat on the south flank) (Figs 1f and 6), and he also repaired the ancient Roman aqueduct (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 64-65) among other developments. Moreover, he ordered the construction of quays equipped with ramps on both banks of the river (Ibn Abī Zarʿ al-Fāsī, *Rawḍ al-Qirṭās*, ed. Huici Miranda, 1964: 417). Another chronicler, Ibn Ṣāḥib al-Ṣalāh, reports how the same caliph also ordered the construction of shipsheds between the bab al-Qata'i (Gate of the Ships) and the bab al-Kuhl (Gate of the Alcohol) (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 200). In recent years, the location of these shipsheds from the Almohad period may have been identified (Fig. 6).

Excavations conducted in 2001 at the Casa de la Moneda site (Romo Salas and Ortega Gordillo, 2002), in connection with an archaeological excavation of the 13th-century Christian shipsheds (Amores Carredano and Quirós Esteban, 1999), led one of the present authors, Fernando Amores, to propose the hypothesis outlined below regarding the location of the Almohad shipyard built by order of the Caliph Abu Ya'qub at the end of the 12th century.

The Almohad dockyard of Ishbiliyya and its shipsheds

Torres Balbás (1946: 177) was the first author to study the construction of *atarazanas* (shipsheds) in Seville, mainly through historical sources. These inform us how, in the mid 9th century, the Umayyad emir Abd al-Rahman II ordered the construction of a navy and shipsheds to defend the area from Viking raids (Lévi-Provençal and García Gómez, 1950: 144-150; Bosch Vilá, 1984: 35-50). There is no other information specifically referring to shipsheds until 1184 when the Almohad Caliph Abu Ya'qub Yusuf:

> ...ordered the governor Abu Dawud Yalul ben Yildasan to take care during his absence to build an *atarazana* for the ships, from the wall of the citadel built on the banks of the river, by the Gate of the Ships to the lower part of the Gate of the Alcohol. (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 200; Torres Balbás, 1946: 184)

Torres Balbás assumed that the Almohad 12th-century shipsheds would have been close to the place where later, in 1252, King Alfonso X of Castile and Leon built the Royal Shipsheds.

Having no recognizable material evidence of the Islamic shipsheds from the Almohad period, González (1951: 199, 519) assumed that the Castilian army destroyed them in 1248 during the siege prior to the conquest of the city. Later authors accepted this interpretation, some further denoting their possible reconstruction by King Alfonso X (Jiménez, 1981: 19). Such a view would imply that both shipsheds, the Almohad and the Castilian, stood on the same location.

Fernando Amores and Cruz Agustina Quirós carried out archaeological excavations in the Castilian shipsheds between 1992 and 1995 (Amores Carredano and Quirós Esteban, 1999). Evidence unearthed during the excavations revealed several facts. Remains of an Almohad barbican, which historical sources indicate was constructed in 1221, were discovered. The preserved buildings of the Castilian shipsheds overlay these Almohad fortified defences, so their construction must have occurred after 1221, as was the case (Fig. 7).

It was confirmed that the Castilian shipsheds were built entirely *ex novo*, are of Christian chronology, and present homogeneous construction characteristics. Consequently, the Almohad shipsheds of 1184 could not have been built on the site occupied by the Christian shipsheds of 1252. Thus, the hypothesis that the Almohad and the Castilian shipsheds once stood on the same location (Jiménez, 1981: 19) is refuted.

The excavations of 1992-1995 provided, for the first time, empirical archaeological data in a discussion previously dominated by the interpretation of Islamic and Christian historical chronicles. However, they discarded a potential location for the Almohad shipsheds while offering, at that time, no alternative hypothesis.

A few years later, in 2004, Fernando Amores pointed out a potential site for the Almohad shipsheds (Fig. 8). There is walled enclosure historically known as 'Casa de la Moneda' on a location adjacent to the city wall, facing towards the river, and near the harbour. It is so-called because it was the site of the Royal Mint from the 16th century onwards (Espiau, 1991). In this enclosure, restored in the 1980s, still stand the remains of a gate facing the river; it is 7.3 m wide and its foundations must have been deeper than the current ground level at 6.5 m above mean sea-level. Fernando Amores pointed out the potential historical value of this gate. Because of its location, width, and original depth, it could have been the access gate to the Almohad dockyard from the river; this proposal is based on the similarities that the arch and gate present with another (now destroyed) arch that existed in Algeciras, called 'Puerta del Ojo del Muelle'.

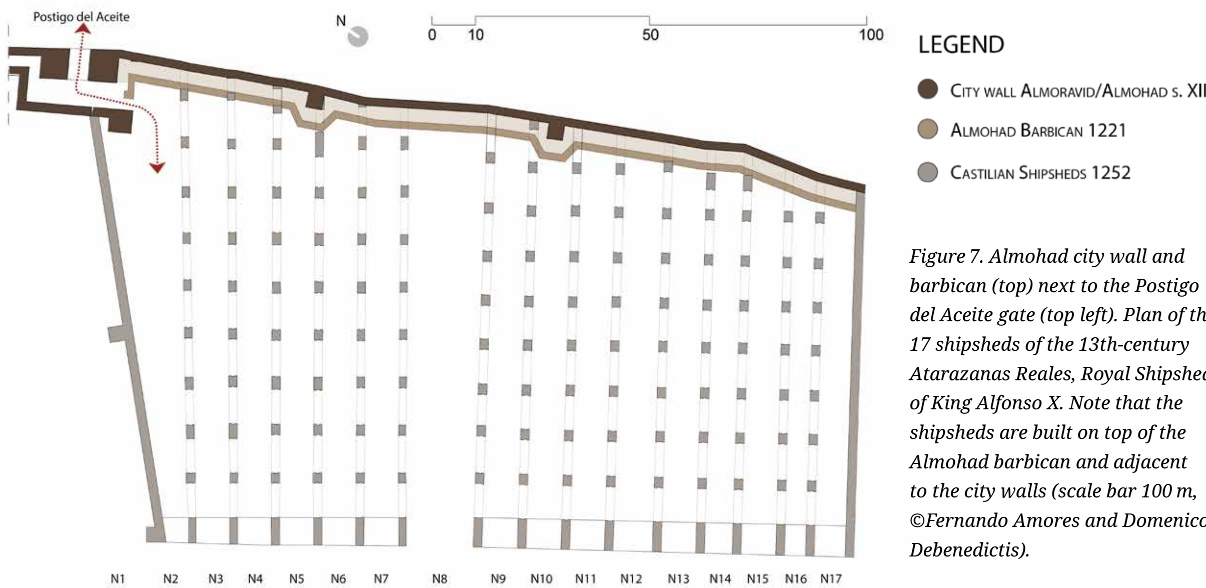

Figure 7. Almohad city wall and barbican (top) next to the Postigo del Aceite gate (top left). Plan of the 17 shipsheds of the 13th-century Atarazanas Reales, Royal Shipsheds of King Alfonso X. Note that the shipsheds are built on top of the Almohad barbican and adjacent to the city walls (scale bar 100 m, ©Fernando Amores and Domenico Debenedictis).

Figure 8. The walled enclosure of the Islamic dockyard with defensive walls and the 'Torre del Oro', over the current plan of the city of Seville. Inside the enclosure, the standing buildings of the Modern Period Casa de la Moneda or Royal Mint (scale bar 200 m, ©Fernando Amores and Valentín Trillo).

Domínguez Berengeno (2008: 239-241) pointed out several historical particulars regarding the construction of the Almohad shipsheds in Seville. The author reflected on the Islamic chronicle that mentions the mandate of the Caliph Abu Ya'qub Yusuf to build the shipsheds in

1184 before leaving for a military campaign in Santarém. However, Abu Ya'qub Yusuf died during the Siege of Santarém, and the historical sources indicate that his successor, his son Abu Yusuf Ya'qub al-Mansur, modified his father's urban-development policy; some works were paralysed and others delayed, although the shipsheds are not explicitly mentioned in the sources. The author suggested that it was not clear that the construction of the shipsheds began in 1184 and that, if construction actually took place, the shipsheds may well have remained unfinished and never been completed. Nevertheless, Domínguez Berengeno supported the general hypothesis of the location of the Almohad shipsheds at the Casa de la Moneda enclosure. However, details related to the defensive design of the enclosure and the lack of vault-remains associated with the standing arch led him to believe that this is an unfinished construction that was halted before the Christian conquest of 1248 (Domínguez Berengeno, 2008: 239).

In the 'Casa de la Moneda' enclosure, a series of rescue archaeological works has been carried out as a result of a restoration project and urban developments; these works, however, have provided limited results. In 1989, the restoration of the so-called 'Torre de la Plata', an octagonal defensive tower located at the northwest corner

Figure 9 (above). State of the west wall of the enclosure: a) in 1988 during the restoration works note that both gates still existed (after Valor Piechotta and Tahiri, 1999: 49); and b) in its current state (©Fernando Amores).

Figure 10 (below). Two photographs from the 2001 excavations at the Casa de la Moneda site showing the 16th- and 17th-century archaeological remains that were unearthed (Romo Salas and Ortega Gordillo, 2002: 195).

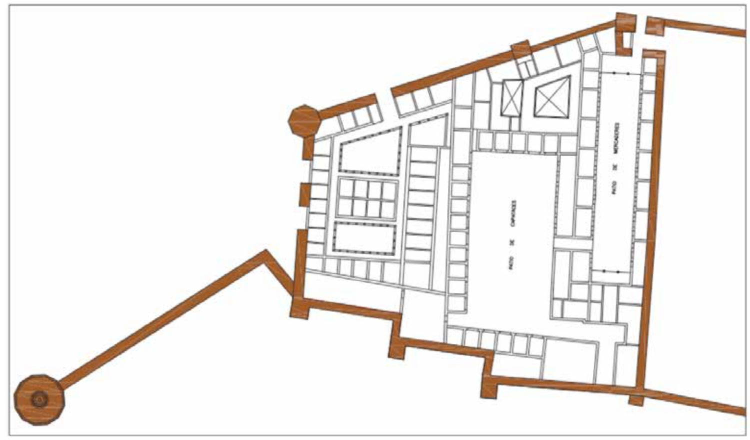

Figure 11. Reconstruction of the plan of the Casa de la Moneda in the 17th century (after Mora Vicente, 2013: vol. 2, 82).

of the enclosure, was undertaken – unfortunately without any archaeological supervision. The works, though, confirmed the Almohad chronology of the enclosure and that it underwent an important renovation in the reign of King Alfonso X (in the second half of the 13th century). The defensive western wall was also restored, and it is important to note during these works, a second gate, similar to the one still standing, was walled up when it was completely filled in with concrete (Fig. 9).

In 2001, archaeological open-area excavations, as well as test pits, were carried out inside the enclosure. The excavation reached 4.5 m in depth (2.85 m above mean sea-level) (Fig. 10), unearthing only the 16th-century levels (Romo Salas and Ortega Gordillo, 2002: 203): so, unfortunately, the Islamic levels were not reached. From the 16th to the 18th centuries, this complex housed the Casa de la Moneda (Royal Mint) (Figs 8 and 11) that was charged with converting the gold bullion imported from the colonies of the Spanish Empire in the Americas into legal currency (Mora Vicente, 2013).

Before the 16th century, historical sources suggest that the complex housed a prison assigned exclusively for knights and members of the nobility. This prison seems to have existed from the second half of the 13th century until the 16th century and to have been generously equipped with a fencing and horse-riding training yard, gardens, and a chapel. However, what is relevant is the name by which the prison was known: 'Atarazana de los Caballeros' (Shipsheds of the Knights) (Pérez González, 1997: 291-292).

In 2011, Gregorio Mora Vicente carried out excavations in the entrance to the Casa de la Moneda (Mora Vicente, 2011), incorporating the conclusions of his findings into his doctoral thesis, which focused on the history of this site between the Middle Ages and the modern era (Mora Vicente, 2013). The author discovered and documented an unknown Islamic city gate that, in pre-Almohad times, gave access to the medina from the south (Mora Vicente, 2013: 145). This gate was

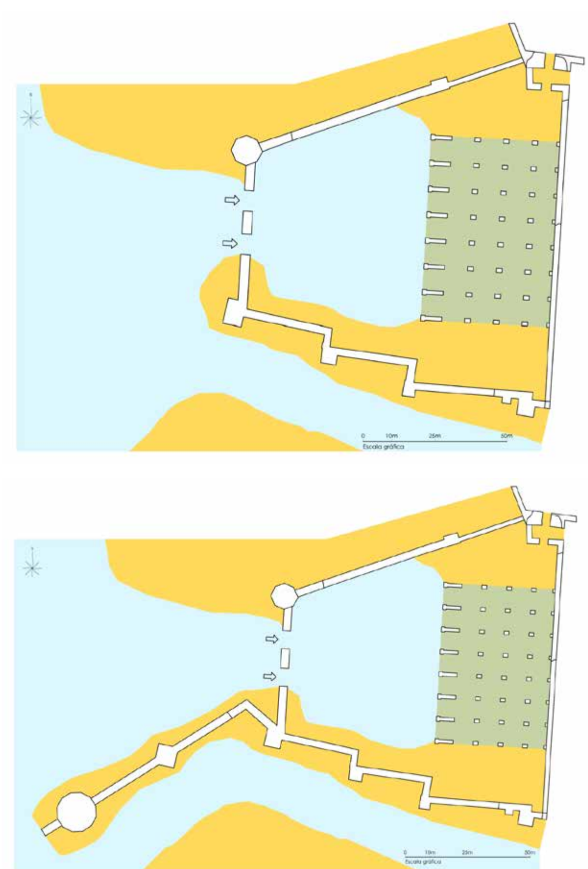

Figure 12. Reconstruction plan of the Almohad shipyard and its estimated seven shipsheds: a) at the time of its construction in 1184 CE; b) second phase of the shipyard around 1221 CE; note that the river has migrated westwards and thus the southern wall was extended in order to reach it (scale bar 50 m, © Fernando Amores and Jesús García Cerezo).

modified during the Almohad period, according to historical sources between 1171 and 1173, as a result of a construction project that extended the city walls towards the south (Figs 8 and 12).

Mora's study supports the hypothesis that the Casa de la Moneda enclosure was the Almohad dockyard, and add new information: it verifies that the bulwarks of the enclosure are newer and different in construction details to the city walls (Mora Vicente, 2013: 144, 146), establishing that the enclosure was built after 1173. The enclosure is clearly of Almohad chronology since it was built before 1221, the date of the construction of the defensive wall and tower known as 'Torre del Oro'. Consequently, it is plausible that the Casa de la Moneda enclosure was built in 1184, as the historic sources state for the shipsheds (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 200). Mora denotes the prominent 'defensive design' of the enclosure with towers protecting three of its sides, as well as crenellated parapets on both sides of the walls (Mora Vicente, 2013: 148). Mora supports the hypothesis of the Almohad shipsheds since, in his reconstruction of the western wall, the author includes an access gate more than 7 m wide, enough for the entrance of galleys, and also includes the twin gate that was walled up and filled in with concrete during the restoration works. Mora presents a reconstruction and elevation plan of the western wall, where the two wide gates are located, and concludes:

> A trapezoidal layout designed for defence, independent of the city, with two gates 7 m wide and, at least, 4 m high, that face the Guadalquivir River and that are protected by bulwarks, perhaps are arguments that validate the hypothesis of the shipsheds… for ships of around 30 m long by 5 in beam… We do not know if these shipsheds were ever in use and if they were, until when.' (Mora Vicente, 2013: 148-149)

As we have seen, the hypothesis that the Almohad shipsheds where located at the enclosure of the Casa de la Moneda has been strengthened by different contributions from Domínguez Berengeno (2008) and Mora Vicente (2013). Fernando Amores has worked on this issue since 2004. Since 1992, these investigations are complemented by those undertaken by the present authors on the 13th century Royal Shipsheds of King Alfonso X. Domínguez Berengeno considered only the western wall and the gate and is unconvinced of the completion of the shipsheds. Mora, even though he provides more information about the enclosure, also questions if they were used: his study establishes an Almohad chronology for the enclosure that is perfectly compatible with the construction date of 1184 mentioned by the historical sources (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 200); the presence of two large gates on the western wall facing the river; and the defensive towers and walls with double parapet. These contributions help to explain the original function of the enclosure; however, there are details within the remains and the layout of the enclosure that can only be deciphered with a deeper understanding of medieval shipsheds and dockyards.

The aforementioned characteristics of the Casa de la Moneda enclosure correspond to shipsheds within an arsenal, and other details not detected by previous studies, including a proposal for the layout of the defensive complex, can be added here (Amores, 2018):

1. The trapezoidal shape of the enclosure protrudes from the front-line of the city walls towards the river. This particularity suggests that it had a specific functionality in relation to the river (Fig. 6).

2. The structural characteristics of the enclosure, in combination with the chronology of the neighbouring, well-dated structures, render 1184 the probable year of construction of this enclosure in agreement with Almohad historical sources that mention the construction of the dockyards (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 200).

3. This is the only stretch of the city walls that has parapets on both sides. This unique feature implies that the structure is designed for defending enemy attacks from both outside and inside the enclosure (Figs 13, 14).

4. The archaeological excavations conducted inside the enclosure in 2001 reached 4.5 m depth from the ground level (2.85 m below mean sea-level), at which point the water table emerged. The archaeological materials found at the deepest strata corresponded to the end of the 15th century (Romo and Ortega 2005: 193), and they are backfill layers, which suggests that the foundations would have been deeper. All strata lower than 2.85 m below mean sea-level are beneath the mean river level and within the reach of the daily tides, and so were not suitable for the construction of urban structures, which in Seville have always been built at least 5-6 m above average sea-levels. This implies that the interior of the enclosure (at least in the open space closest to the western wall) was below the mean river level and, therefore, that it was filled with water, constituting an enclosed *darsena* or dock. The twin access-gates on the western wall would have been at least 8 m in height, and thus adequate for the entrance of galleys into an arsenal.

5. The western wall, in which the twin gates face the river to allow access by galleys, is wider than the

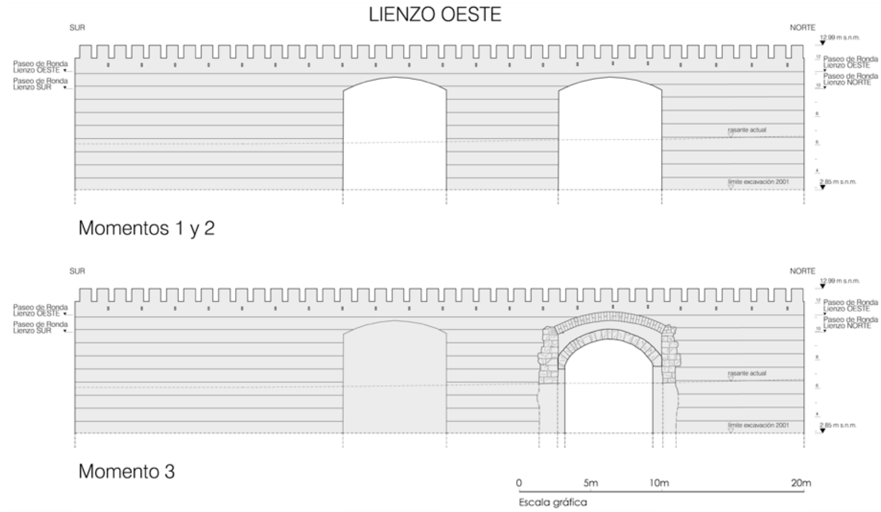

Figure 13. Elevation plans of the west wall of the enclosure showing its estimated original height. The wall presents the two open gateways during the Almohad period (top). Transformation occurred after the Christian conquest of the city in 1248, note that the southern gate (on the left) has been walled up and the northern gate (on the right) has been reconditioned and equipped with a large forge gate (the gudgeons of which are still visible) (scale bar 20 m, © Fernado Amores and Jesús García Cerezo).

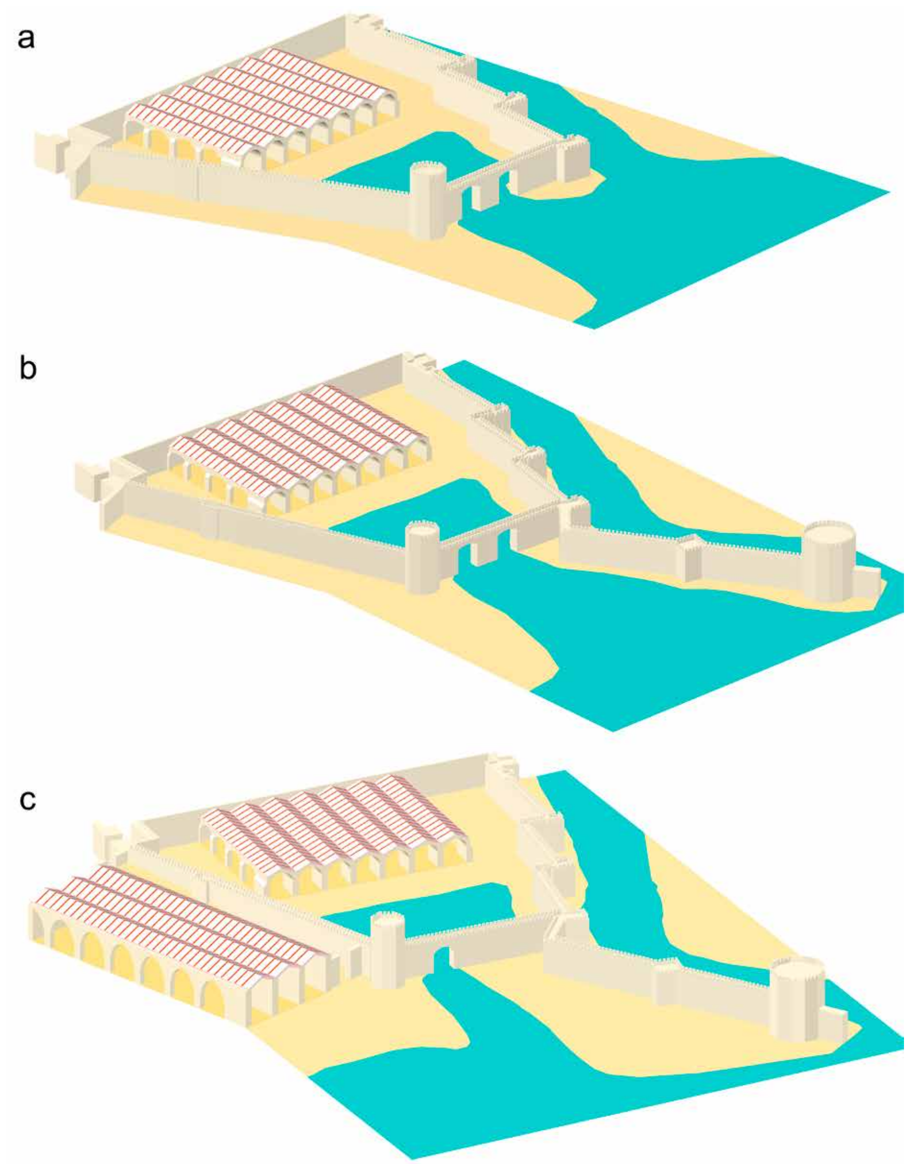

Figure 14. Computer-based 3D reconstruction of the Almohad dockyard and its shipsheds: a) after its construction in 1184; b) after the extension of the southern wall and the construction of the 'Torre del Oro' tower in 1221 with the objective of reaching the river that has migrated away from the original dockyard; c) after the Christian conquest of 1248. The 13th-century Atarazanas Reales, Royal Shipsheds of King Alfonso X are erected adjacent to the site (© Fernado Amores and Jesús García Cerezo).

others: it is 3.2 m wide, compared to 2.5 m and 2.9 m for the southern and northern walls. This is explained by the fact that this wall was in direct contact with the flow of the river, affected by daily Atlantic tides that ranged several metres, and occasional flash floods; thus, it was a reinforced wall. The western wall is also higher than its neighbours by 2 m and this is related to the height of the arches of the twin gates to allow galleys access (Fig. 13).

6. The twin gateways of the western wall would have been open to the exterior without closing mechanisms and their defence would have been provided from the battlements of the wall. This too suggests that the western wall would have been in contact and engulfed by the water of the river, as well as affected by the daily tides (Fig. 14a).

7. The western wall, therefore, presents unique features within the enclosure, in its height, its width, the existence of two gateways of exceptional width and height as well as an octagonal tower on the north-western corner to reinforce the defensive enclosure. The characteristics of this wall define it as a structural element of an arsenal equipped with shipsheds.

8. According to archival evidence, in 1221, aware of the advances towards the south of the Christian armies in the Iberian Peninsula, the governor of Isbiliyya, then the capital of the Almohad Empire, ordered the construction of a new defensive tower known as 'Torre del Oro' (Ibn Abī Zarʿ al-Fāsī, ed. Huici Miranda, 1918: 248). It was connected to the western wall of the dockyard through a new stretch of wall equipped with crenellated parapets on both sides, protecting both the dockyards and the city harbour (Fig. 14b).

9. The arch or gateway that survived the 1989 restoration works presents gudgeons in the upper corners as well as structural reinforcement in its vault and flanks (Fig. 13). These elements seem not to be part of the original construction but to have been added later. The other gateway did not have gudgeons or this type of structural reinforcements. The lack of those elements may have misled the architects of the 1989 restoration, who believed that the gate was a modern renovation: consequently, and without realizing that it was original and exactly mirrored the other gate in dimension and design, they filled it in with concrete.

   The additions of gudgeons and structural reinforcements to the preserved gate indicate a subsequent change in the use of the dockyard. The evidence suggests that after the Christian conquest, sometime between the 13th and the 14th centuries the southern gateway was walled up on the exterior, keeping the northern gateway as the only riverside access to the enclosure; this gateway was then equipped with a large gate made of forged iron bars (of which the gudgeons are still preserved) that would have allowed the water to flow freely through its grille (Amores, 2018: fig. 15). The walling up of the southern arch and the reinforcement of the other arch with a large forged gate (which made it possible to lock the gateway and the enclosure) implies a deliberate change to the western wall to decrease its vulnerabilities and strengthen its defence.

10. The tower known as 'Torre de la Plata', has an octagonal design characteristic of the Almohad period and presents an important change that occurred during the Christian era, perhaps during the reign of King Alfonso X (in the second half of the 13th century). These transformations included defensive openings, embrasures and machicolations, which are present on all sides of the tower and were used to defend the outer and inner flanks of the enclosure. This implies that, after the 1248 conquest, the enclosure maintained the same function as a dockyard as in the Almohad period, and suggests that its shipsheds remained in use (Fig. 14c).

Despite the fact that the historical sources only briefly mentioned its construction, the archaeological information that we have now strongly suggests that the enclosure at the Casa de la Moneda was once an arsenal or dockyard built and used during the Almohad period. The defensive walls equipped with parapets on both sides, the twin gates, and the defensive towers that comprise the enclosure, in combination with the topographic information offered by the examination of the gate and the archaeological survey of 2001, constitute empirical evidence that allows us to defend the existence of the Almohad dockyard and the probable existence of shipsheds within it.

The current ground level at the site is at 7.4 m above mean sea-level, well above the Almohad strata, and the existing standing buildings at the Casa de la Moneda do not allow open-area archaeological excavations to be conducted (Fig. 10). Consequently, some of the hypotheses that we are about to discuss, regarding the original layout of the dockyard and its shipsheds, are based on the existing and analogous evidence but have not been archaeologically verified.

The trapezoidal enclosure of the Casa de la Moneda protrudes towards the river, and on its southern flank a stream, the Tagarete, was channelled to act as a moat (Figs 1f and 6), thus adding to the defences of the military complex (Cabrera Tejedor, 2019: 181; fig. 162).

The dimensions of the enclosure (north wall: 96 m; east wall: 112 m; south wall: 105 m; and west wall: 51 m; distance between the east and west walls: 105 m) provide a total surface area of 9254 sqm. We believe that the enclosure would have been composed of an internal dock connected to the river and that, at the back of the enclosure and above the mean river level, there would have been an undetermined number of shipsheds to house galleys (Fig. 12).

In order to determine the number and dimensions of the shipsheds, we can look at analogous archaeological examples. Other Islamic shipsheds were built in al-Andalus but there are hardly any surviving archaeological remains (Torres Balbás, 1946); however, there is one preserved archaeological parallel of Islamic 13th-century shipsheds in modern-day Turkey: the Alanya shipsheds (Torres Balbás, 1946: 207-209), which had five shipsheds or galleries 7.5 m wide and 31-40 m long (Johns, 2010: 185). These dimensions seem to have been adequate to house contemporary galleys, since the 13th-century war galleys ordered by the king of Sicily, Charles I of Anjou, in 1275, were 4.45 m wide and 39.3 m long (Johns, 2010). It is probable, therefore, that within the available space inside the enclosure at least seven shipsheds (each 7.5 m wide) were built. The length of their galleries would be approximately 40 m, similar to other medieval shipsheds. This would leave large spaces on either side of the shipsheds, which would have been needed in a working dockyard (Figs 12, 14a, 14b).

From the western wall to the façade of the proposed shipsheds would have measured about 65 m; this space would have been enough to allow the galleys to be towed into the enclosure and manoeuvred to face the slipways to position them inside each individual gallery of the shipsheds. We propose a gabled roof for the shipsheds similar to that of the Royal Shipsheds of Alfonso X (Figs 12, 14a, 14b). The general dimensions of the enclosure, its design and configuration, also support the likelihood of the existence of shipsheds.

To summarize, the historical development of the defensive complex, from the 13th to the 16th centuries, would be as follows:

- 1184: Abu Ya'qub Yusuf orders the construction of the Almohad dockyard; it is provided with an internal dock, two open gates, and possibly seven shipsheds (Figs 12, 14a).

- 1221: construction of the Almohad tower 'Torre del Oro' and a stretch of defensive wall to connect it with the dockyard complex, to defend the dockyard and its shipsheds as well as the city harbour from potential enemy attacks from the river (Fig. 14b). The construction of this new defensive tower and wall is likely to have been closely related to, and a consequence of, the lateral displacement of the river westwards.

- 1248: siege and capture of the city of Ishbiliyya by the armies of King Fernando III of Castile and Leon. The chronicles do not mention the Almohad shipsheds.

- 1252: construction of the Royal Shipsheds by King Alfonso X in the area next to the Almohad dockyard with a different design and of larger dimensions (Figs 7, 14c). The monarch kept the Islamic dockyard active, adding greater capacity to the navy in its fight against the Muslim powers in the Strait of Gibraltar.

- 1252-1300: renovation and transformation of the tower 'Torre de la Plata' and, possibly, of the access-gates to the dockyard, walling up the south gate and reinforcing the north gate with a large forged gate to allow the dock to be locked (Fig. 14c; Amores, 2018: figs 14, 15).

- 14th-16th centuries: abandonment of the enclosure as a dockyard, backfilling the internal *darsena*, or dock, and transforming the complex into a prison for noblemen, historically known as the 'Atarazanas de los Caballeros' (Shipsheds of the Knights). This name, used in the historical source to describe this complex used as a prison (Pérez González, 1997: 291-292), supports the prior existence of the Almohad shipsheds.

- 1584-1589: Juan de Minjares adapts the precincts of the 'Atarazanas de los Caballeros' to the Casa de la Moneda (Royal Mint), raising the overall ground level with backfill, thus concealing traces of the previous structures (Fig. 11).

With respect to the design and river-related characteristics of the Almohad dockyard of Seville, it is worth mention that they have much in common with those of Pisa. The Arsenali Repubblicani of Pisa, the 'Tersana', was built in the mid 13th century and consists of a large, walled enclosure nearly 6 hectares in surface and designed with gateway access to the River Arno (Redi, 2010). From the river, the water entered a large canal within the enclosure where, according to historical descriptions of the time, 80 shipsheds were located on its flanks. Redi considers that perhaps this was an exaggeration, but there is enough space for 40 shipsheds, although archaeological excavations to verify this have not been conducted.

Both arsenals, Seville and Pisa, had the primary function of protecting the galleys inside several parallel shipsheds located within a fortified enclosure with an internal *darsena* or dock that accessed the river by

Figure 15. Detail of tapestry (No. 10) of the series depicting the conquest of Tunisia by Emperor Charles V (1535) on display at the Alcazar of Seville. In the centre of the image note the walled complex housing six vaulted shipsheds (©Fernando Amores, Alcazar de Sevilla).

one or two gates. In both cases, an outer wall defended the entire complex to prevent enemy access. A similar complex, equipped with vaulted shipsheds, seems to have existed in Tunisia as depicted on tapestry No. 10 of a series depicting the conquest of Tunisia by King Charles I (1535), which is kept at the Alcázar of Seville (Fig. 15). The complex depicted in the tapestry is an enclosure near the sea which is accessed by a monumental gate that gives way to an open space where six shipsheds able to house galleys are located.

We have not found any archaeological remains of the 9th-century shipsheds that, according to the historical chronicles, Abd al-Rahman II ordered to be built in Seville (Lévi-Provençal and García Gómez, 1950: 144-150; Bosch Vilá, 1984: 35-50). However, it would be interesting to see if the 12th-century shipsheds were built on the same site as those of the 9th century. Perhaps the Caliph Abu Ya'qub, instead of building a dockyard from scratch in the 12th century, ordered the restoration of the 9th-century dockyard and its shipsheds, as he did with other ancient urban infrastructure in Ishbiliyya, such as the Roman aqueduct (Ibn Ṣāḥib al-Ṣalāh, ed. Huici Miranda, 1969: 64-65).

At present, this is an academic hypothesis deduced from the optimal location of this site in relation to the river. In this regard, it is interesting to note that this 12th-century dockyard (and perhaps the 9th-century one) is in the same area proposed as having housed Roman masonry-quays at the southern harbour of the Roman port of Hispalis (Cabrera Tejedor, 2019). If future archaeological excavations could verify that the 9th-century shipsheds were located there, one wonders if the Roman harbour infrastructures and their masonry were re-used to build these 9th-century Islamic shipsheds. In other words, it would be interesting to see if in the 9th century, the site of a long-abandoned Roman harbour and its associated infrastructure, such as quays built with excellent-quality Roman construction materials, such as ashlars, were reused to erect a new dockyard equipped with shipsheds (Lévi-Provençal and García Gómez, 1950: 144-150; Bosch Vilá, 1984: 35-50). After all, the re-use of Roman quay foundations for building Islamic walls has been attested in Seville at La Campana excavation (Jiménez *et al.*, 2014) and the use of Roman *spolia* is well documented in the construction of the 11th-century fortification walls of the Alcázar of Seville (Tabales Rodríguez, 2013: 100, footnote 25).

Figure 16. Detail of an engraving of 1617 by Janssonious depicting the Guadalquivir River and Seville's natural harbour known as El Arenal. At the centre, the façade of the 13th-century Royal Shipsheds of King Alfonso X used in the 17th century as workshops and warehouses; on the right, the Torre del Oro and Torre de la Plata towers (©Museo Naval, Madrid).

Conclusions

This article has shown that, during the Islamic period, the hydrological and geomorphological changes of the River Guadalquivir are key to understanding and closely related to both the urban transformations of Seville and the construction of different defensive systems that were erected to defend the city. The change in the course of the river profoundly transformed the Islamic medina of Ishbiliyya, significantly increasing the size of the city and developing, as a result, vast new districts later occupied by its flourishing population (Figs 1d and 1e). This also represented a challenge for the rulers of Seville in the 12th and 13th centuries, who undertook ambitious urban developments including an extensive defensive city wall and the foundation of a new port (the current port of Seville) with quays on both banks equipped with ramps, and a dockyard equipped with shipsheds.

The location, layout, and characteristics of the 12th-century Almohad dockyard equipped with possibly seven shipsheds have been discussed and presented. What remains unclear is whether these Islamic shipsheds from al-Andalus were constructed as a reflection of contemporary eastern Mediterranean examples, or if they were inspired by those of the Roman Period (Rankov, 2013: 30; Blackman forthcoming). In any case, they were dwarfed by the shipsheds built in Seville by King Alfonso X of Castile in the 13th century (Amores Carredano and Quirós Esteban, 1999) (Figs 6 and 7).

Regarding the morphology and facilities of the new Islamic port, it can be said that after the avulsion of the ancient channel and the formation of a new riverbed, the east bank was convex in shape, sloped, and subject to flooding by the daily tides. This convex bank became known as 'el Arenal' in the 16th century. Its gentle slope created a natural harbour and shipyard ideal for berthing flat-bottomed riverboats and for the construction and repair of ships. In this sloped natural harbour, simple wooden jetties were constructed to facilitate the mooring of larger ships and transhipment of goods. All these operations were represented in many 16th-century illustrations of Seville (Fig. 16).

This new port might have been, at first, a mere shadow of its predecessor; yet, in the coming centuries, this newly founded port would become no less than the most prominent and important port of Europe. It was to connect, for the first time in history, the Old World of Europe with the New World of the Americas and the Far East in the thriving 16th century, the Age of Discovery. The port of Seville was the base used by the Kingdom of Spain to enable Spain to become the world's first trans-oceanic imperial power (Chaunu, 1977).

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MARITIME LANDSCAPES

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Mariners, Maritime Interaction, and the 'Ritual' of Sea Travel in Early Neolithic Cyprus

Duncan Howitt-Marshall

During the early Neolithic, the transfer of people, new animal species, and domestic crops to Cyprus from the neighbouring Levant and Anatolia was facilitated by small groups of coastal foragers and pioneer farmers with the necessary skills and technology to undertake regular sea-crossings. This gradual process of Neolithization, in parallel with the long-distance movement and circulation of higher-value goods, such as obsidian and carnelian, attest to advanced levels of seafaring knowledge and the development of a maritime way of life. A survey of early Neolithic coastal sites on the island affirms frequent interaction between people living either side of the maritime straits, and that, over time, seafaring may have assumed an ideological or ritualized context.

Keywords: Cyprus, early Neolithic, maritime interaction and materialism, specialized voyager communities, seafaring ideology, symbolism and ritual.

In the millennia following the end of the last Ice Age, the early domestication of wild cereals and herding animals, the so-called Neolithic package, spread from the shores of southwest Asia to the great islands of the Mediterranean on a 'semi-maritime latitudinal axis' (Broodbank, 2006: 214; see also Knapp, 2010; Fernández *et al.*, 2014; Simmons, 2014; Shennan, 2018). The arrival of this increasingly sedentary, agro-pastoral way of life on Cyprus (*e.g.* Peltenburg *et al.*, 2000; Peltenburg, 2004a; Colledge, 2004; McCartney, 2010; Conolly *et al.*, 2011), the first insular port of call in the eastern Mediterranean, implies a high level of seafaring knowledge by coastal foragers and migrating groups of pioneer farmers transporting people, livestock, founder crops, and raw materials from the Levant and Anatolia. This knowledge likely developed during the preceding Younger Dryas climatic event at the end of the Pleistocene, *c.*10,700-9600 Cal BCE, a return to the cold, arid conditions of the Last Glacial Maximum, when bands of coastal hunter-gatherers took to the sea in search of new lands and opportunities (Simmons, 1999; 2013; 2014; Broodbank, 2006: 208-211; see also Perlès, 1979; 1987: 142-145; Papoulia, 2016; Carter *et al.*, 2016; Sampson, 2018 for similar discussions on early maritime activity in the Aegean). The earliest demonstrated presence of hunt-

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er-gatherers (hereafter 'seafaring fisher-foragers')[1] on Cyprus at the south coast site of Akrotiri *Aetokremnos* in the Late Epipalaeolithic, *c.*11,000-9000 Cal BCE, suggests the early development of a 'seafaring ethos' (Broodbank, 2006: 216) in response to the climatic downturn and increasing demographic pressure on the neighbouring mainland (see also Bar-Yosef, 2001; Simmons, 2004: 10; Barker, 2005: 47-49, fig. 3.2; Sherratt, 2007: 4-6; Knapp, 2013: 69-74). The maritime spread of the Neolithic way of life in the subsequent post-glacial period, coupled with the 'expansionist ideology and demographics' (Broodbank, 2006: 216) of late forager/early hunter-cultivator populations in the Levant and southeast Anatolia (see also Watkins, 2005), transformed the sea from a 'local provider of resources to a vector for travel' (Broodbank, 2006: 210). As maritime skills and technologies developed, mariners paved the way for the permanent settlement of Cyprus, enabling the transfer of increasing numbers of people and the introduction of both domesticated crops and herded (or 'managed') animals from the adjacent Levantine (Syro-Cilician) mainland (Vigne *et al.*, 2009; see also Peltenburg *et al.*, 2001a: 55-60; Peltenburg *et al.*, 2003: 98-99; Peltenburg, 2004b: 4-5; Sherratt, 2007: 11).

In the context of increased or 'more ambitious maritime activity' (Broodbank, 2006: 208) that developed in the eastern Mediterranean at the end of the Pleistocene, this study presents an overview of the current evidence for the early Neolithization of Cyprus – chronologically defined as the Late Epipalaeolithic (*c.*11,000-9000 Cal BCE), the Initial Aceramic Neolithic (Cypro-PPNA, *c.*9000-8500 Cal BCE), and the Early Aceramic Neolithic (Cypro-PPNB, *c.*8500-7000/6800 Cal BCE) (Knapp, 2013: 25-28; see also Manning, 2013). It considers the spread of agro-pastoralism to the island from a liminal perspective – the study of thresholds and transformative spaces – and seafaring as an emerging socio-economic specialization that opened up new opportunities for networks of interaction and materialism during a time of significant change. Finally, and less tangibly, it focuses on the development of a maritime way of life that enabled the transfer of ideas and knowledge between communities on the island and the Pre-Pottery Neolithic (PPNA, PPNB) cultures of the Levant and Anatolia. In this scenario, it is argued that sea travel may have assumed an ideological or ritualized context, especially in the maintenance of social relations with communities on the neighbouring mainland (pathways to ancestral homelands?) and the circulation (and consumption) of exotic raw materials non-native to the island, such as obsidian (Moutsiou, 2018: 242) and carnelian (Moutsiou and Kassianidou, 2019: 258-259).

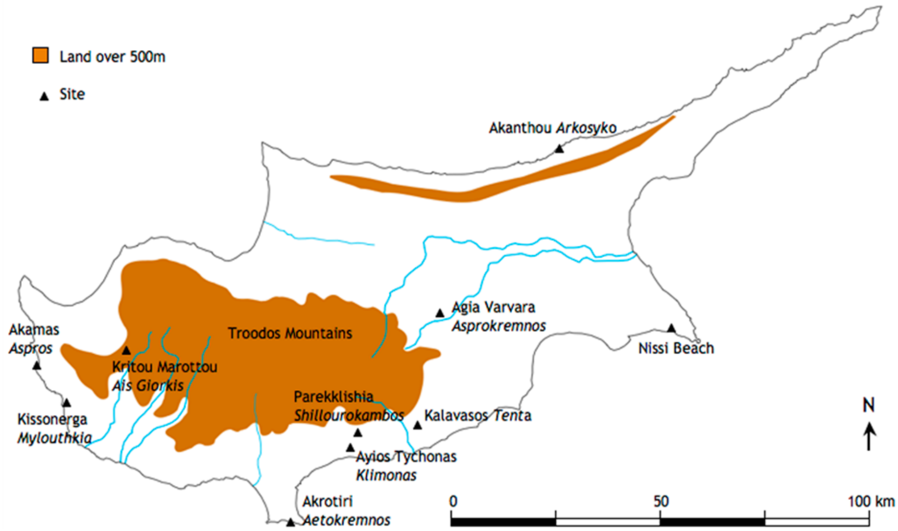
It is important to stress from the outset that some of the ideas and proposals put forward in the following sections are not yet fully substantiated in the archaeological record. Where inconsistencies or gaps occur, suggestions are made for further study.

The cultural creation of maritime space

The evidence for increased maritime mobility in the Late Pleistocene-Early Holocene transition, coupled with the knowledge of incipient forms of agriculture and the development of new types of material culture, may represent a cognitive/ideological shift motivated by a 'desire to transform the wild into the cultural' (Cummings, 2014: 773; see also Hodder, 1990; Gamble, 2003: 232-233). The transfer of exotic raw materials to Cyprus throughout the early Neolithic – obsidian and carnelian from central Anatolia and the Caucasus – provides valuable insight into the nature and extent of maritime interaction at this time (for discussion of the PPNB Levantine interaction sphere, see Bar-Yosef and Belfer-Cohen, 1989; Kuijt, 2004; Simmons, 2004). Discoveries of early coastal and near-coastal sites on the island (Fig. 1) have emphasized the continuation of strong affinities with aspects of material culture on the surrounding mainlands, particularly in the shared typo-technological characteristics of stone tools and early forms of architecture (see McCartney, 2004; 2010; 2011; Knapp, 2010; 2013). It has been argued that these affinities may reflect a shared symbolic system, a series of 'ideational networks' (Manning *et al.*, 2010: 697) that not only involved the transfer (and circulation) of exotic materials, objects, and craft technologies between island and mainland communities (see also Asouti, 2006; Watkins, 2008), but also the adoption of symbols, rituals, and social institutions (Peltenburg *et al.*, 2001a: 37-39; Jones, 2008: 81-95; Moustiou, 2018: 229-231). Seafarers were the prime facilitators in this process (current chronological data, key sites, and associated material markers for maritime activity on Cyprus are summarized in Table 1), and there is little doubt that the maintenance of long-distance social contacts with populations on the mainlands played a crucial role in counteracting the potentially 'paralysing isolation' (Moutsiou, 2018: 242) of early island life. For those individuals who possessed the necessary skills and were willing to undertake the challenges and risks of

1 The term 'seafaring fisher-forager' is used here to describe mobile groups of foragers that possessed seafaring capabilities and exploited a range of marine and coastal resources – fish, shellfish, marine avifauna – within the broader spectrum of hunting and gathering (Knapp, 2010; 2013: 69-74; see also Sherratt, 2007: 6). Although the term is synonymous with 'coastal' or 'maritime hunter-gatherer' (Bailey and Milner, 2002; Bailey, 2004), it is consistent with recent archaeological literature concerning the earliest visitors to Cyprus in the Late Pleistocene and Early Holocene (Knapp, 2010; 2013; see also the use of alternative terms in Ammerman, 2010).

Figure 1. Map of Cyprus with Late Epipalaeolithic and early Neolithic sites mentioned in the text (Drawn by Blake Sawicky and Duncan Howitt-Marshall).



Coastal and near-coastal sites	Period (with approximate dates Cal BCE)	Maritime activity and associated material markers
Akrotiri *Aetokremnos*	Late Epipalaeolithic, *c.*11,000-9000 Cal BCE – 'Akrotiri Phase'. Four AMS-based determinations provide a date range between *c.*10,900-10,100 Cal BCE.	Seafaring; fisher-forager exploration; early game stocking. 13 wild pig phalanges (introduced from the mainland) (Reese, 1995: 154). 73,365 marine invertebrate fragments (21,576 individuals), including mainly edible topshell (*Phorcus*) and limpets (*Patella*), and some 100 shell beads worked from *Antalis*, *Conus ventricosus*, and *Columbella rustica* (dove shell), 3 pieces of crab, 1 sea urchin (*Paracentrotus lividus*), and 1 cuttlefish (*Sepia* sp.) (see Reese, 1999a: 188-191). A single vertebra of a grey mullet (Mugilidae).
Akamas *Aspros*, *Alimman*, and Nissi Beach	Continuation of Upper Palaeolithic/Epipalaeolithic coastal foraging pattern? N.B. Two AMS dates for Nissi Beach provided ranges between *c.*7592-7551 and *c.*7586-7547 Cal BCE respectively, placing the site well within the later EAN 3 [Cypro-Late PPNB].	Seafaring; coastal foraging (fish, shellfish, marine avifauna, seaweed, and salt?). 26 marine shells at Nissi Beach, including edible species (principally *Phorcus*, *Patella*, and muricids), and various taxa used for decorative purposes (*e.g. Conus ventricosus* and *Columbella rustica*) (see report by Ken Thomas in Ammerman *et al.*, 2013: 129-135).

Coastal and near-coastal sites	Period (with approximate dates Cal BCE)	Maritime activity and associated material markers
Ayios Tychonas *Klimonas*	Initial Aceramic Neolithic (Cypro-PPNA), *c.*9000-8500 Cal BCE. More precise determinations provide a date range between *c.*9155 and 8615 Cal BCE.	Seafaring; hunting; early cultivating; limited coastal foraging; game stocking (small wild boar). 31 marine shells (plus an additional 156 of equally early date). Shell beads and pendants (Vigne *et al.*, 2011: 10-12, figs 9-19, table 2). Obsidian (3 pieces).
Parekklishia *Shillourokambos*	Early Aceramic Neolithic (EAN) 1-3. Four main phases of occupation, *c.*8400-7000/6900 Cal BCE.	Seafaring; fishing; hunting; cultivating; game stocking (including deer, sheep, goat, and cattle). Fish remains, especially sea basses and large groupers (Serranidae) (4 to 17 kg); marine molluscs (372 pieces) for food (*e.g. Phorcus, Patella*), decoration, personal ornamentation, or use as other tools (*e.g.* containers). Grooved stones (net sinkers?); several *micro-godets* of picrolite (representing early boat models?). Obsidian (451 pieces) from central Anatolia.
Kissonerga *Mylouthkia*	Early Aceramic Neolithic (EAN) 1-3. Radiocarbon dates for Period 1, Phase A and B, *c.*8517-6836 Cal BCE.	Seafaring; fishing; hunting; cultivating; game stocking. Large number of fish remains; marine molluscs (including 2,285 limpet shells); several crab claws (see Croft, 2003: 50). Fishhook made of pig tusk found in Well 116. Obsidian (24 pieces) from central Anatolia.

Coastal and near-coastal sites	Period (with approximate dates Cal BCE)	Maritime activity and associated material markers
Kalavassos *Tenta*	Early Aceramic Neolithic (EAN) 1-3. Radiocarbon dates for Period 5 (the earliest habitation phase), *c.*8608-7336 Cal BCE. N.B. Most of the obsidian artefacts were uncovered from stratigraphic units linked to Periods 4-2, *c.*7900-7000 Cal BCE (Moutsiou, 2018: 232).	Seafaring; fishing; hunting; herding; cultivating. Fish remains (25 bones; period/date unclear); marine molluscs (471 pieces) for food (*e.g. Phorcus*, *Patella* and *Cerastoderma*), and perforated shells for ornaments (*e.g. Columbella*, *Conus*, and *Semicassis*); the remains of marine crabs (*Eriphia*) (see Reese, 2008). Obsidian (36 pieces) from central Anatolia.
Akanthou *Arkosyko*	Early Aceramic Neolithic (EAN) 1-3. Radiocarbon dates for the earliest phases of the site provide a range of *c.*8234-7748 Cal BCE (Şevketoğlu and Hanson 2015: 236).	Seafaring; fishing; hunting; herding; cultivating; an early example of a Mediterranean Fishing Village-style economy? Fish remains, including deepwater hake, dogfish, shark and tunny (tuna); 10 complete sea turtles (*Caretta caretta*); marine molluscs (at least 36 pieces), including *Dentalium*, cowrie, and bivalves. Fishhooks; two picrolite *micro-godets* (boat models?); shell beads. Obsidian (*c.*5,000 pieces) from central Anatolia.

Table 1. Sites, dates, and socio-economic practices related to maritime activity from the Late Epipalaeolithic to the end of the Early Aceramic Neolithic (EAN/Cypro-PPNB), c.11,000-7000/6800 Cal BCE.

regular sea-crossings, the benefits must have outweighed the cost, perhaps by the enhancement of their social status or prestige within their respective communities (Robb and Farr, 2005; Farr, 2006; 2010: 187; see also discussions in Helms, 1988: 80-94).

Conceptual and interpretative frameworks

Seafaring technology

There is limited archaeological evidence for the types of seacraft used in the early Neolithic Mediterranean. What is known is largely derived from one logboat found in Lake Bracciano in central Italy dating to the 6th millennium Cal BCE, at the now-submerged Neolithic site of La Marmotta (Fugazzola Delpino *et al.*, 1993; Fugazzola Delpino and Mineo, 1995; Fugazzola Delpino, 2002; Farr, 2010: 183, fig. 14.6), and the outline of a similarly shaped vessel at the lakeside settlement of Dispilio, northwest Greece, *c.*5400-3500 Cal BCE (Chourmouziadis, 1996; Marangou, 2003). The well-preserved remains of similar logboats discovered in Mesolithic and Neolithic contexts across northern and temperate Europe have provided comparative evidence for their construction and design, as well as useful information on the development of more complex forms in the later Bronze and Iron Ages (see McGrail, 2001: 172-181). Ethnographic research and experimental reconstructions of small reed-built rafts and dugout canoes have provided further insight into the materials used, possible construction techniques, and their manoeuvrability at sea (Tzalas, 1995; Bednarik, 1999; 2003; Tichy, 1999). The tradition of reed-craft production until recent times, especially in Kerkyra (Corfu) and Sardinia, has prompted many scholars to agree that some form of reed-bundle raft was one of the earliest complex forms of seacraft in the Mediterranean (Tzalas, 1995). Others have argued that some early types may have been constructed using pairs of logboats and/or stabilizing timbers at the waterline, which would have given them greater transverse stability at sea (Medas, 1993; McGrail, 2001: 105; Bar-Yosef Mayer *et al.*, 2015: 417) – a catamaran or 'double canoe'.[2]

For sea-crossings to Cyprus in the EAN, *c.*8500-7000/6800 Cal BCE, Vigne (2009, fig. 7c) has put forward the intriguing possibility of the early development and use of the sail. Controversial as this may seem, especially as it predates the earliest depictions of a true sail by some five millennia (Johnstone, 1980: 75-77,

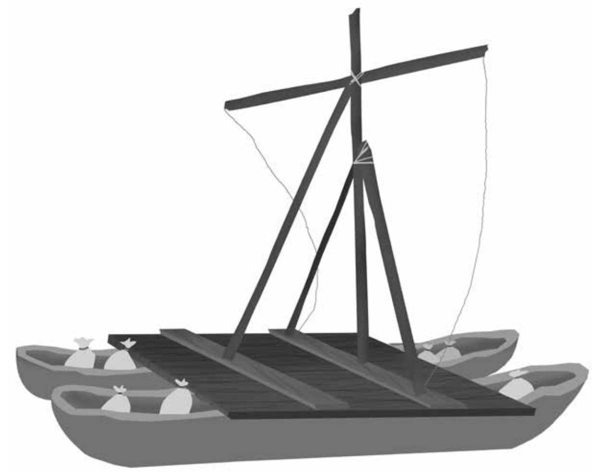


Figure 2a. Hypothetical, schematic reconstruction of a composite seacraft based on historical designs from southern Europe and south India (see Pomey, 2012). Note the rigid superstructure of two dugout canoes, decking, and a mast for attaching a sail (Simmons, 2014: 96, fig. 4.2, modified by Russell Watters from Vigne, 2009: fig. 7c. Courtesy of Alan H. Simmons).

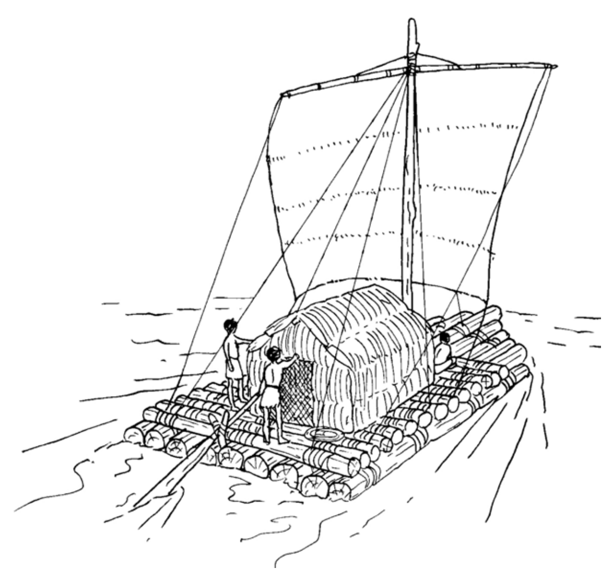


Figure 2b. Reconstruction of a large, seagoing sailing raft based on the familiar design of the Kon-Tiki raft used by Thor Heyerdahl and his crew to voyage across the Pacific Ocean from South America to the Polynesian islands in 1947 (Heyerdahl, 1950: 35-60). The raft is composed of single logs lashed together with cordage made of plant fibres (e.g. reed or wild flax), animal hair, or skin. Note the large steering oar at the stern, and the use of a single mainsail (Howitt-Marshall and Runnels, 2016: 146, fig. 3b. Drawn by Yannis Nakas).

2 Significantly, ceramic models of logboats or 'double dugouts' have been found at Lake Kastoria in Macedonia, Greece, dating to the 6th to 5th millennium Cal BCE (Marangou, 1992: 40, 429, fig. 80g; 1996; 2001; 2003: 14).

fig. 7.10; see also discussion in McGrail, 2001: 17-20), Vigne argues that early Neolithic mariners may have adopted the sail in order to increase speed across open water,[3] a necessary factor when transporting sheep, goat, fallow deer, and cattle in cramped conditions (see a schematic reconstruction of composite seacraft or double canoe with a sailing rig in Fig. 2a, and an alternative hypothetical version of a large, seagoing sailing raft in Fig. 2b). It is known that these ruminants, particularly cattle, are prone to downer cow syndrome when rendered immobile for periods of up to three or four hours (Cox *et al.*, 1982; Cox, 1988). One of the main causes of this potentially fatal syndrome is the rapid build-up of gas in the animal's stomach – ruminal tympany (or bloat) – and characterized by nerve inflammation and ischaemic necrosis of the hind limbs (Cox, 1982; discussed in Vigne, 2013: 52-53; see also Papoulia, 2016: 43). Vigne speculates that this would have presented Neolithic mariners with a considerable logistical challenge, requiring them to make the crossing in the shortest possible time to avoid the loss of valuable livestock.

Without direct physical evidence, it is impossible to be precise about the true nature of these early forms of seacraft, but it is conceivable that their overall size and structure allowed for some form of decking and sufficient space for animals to stand up to alleviate the risk of bloat. Vessels of this size might have inadvertently transported small rodent stowaways, such as non-indigenous mice (*Mus musculus domesticus*) (Cucchi *et al.*, 2002; Broodbank, 2006: 215-216; Vigne *et al.*, 2013: 169; Shennan, 2018: 63).

Exotic objects and the symbolic significance of maritime distance

Following the permanent settlement of Cyprus in the later stages of the Early Aceramic Neolithic (EAN), affiliations with places, people, and objects from the mainland may have been imbued with various symbolic connotations. Obsidian is perhaps the best-known material marker for ongoing maritime interactions in the eastern Mediterranean at this time, the nearest source to Cyprus being around 400 km away in Cappadocia, central Anatolia (Carter *et al.*, 2011; Moutsiou, 2018) (Fig. 3). The acquisition modes by which obsidian arrived on the island were either directed from the southern Anatolian coast to northern Cyprus (north to south) or from the northern Levantine coast to southern Cyprus (east to west), but it is not known whether these modes were a result of direct procurement or down-the-line exchange (Moutsiou, 2018: 238-240). Obsidian assemblages on the island – equivalent to only 3 kg of raw material across five EAN sites – are dominated by small blades or bladelets (Moutsiou, 2018: 231, table 1, 235). It has been argued that these sharp cutting tools, noted for their striking black lustre, may have been reserved for certain ritual functions, including shaving, scarification, circumcision, or sacrifice (Carter, 1994; 1997; 1998; Robb and Farr, 2005: 38). Another imported material is carnelian, a semi-precious gemstone of brownish-red colour used to make beads and pendants, although its paucity in EAN contexts on Cyprus (two beads at the upland site of Kritou Marottou *Ais Giorkis* and a single bead at Parekklishia *Shillourokambos*) makes it difficult to determine its true social significance or value (for more recent analysis and discussion, see Moutsiou and Kassianidou, 2019).

It could be argued that the acquisition of such geographically charged objects represented a shift in social relations in the early Neolithic (see discussions in Carter, 2011; Moutsiou, 2018). Due to their rarity, imported objects may have been seen as conspicuous symbols of wealth or status, representative of social differentiation or emerging hierarchies within early agricultural communities (see Christou, 1994: 664). Alternatively, the exchange of exotic objects, notable for their distinctive physical qualities, was an effective means of creating and maintaining social relations, kinship or alliance relationships, in a rapidly changing Neolithic world (Moustiou, 2018: 241-242; see also Gosden, 2001: 165-166; Robb, 2001; Hodder, 2012: 41-63; Moutsiou, 2014: 5-15). The rarity and eye-catching aesthetic of obsidian and carnelian may have imbued them with symbolic power, giving them the capacity to bond communities and individuals together across land and sea. As Moutsiou (2018: 241-242) argues, these artefacts may have functioned as 'symbols of relatedness', maintaining social connections between the island and the adjacent mainlands.

At a time of significant cultural, economic, and social change in the eastern Mediterranean, long-distance associations with people and places in the nearby Levant and Anatolia, ancestral or otherwise, would have played a significant role in the success of early sea-crossings to and from Cyprus. These associations may have provided food, water, and shelter to mariners arriving at established coastal locations on either side of the maritime straits, where the exchange of information, exotic artefacts, or trinkets (such as translucent chert, shaft straighteners, lozenge points, and perforated shells) would have been instrumental in forging contacts and social bonds between island and mainland communi-

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3 Despite no direct evidence for sails in the early Neolithic, hide working and cordage from plant fibres is well attested by the Upper Palaeolithic, and probably as old as the use of stone tools (Schick and Toth, 1994: 160-162; Howitt-Marshall and Runnels, 2016: 145). Evidence for woven flax fibres at Dzudzuana Cave in the foothills of the Caucasus, Georgia (Kvavadze *et al.*, 2009) suggests the technology to weave baskets, sew garments, and even manufacture a rudimentary form of sail existed as early as 30,000 Cal BP.

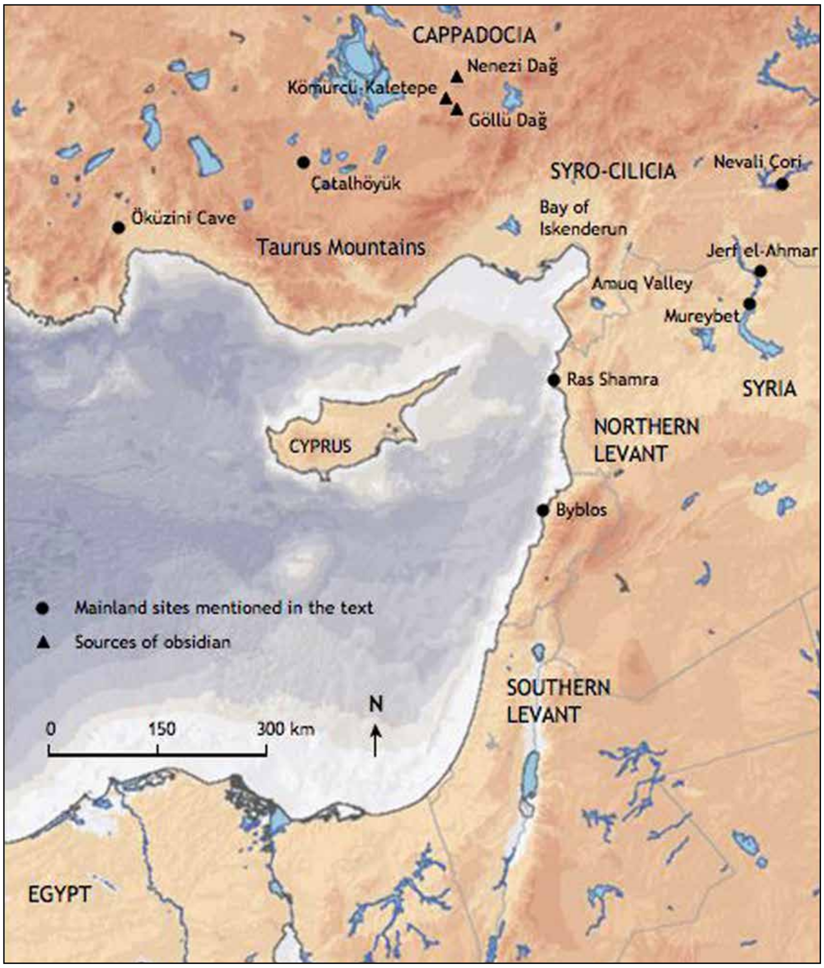

Figure 3. Map of the eastern Mediterranean with obsidian sources and mainland Neolithic sites mentioned in the text (Drawn by David Redhouse and Duncan Howitt-Marshall).

ties (see discussions in Farr, 2006; 2010: 187), as well as divergent populations on the island (for discussion of obsidian and picrolite as exchange items between coastal and inland groups, see Peltenburg *et al.*, 2001a: 42). It is conceivable that these meeting points on or near the coast became significant or symbolic places for itinerant traders and other coastal groups engaged in sea-related activities to gather and exchange knowledge. With commanding views of the surrounding sea, the coastal sites of Akamas *Aspros* and Nissi Beach (Ammerman *et al.*, 2006; Ammerman, 2011; 2013) and Akanthou *Arkosyko* (Şevketoğlu, 2002; 2006; 2008; 2018; Şevketoğlu and Hanson, 2015) (see further discussion below) are possible examples of meeting points on the island. Across the sea, the PPNB site of Ras Shamra on the Syrian coast, and further south at Byblos, where chipped stone assemblages bear close parallels to lithic technologies on Cyprus (McCartney, 2007: 77; see also Knapp, 2010: 106), may have served as places of interaction and exchange on the mainland. In the case of later trade networks in the central Mediterranean, *c.*6500-3500 Cal BCE, Farr (2006: 96) argues that the 'practice and experience from regular trips' was not only vital for maintaining knowledge of sea routes but also for the continuation of social contacts with other communities across the region.

Liminality and land-water interfaces in the early Neolithic

It has been argued that early food-producing societies marked spatial zones in the landscape by contrasting categories of experience and territorial differentiation, including open spaces for social and ceremonial activities, aggregation, and mobility routes, as well as liminal zones of interaction between neighbouring groups (*e.g.* Bar-Yosef, 2001: 147-149). For island and coastal societies, dry land, littoral, and sea, as well as the distant lands on or beyond the horizon, would have provided the most obvious zones that demarcated the lines between the known and the unknown, or the safe and the dangerous (Helms, 1988: 24; Ford, 2011: 763-764). The transfer of animals, domesticated crops, and raw materials across the sea to Cyprus represented a 'deliberate and conscious choice to move and to re-create place' (Jones, 2008: 90; similarly Dawson, 2014: 54-58; Rockman, 2003). The arrival of people also resulted in the transmission of ideas, beliefs, and preoccupations from their past lives on the mainland; intangible esoterica that underwent transformation in a new, island context (see Helms, 1988: 94-110 for other examples in the ethnographic literature on long-distance travel and the transmission of cultural and ritual knowledge). Any interpretation of maritime interaction and the transference of ideological components to Cyprus in the early Neolithic must, therefore, consider the sea and the practice of seafaring from a liminal perspective (*e.g.* Horden and Purcell, 2000; Westerdahl, 2005; Monroe, 2011: 87-91).

Perhaps the most obvious examples of liminality or place-making include the introduction of small wild boar during the earliest visitations to the island in the Akrotiri Phase and the emphasis on pig-hunting as the primary means of subsistence in the Initial Aceramic Neolithic, most notably at Ayios Tychonas *Klimonas* (Vigne *et al.*, 2009; 2013) and Ayia Varvara *Asprokremnos* (McCartney, 2011). This process of repeated game stocking over the course of multiple generations would have buffered against the risks of potential failure on the colonizing frontier in a new island environment. It further suggests the continuation of an ancestral economy that had its roots on the mainland during the Late Natufian period *c.*10,800-9500 Cal BCE, when people were able to manage wild boar to the point of transporting them overseas (Vigne *et al.*, 2013: 162; see also Tsuneki *et al.*, 2006: 57, 66 for discussion on the dominance of pig in the faunal assemblage at the PPNB Syrian site of Tell Ain el-Kerkh). Indeed, the practice of herding and transporting wild boar/pig must have involved boats that were sufficiently large enough for the animals to stand up but remain tethered or strictly controlled during the voyage (Vigne, 2013; see also Papoulia, 2016: 43). Over time, such communities may have adopted a more sedentary way of life further inland, but continued to subsist on a mixed diet of terrestrial foods and mammalian protein, supplemented by marine molluscs and fish (*e.g.* the near-coastal sites of Parekklishia *Shillourokambos* and Kalavassos *Tenta* – see discussion below).

By viewing sea travel as the transformative action that enabled the 'targeting of a fertile, empty (more or less) niche' (Broodbank, 2006: 216), it is possible to situate human movement and the early Neolithization of Cyprus within the broader landscape/seascape of social and economic change in the Late Pleistocene-Early Holocene eastern Mediterranean. Throughout this period, mariners acted as the hydroliminal agents who traversed the maritime threshold, transferring people, livestock, crops, and exotic materials and artefacts to the island, while maintaining social contacts with communities on the mainland (for further discussion on the broader use of the term 'hydroliminal', albeit in reference to the Late Bronze Age, see Monroe, 2011: 87-91). At the same time, the transformative power of sea travel resulted in the development of new cultural practices, a new island identity, and new 'ways of being' (Jones, 2008: 97; see also Clarke, 2003; Simmons, 2017).[4] It could be further argued that, over time, seafaring became a self-serving practice, an endeavour that maintained a specific maritime world view for small groups of mariners and their respective communities on or near the coast – the emergence of maritime communities of practice or specialized voyager communities (see discussion in Vigne *et al.*, 2013: 167). Knowledge of fishing, boatbuilding, and wayfinding/navigation must have been transmitted from generation to generation, giving their maritime way of life an ancestral order. It is conceivable, therefore, that seafaring itself became increasingly specialized, where experienced mariners negotiated the risks and reaped the rewards of regular voyaging (Farr, 2010: 187).

Mariners as long-distance specialists

Beyond the growing corpus of evidence for maritime activity in the Middle and early Upper Pleistocene (see Strasser *et al.*, 2010; Simmons, 2014; Runnels, 2014; Runnels *et al.*, 2014; Howitt-Marshall and Runnels, 2016; Papoulia, 2017; Carter *et al.*, 2019; cf. Cherry and Leppard, 2015; 2018; claims for a possible Palaeolithic presence on the island are summarized in Knapp, 2013: 43-48), the human presence on Cyprus at Akrotiri *Aetokremnos* remains the most compelling example of repeated open sea-crossings to a Mediterranean island in the Pleistocene. These early expeditions in the 11th millennium BCE likely involved small groups of logistically mobile foragers from the coastal regions of the neighbouring Syro-Cilician mainland already active in coastal, inshore seafaring – a maritime extension of the mobile Late Natufian (Broodbank, 2006: 211). The arrival of pioneer farmers on the island some two thousand years later implies that boatbuilding technology and the strategies involved in transporting larger numbers of people and accompanying livestock, crops, and raw materials, had made a significant leap forward in terms of technical and logistical complexity.

It has been estimated that sea-crossings to Cyprus from the nearest point on the southern Anatolian coast would have taken around 30 hours (Held, 1993: 26-27; Broodbank, 2006: 209-210), covering a distance of some 70 km. Others have suggested two shorter crossings from a departure point in the vicinity of the Bay of Iskenderun, following the presumed existence of a small stepping-stone islet when sea-level was -100 m (see Okyar

4 As exemplified by the high frequency of artificial cranial modification during the Aceramic Neolithic (Jones, 2008: 91-95).

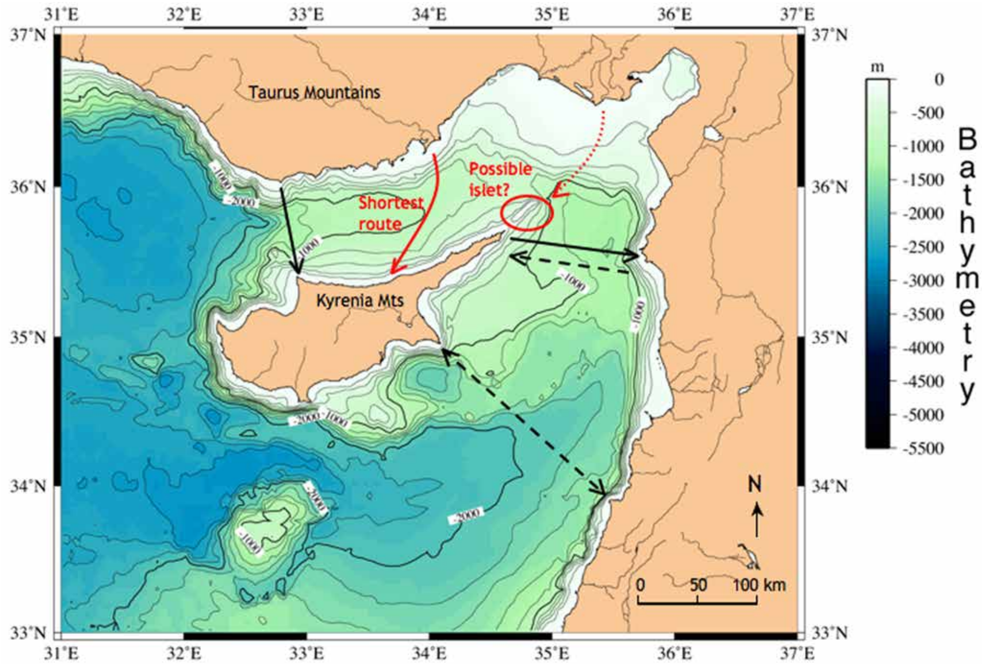

Figure 4a. Bathymetric map of the northeast Mediterranean showing the shortest route to Cyprus from the mainland and the location of a possible stepping-stone islet (circled in red). Three alternative routes between the island and the coastal Levant and southern Anatolia are shown in black (following Bar-Yosef Mayer et al., 2015: 416, fig 1). The solid lines and arrows represent the direction of proposed secure passages, while the dashed lines represent riskier passages (ETOPO 2 Dataset, courtesy of the National Oceanic and Atmospheric Administration, US Department of Commerce. Modified by Katy Croff and Duncan Howitt-Marshall).

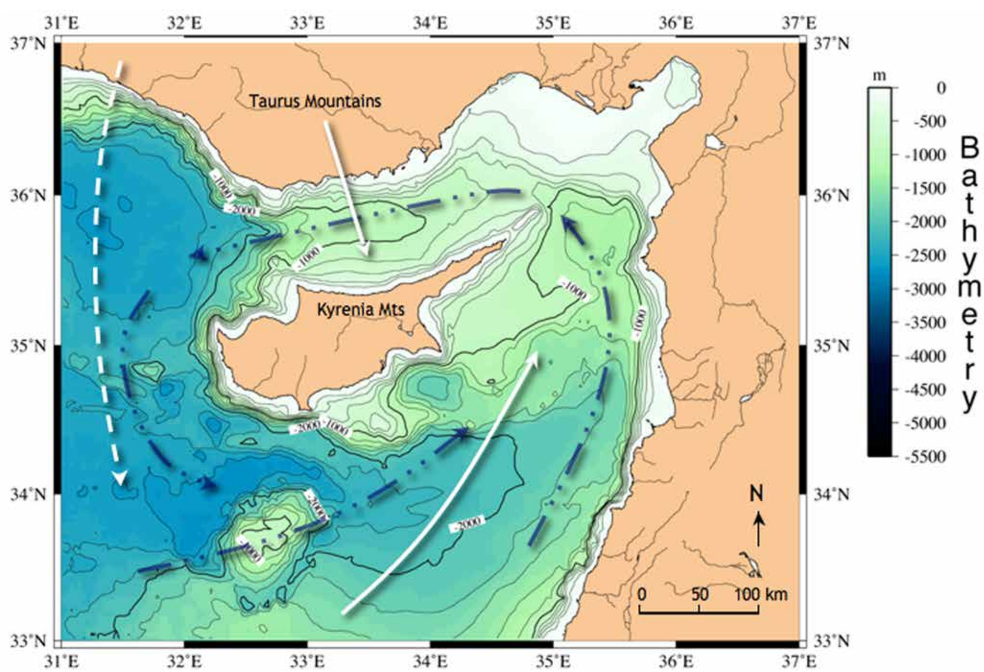

Figure 4b. Second bathymetric map showing prevailing winds (in white) and surface currents (dark blue) based on present-day data (following Morton, 2001: fig. 23). The solid white lines represent the winter Boreas wind from the north and the Sirocco wind from the southwest, while the dashed line depicts the summer Etesian wind from the north. It is important to note that the coastal margins around the basin would have been significantly altered in the Late Pleistocene and Early Holocene due to lower sea-levels, perhaps by as much as -100 m below present levels. As such, wind patterns and surface currents may have been considerably different (ETOPO 2 Dataset, courtesy of the National Oceanic and Atmospheric Administration, US Department of Commerce. Modified by Katy Croff and Duncan Howitt-Marshall).

et al., 2005; Vigne *et al.*, 2013: 159; 161, fig. 1) (Fig. 4a).[5] More recently, Bar-Yosef Mayer *et al.* (2015) conducted a study of optimal sailing routes (Bar-Yosef Mayer *et al.*, 2015: 416, fig. 1) (Fig. 4a) based on detailed observations of the surface currents, prevailing wind patterns, and sea conditions throughout the year (see also Morton, 2001: fig. 23) (Fig. 4b). This comprehensive study concluded that a crossing from the south coast of Anatolia in favourable conditions would have been achievable within daylight hours in a paddled logboat between the months of April and October (Bar-Yosef Mayer *et al.*, 2015: 428). The alternative route to the island from the east, from a departure point some 95 km away on the Syrian coast, would have taken longer, perhaps 24 to 36 hours, thus requiring knowledge of night navigation, but would have been more favourable for return crossings (Bar-Yosef Mayer *et al.*, 2015: 429).

In any scenario, sea travel requires advanced planning and provisioning, and raises a number of questions concerning the level of social organization required to undertake such expeditions in the early Neolithic. A vessel transporting a cargo of people, livestock, and raw materials likely consisted of a crew of multiple paddlers/rowers, but how were they organized? And what was the crew dynamic on board? Farr (2010: 187) raises the possibility of 'master navigators' serving as expedition leaders, individuals with a deep understanding of maritime space, wayfinding/navigation, and the authority to assert control over the rest of the crew. On a clear day, Cyprus is intervisible with the mainland (Schüle, 1993), but only at a significant elevation in the mountains and not from sea-level. Attempting such a passage out of sight of land would have required a working knowledge of coastlines, surface currents, and prevailing winds, as well as the ability to forecast conditions in distant waters further offshore (McGrail, 2010: 97). Tracking the movement of the sun – and star constellations if voyaging at night – would have enabled early mariners to estimate how fast they were travelling. This type of navigation without instruments is often referred to as 'dead reckoning' and was used until modern times by Micronesian mariners in the Pacific (see McGrail, 2001: 339-345). The individuals who organized and assumed leadership of these expeditions must have 'inherited sea, sky and weather lore' (McGrail, 2010: 97) and a 'conceptual chart' of the routes involved, as well as mastered the necessary skills to construct suitable seacraft (Le Brun, 2001: 116-117). This highly specialized knowledge would have taken time to develop, and was conceivably transmitted from generation to generation.

It has already been suggested that geographically charged objects, such as obsidian and carnelian, were considered exotic materials due to their rarity and unique aesthetic qualities (Moutsiou, 2018: 241-241; see also discussions in Helms, 1988: 111-130). Their acquisition from distant sources in central Anatolia and the Caucasus (Moutsiou, 2018; Moutsiou and Kassianidou, 2019) not only involved a potentially dangerous sea-crossing to the mainland, but also the necessary social contacts on the other side. It is likely that their procurement formed part of a larger network of exchange (Moutsiou, 2018; see also Watkins, 2008; Melson, 2010), which, in the case of Cyprus, may have involved objects made of high-quality translucent chert (McCartney, 2010: 192) or local picrolite, a soft, easily carved, soapstone from the ophiolite deposits in the Troodos Mountains, also noted for its striking aesthetic (Xenophontos, 1991). While there is no evidence for Cypriot exports in early Neolithic contexts on the mainland, the high density of chert reduction (debitage) relative to subsistence at Ayia Varvara *Asprokremnos* (McCartney *et al.*, 2006; 2007; 2009) and finished tools at Parekklishia *Shillourokambos* (Guilaine and Briois, 2006: 167) suggest intensive extraction and exploitation that may have served mainland demand. Indeed, the movement of rare or visually distinctive stone objects could have taken the form of gift exchange, thus 'binding together people into extensive networks of communication' (Moutsiou, 2018: 242). It may have been the case that the real value of these objects was not only their striking physical qualities but also the 'symbolism of its journey, the knowledge, skill and risk which had been undertaken' (Farr, 2006: 96). In this scenario, mariners performed the role of long-distance specialists by developing the ability to traverse maritime space, communicate with disparate groups, and procure eye-catching objects imbued with symbolic power.

The archaeological record: coastal and near-coastal sites

Seasonal visitations by seafaring fisher-foragers

Of the four distinctive strata at Akrotiri *Aetokremnos*, Strata 2 and 4 contained the most significant amount of well-preserved faunal remains, including over 222,000 bones (98.3 percent pygmy hippopotamus [*Phanourios minor*] – at least 505 individuals), some 70,000 marine invertebrate fragments (crabs, sea urchins, limpets, and topshell; see Reese, 1999a), 73 avifauna (including

5 A stepping-stone islet may have been present when sea-levels reached a lowstand of -100 m in the period between the Late Glacial and the Early Holocene (until *c.*8500 Cal BCE). This islet would have broken the voyage from the south coast of Anatolia near the Adana plain to the northeast coast of Cyprus on the Karpass peninsula (42 km plus 25 km respectively), and allowed the animals and crew to disembark, rest, and forage for food (fish, gather shellfish, and hunt marine avifauna).

Figure 5. The aeolianite formation at Akamas Aspros. View to the northeast. The black arrow points to the nearby satellite site of Alimman, 200 m to the north (Photograph by Duncan Howitt-Marshall, 26 October 2017).

bustards, geese, and ducks), a minimum of three dwarf elephants (*Paleoloxodon cypriotes*), and 13 phalanges that belonged to at least two small-sized wild pigs, a species that had been brought from the mainland (Vigne *et al.*, 2009: 16136). Among the cultural remains were hearths, shell, and picrolite beads, and over 1000 pieces of chipped stone (Simmons, 1999). A single vertebra of a grey mullet (Mugilidae), perhaps 0.50 m or more in length and 1-1.2 kg in weight, was found in Stratum 4 (Rose, 1999: 187), indicating an ability to catch medium-sized fish in coastal waters. Simmons (2013: 142-144) maintains that Strata 2 and 4 are closely related, both culturally and chronologically, and the chipped stone assemblage demonstrates clear parallels with microlithic and blade/bladelet-oriented technologies found in Late Epipalaeolithic contexts on the mainland (*e.g.* Natufian, *c.*13,000-10,000 Cal BCE) (Simmons, 1999; 2007; 2013). *Aetokremnos* is significant because it is one of the first stratified pre-Neolithic sites to be found on any of the 'true' islands in the Mediterranean (Vigne, 2013: 46), whether oceanic in the geological sense of the term (Held, 1989: 11-15) or simply separated from the mainland for a substantial period of time (Vigne, 1999).

The early sites of Akamas *Aspros* and *Alimman* on the central west coast (Fig. 5), and Nissi Beach on the southeast coast may represent a continuum of the coastal foraging pattern seen during the Akrotiri Phase (Ammerman, 2011; 2013). All three sites are situated on aeolianite formations, fossilized sand dunes that are common around the shores of Cyprus and the eastern Mediterranean (Knapp, 2013: 60). Lower sea-levels would have positioned the sites hundreds of metres away from the late glacial shoreline (for discussion of the underwater site in front of *Aspros*, Dive Site C, see Ammerman *et al.*, 2008; 2011; Ammerman, 2020), but small basins in the aeolianite (epi-karst) would have still collected sea salt, a useful resource for a variety of tasks, including food preservation (Ammerman, 2011: 44, fig. 3). Despite their exposed location, access to nearby freshwater and commanding views of the surrounding sea would have made these sites favourable as short-term, seasonal (warm weather) campsites (Ammerman *et al.*, 2006: 17-18; cf. Simmons and Mandel, 2007: 480; 2016). The chipped stone assemblages recovered from all three sites are broadly homogeneous and similar to the ones found at *Aetokremnos*, including distinctive thumbnail scrapers and geometrics (truncations and backed pieces) (see McCartney in Ammerman *et al.*, 2006: 13-14, figs 8-9). More recent analysis of the 60 lithic artefacts recovered from Dive Site C noted close parallels with the 'hyper-microlithic' assemblages (backed bladelets and thumbnail scrapers) from the Final Palaeolithic levels at Öküzini Cave in southern Anatolia (*c.*14,500-11,000 Cal BCE) (Kacsanowska and Kozłowski, 2014: 63; see also Bar-Yosef, 2001: 136-137; Yalçinkaya *et al.*, 2002). On the basis of these similarities, Ammerman (2010: 87; 2020) implies that the sites should be considered more-or-less contemporary with the Late Epipalaeolithic Akrotiri Phase. Nevertheless, radiocarbon dating (AMS) of two marine shells (*Patella caeruilea*) found at Nissi Beach indicate the site was occupied in the mid 8th millennium Cal BCE (Knapp, 2013: 61; see discussion in Simmons, 2014: 164), well within the date range of the EAN, and some three-and-a-half millennia after the initial occupation at *Aetokremnos*.[6] One possible explanation is that some groups of seafaring fisher-foragers actively maintained their coastal way of life by making seasonal voyages backward and forward to Cyprus for at least 2000 years after the advent of farming on the island (Broodbank, 2006: 209; see discussion on foraging seascapes in Barker, 2005: 47-49). As Ammerman (2010: 89) notes, these foragers 'were not heading toward the Neolithic but away from it (in terms of their lifestyle and interests)' – in other words, 'disenchanted mainlanders' who chose not to become villagers (Simmons, 2004: 10).

Game stocking and the first permanent settlements

Ayios Tychonas *Klimonas* is located on a terraced slope on the south coastal plain some 2 km from the sea, and dates from the late 10th to the middle of the 9th millennium Cal BCE (Initial Aceramic Neolithic) (Vigne *et al.*, 2011), contemporary with the mainland Pre-Pottery Neolithic A (PPNA). A substantial chipped stone assemblage was found, much of it sourced from a nearby outcrop several hundred metres northwest of the site. The assemblage is dominated by high-quality translucent flint (Lefkara chert) and includes a large number of arrowheads with short tangs, characteristic of the PPNA Mureybetian tradition of the northern Levant (Briois and Guilaine, 2013: 178-179; 181-183; Vigne *et al.*, 2017: 23). These projectiles were most likely used to hunt small wild boar (*Sus scrofa*), a species that was introduced to the island during the earlier Akrotiri Phase (Vigne *et al.*, 2009; Vigne *et al.*, 2013: 160-162; 2017: 40). Three pieces of obsidian were also recovered (Briois and Guilaine, 2013: 179), suggesting that the material was already arriving on the island by this time, albeit in low quantities. Over the course of excavations, a total of 34 buildings were uncovered at the site (Vigne *et al.*, 2017: 37), including a circular semi-embedded feature, 10 m in diameter, similar in style to the largest examples discovered in the PPNA villages in southeast Anatolia and the Euphrates valley, such as Jerf el-Ahmar (Vigne *et al.*, 2017: 28-32). This particular feature has been interpreted as a 'multi-functional communal structure' used for storage or communal gatherings/ceremonies (Briois and Guilaine, 2013: 178), and implies a more permanent or long-term occupation of the site. The material and architectural characteristics of *Klimonas* not only confirm the existence of mainland PPNA-style traditions on the island but also the continuation of certain characteristics from the Late Epipalaeolithic, including the exploitation of wild boar (comprising nearly 97 percent of the faunal remains – Vigne *et al.*, 2017: 40), and the use of distinctive microlithic and blade/bladelet-oriented tools. This could be regarded as evidence for regular visitations by mainland-based seafaring hunter-cultivators in the millennia after the Akrotiri Phase (McCartney, 2010: 188; Vigne *et al.*, 2017).

The later site of Parekklishia *Shillourokambos*, also on the south coastal plain, 2.5 km further north of *Klimonas*, has been assigned four chronological phases between *c.*8400-7000/6900 Cal BCE (EAN 1-3) (Briois, 2003; Guilaine, 2003a: 4-12; Guilaine and Briois, 2006: 173-174). Distinctive characteristics of the earliest phases (A and B [EAN 1-2], *c.*8400-7600 Cal BCE) include circular dwellings, wells, and an assemblage of several hundred thousand pieces of chipped stone. These include vitreous, translucent chert for projectile points (resembling Amuq and Byblos points from the mainland), blades/bladelets and sickle elements (Guilaine and Briois, 2006: 167-170, figs 7-8; Briois, 2011a). More than 450 pieces of obsidian, nearly all bladelets, from Göllü Dağ in Cappadocia were also recovered (Briois *et al.*, 1997: 101, tables 1-2, 105-111; Briois, 2003; Guilane and Briois, 2006: 170-171; Guilaine *et al.*, 2011: 707-719; Briois, 2011b). The significantly larger quantity of obsidian at *Shillourokambos* indicates that Cyprus was now an active participant in the PPNB Levantine interaction sphere (McCartney, 2010: 192; see also Bar-Yosef and Belfer-Cohen, 1989; Kuijt, 2004; Simmons, 2004). Similarly, the subsistence package was much broader than the earlier site at *Klimonas*, including newly introduced fallow deer (*Dama mesopotamica*), sheep (*Ovis aries*), goat (*Capra aegagrus/hircus*), and cattle (*Bos taurus*) from the mainland Levant (Vigne *et al.*, 2000; 2003; 2004; Vigne, 2001; Guilaine *et al.*, 2011: 919-1073), and two types of pig, one being feral, the other 'managed domestic' (Vigne *et al.*, 2003: 248-251). This had to have been a coordinated move on the part of the colonizers, a gradual process that took place over multiple generations, that is pioneer colonizers stocking the island with wild game ('ethnotramps') (Horwitz *et al.*, 2004: 43-44). In terms of marine resources, the inhabitants focused on sea bass and grouper (Serranidae). Large groupers (subfamily Epinephelinae), ranging in length 0.63-1.1 m and weighing 4-17 kg, form 90 percent of the ichthyofaunal assemblage (Desse and Desse-Berset, 2011: 842; Bar-Yosef Mayer, 2013: 86). Of the fossil and marine shells found at the site (372 pieces), around 90 percent were likely used as personal ornaments or functioned as other artefact types, such as containers, tools, or net sinkers (Serrand and Vigne, 2011: 807-833; Bar-Yosef Mayer, 2013: 89; 2018: 2011). A number of grooved stones with carved geometric motifs were also found, and may have been used as net sinkers for fishing (Knapp 2013:

6 A degree of caution must be exercised here. It is not immediately apparent whether the two shells are the result of cultural deposition or occur naturally (i.e. washed up on shore).

Figure 6. The coastal cliffs at Kissonerga Mylouthkia. View to the northeast. Location of the Neolithic wells (black arrow) in relation to natural water springs in the bay below (white arrow). Note the rapid build-up of urban development at the site compared to the photograph taken in 2004 by Galili et al. (p. 98, fig. 8.3) (Photograph by Duncan Howitt-Marshall, 26 October 2017).

91), as well as several small hollow cups (*micro-godets*) of picrolite, possibly representing early boat models (Guilaine, 2003b: 334, fig. 2d; 337-338; 2011: 1205, fig. 9).

The Early Aceramic Neolithic component at Kissonerga *Mylouthkia* (Period 1, Phase A and B [EAN 1-3]), a severely eroded site on the west coast (Fig. 6), dates to 8517-6836 Cal BCE (Peltenburg, 2003: 15-16, table 1). The bulk of the material published from this site comes from two wells: 116 (Period 1A-EAN 1) and 133 (Period 1B-EAN 3) (Fig. 7a-b). Reaching a preserved depth of 8.5 m, Well 116 contained a number of faunal remains, molluscs, fish bones, carbonized seeds, red ochre, human bone, and stone tools, including 23 pieces of obsidian (Peltenburg, 2003: 24-26; Knapp, 2013: 98, 100). The large number of limpet shells (2285) and fish are thought to have been consumed at the site (Croft, 2003: 50). A fishhook made from a piece of pig tusk was recovered from the lowest fill of Well 116, a further indication of maritime activity at the site (Peltenburg *et al.*, 2001b: 76). Far fewer stone tool fragments and only a single piece of obsidian were found in Well 133, lending support to the idea of diminishing contact with the mainland in the later stages of the EAN. Again, all the obsidian at the site originated from Cappadocian Göllü Dağ, indicating a similar pattern for obsidian finds at sites in the PPNB Levant (Gratuze. 2003: 30-35). Nevertheless, obsidian at *Mylouthkia* (Period 1A) accounts for 12 percent of the overall stone tool assemblage (McCartney and Gratuze, 2003), while at *Shillourokambos* (Early Phases A and B) it accounts for only two percent (Briois *et al.*, 1997; Briois, 2003; Guilane and Briois, 2006).

Insular but not isolated

The site of Kalavassos *Tenta* is located in the southern coastal region of the island in the lower reaches of the Vasilikos River valley (Fig. 8), some 3 km north of the present shoreline (Todd, 2001: 95). Strategically positioned on the major east-west axis that runs along the south coast, the site sits atop a small natural hill with commanding views of the surrounding landscape and access to the sea. Based on the current material record, four of the five chronological phases recorded at the site are associated with the EAN (Todd, 1987: 173-178; 2005: 379). Period 5 represents the earliest habitation phase (*c.*8608-7336 Cal BCE), broadly contemporary with EAN Phases 1-2 at *Shillourokambos* and *Mylouthkia* (Todd, 2005: 382). With easy access to the interior of the island and the Troodos Mountains (Knapp, 2013: 103), the complex stratigraphy of *Tenta*, including well-preserved architecture with plastered floors and, in later phases, a large exterior wall, is testament to the accelerating pace of change that ultimately led to the permanent settlement of the island during the EAN. Structure 14 has been compared to a similar feature at Jerf el-Ahmar, a PPNA

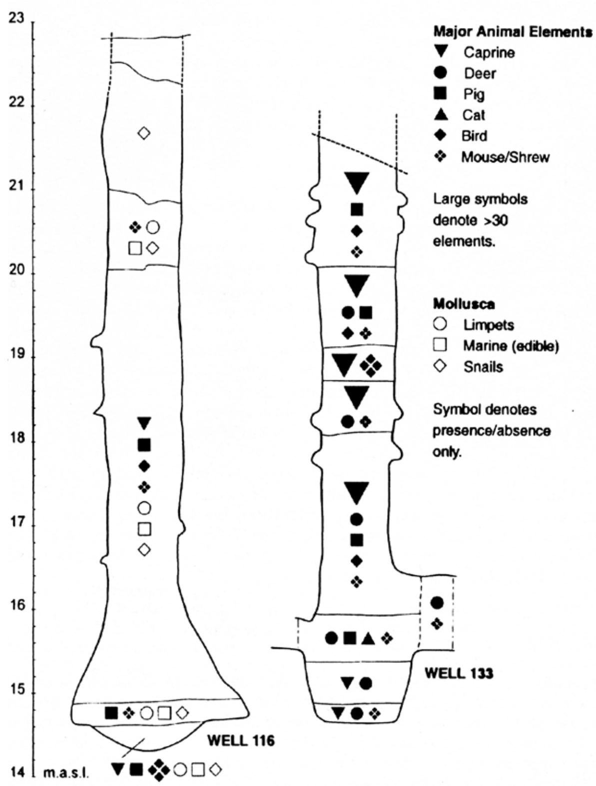

Figure 7a. Kissonerga Mylouthkia, Wells 116 (EAN 1) and 133 (EAN 3), showing the sequence of major faunal remains and mollusca, including marine shellfish (limpets). A fishhook made of pig tusk was recovered from the lowest fill of Well 116, providing further evidence of marine resource exploitation at the site (Peltenburg, 2003: 22, fig. 3. Courtesy of Edgar Peltenburg and Diane Bolger).

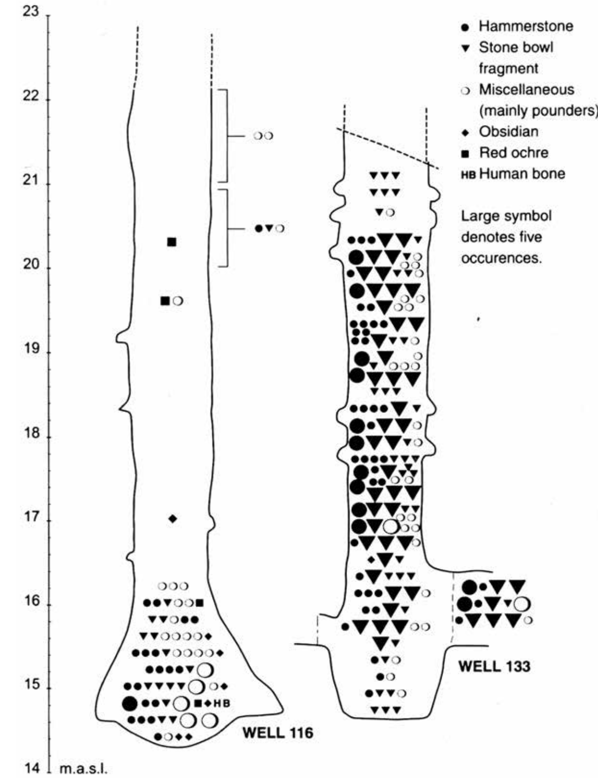

Figure 7b. Distribution of stone artefacts, including obsidian, and other miscellaneous remains in Wells 116 and 133 (Peltenburg, 2003: 23, fig. 4. Courtesy of Edgar Peltenburg and Diane Bolger).

Figure 8. Kalavassos Tenta. View to the northeast. Parts of the outer stone wall are visible in front of the modern tent-like covering (Photograph by Duncan Howitt-Marshall, 28 October 2017).

site in Syria, and may have been used for food storage and communal gatherings (Peltenburg *et al.*, 2001a: 41-42). The chipped stone assemblages also suggest a link with the mainland Levant, including blades and distinctive Byblos- and Amuq-type points (Knapp, 2013: 104). The presence of obsidian, while limited (36 pieces) (Moutsiou, 2018: 213, table 1), is a further indication of continuing contacts with the mainland (Todd, 1987: 78-79; Gomez *et al.*, 1995). A large variety of fossil and marine shells were also found at the site, including a

Figure 9a. Akanthou Arkosyko, EAN. Coastal site with substantial quantities of obsidian of Anatolian origin (Şevketoğlu, 2006: 129, fig. 1. Courtesy of Muge Şevketoğlu and the Akanthou/ Tatlısu Rescue Excavation Project Archive).

Figure 9c. Bone fishhook, a material marker for marine resource exploitation (Şevketoğlu, 2006: 136, fig. 22. Courtesy of Muge Şevketoğlu and the Akanthou/Tatlısu Rescue Excavation Project Archive).

Figure 9b. Obsidian pieces, mostly complete tools (bidirectional blades and bladelets) (Şevketoğlu, 2006: 133, fig. 11. Courtesy of Muge Şevketoğlu and the Akanthou/Tatlısu Rescue Excavation Project Archive).

number of perforated gastropod (sea snail) shells (*Columbella rustica*, *Conus ventricosus*, and the lips of two *Semicassis undulata* (Reese, 2008: 35). These likely functioned as personal ornaments (Bar-Yosef Mayer, 2018: 212). The collection of fossil shells, especially *Dentalium*, is notably similar to the assemblage from Çatalhöyük in southern Anatolia (Bar-Yosef Mayer *et al.*, 2010).

Located in the central region of the north coast, Akanthou *Arkosyko* lies on top of a high marine terrace with commanding views of the sea (Şevketoğlu, 2008: 68) (Fig. 9a). The site is surrounded by rich, cultivable soils along the tops of a cliff to the south, a small pebble beach to the north, and a sheltered bay to the east (Şevketoğlu, 2006: 122-123). The significance of this well-protected, coastal site in terms of its interaction with Anatolia has been extensively documented (Şevketoğlu, 2002; 2006; 2008). Of particular note are the substantial quantities of obsidian from at least two central Anatolian sources (Göllü Dağ and Nenezi Dağ – and possibly a third at Kömürcü-Kaletepe), and a small number of cattle bones (Şevketoğlu, 2002: 103, 105; 2006: 154-125; 2008: 67-69; Frame, 2002: 235-236). The approximately 5000 pieces of obsidian (see Şevketoğlu, 2006: 124; Şevketoğlu and Hanson, 2015: 235; Moutsiou, 2018: 232-233), including complete tools (blades and bladelets) (Fig. 9b), exceed the total amount of obsidian published from all other EAN sites on the island by a factor of ten (Knapp, 2013: 113).[7] It has been argued that *Arkosyko* may have served as a conduit for obsidian on the island (Peltenburg *et al.*, 2001a; Moutsiou, 2018: 233). A significant number of architectural features with plastered floors, storage pits, and hearths indicate a permanent coastal settlement engaged in mixed resource exploitation, including cereal

7 Obsidian found at other EAN sites on Cyprus include: 451 pieces at Shillourokambos Early Phases A and B (8400-7600 Cal BCE), 24 pieces from the wells at Mylouthkia Period 1, Phases A and B (*c.*8517-6836 Cal BCE), 66 pieces from Ais Giorkis (c.7700-6850 Cal BCE), and 36 from Tenta (see Moutsiou, 2018: 231, table 1).

cultivation, hunting, herding, and fishing (Fig. 9c). Indeed, the rich and diverse array of marine species, including hake, dogfish, shark, and tuna, all deepwater species, in addition to a number of smaller fish from near-shore habitats and the remains of ten complete sea turtles (*Caretta caretta*) conspicuously lacking any butchery marks (Şevketoğlu, 2006: 125, 136, fig. 24; Şevketoğlu and Hanson, 2015: 235-236; Gannon, 2017), far exceeds the level of marine resource exploitation at sites along the southern coastline. Furthermore, two picrolite *micro-godets*, similar in pattern and style to the *godet barquiforme* (boat model) artefacts found at *Shillourokambos* (Guilaine, 2011: 1205), were also uncovered at *Arkosyko* (Şevketoğlu, 2018: 22-23, figs 15 and 16) (Fig. 10a-b).

Figure 10a. Small hollow cup (micro-godet) (< 30 mm) made of picrolite, perhaps depicting a boat model (godet barquiforme), decorated by horizontal and vertical hatching on the outside (Photograph by İsmail Gökçe in Şevketoğlu, 2018: 22, fig. 15. Courtesy of Muge Şevketoğlu and the Akanthou/Tatlısu Rescue Excavation Project Archive).

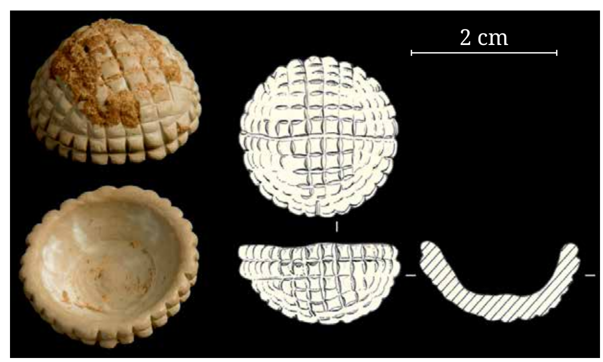

Figure 10b. Round-shaped boat model in picrolite, reminiscent of a coracle (or quaffa) – small, elliptical watercraft made of wickerwork frames and covered by hide (Photograph by İsmail Gökçe and drawing by David S. Neal in Şevketoğlu, 2018: 23, fig. 16. Courtesy of Muge Şevketoğlu and the Akanthou/Tatlısu Rescue Excavation Project Archive).

Discussion

Seafaring and the Neolithization of Cyprus

Current evidence for the permanent, year-round settlement of Cyprus in the early Neolithic, as opposed to seasonal campsites, suggests that it was not a single colonization event (McCartney *et al.*, 2007: 27, 29) or so-called 'Noah's Ark' scenario (see discussion in Steel, 2004: 40-43). Instead, it took place over the course of multiple generations, partly driven by the changing climatic and environmental conditions of the Younger Dryas (*c.*10,700-9600 Cal BCE). This 'climatic forcing mechanism' (Sherratt, 2007: 7; see also Wasse, 2007: 45-46; Stutz *et al.*, 2009) was a major factor that led hunter-gatherers on the mainland to experiment with animal husbandry and the cultivation and storage of plant foods, thus the steady march to a very different, increasingly sedentary, agro-pastoral way of life (Garrard, 1999; Watkins, 2008; Zeder, 2009: 45-48; Shennan, 2018: 59; see also discussion in Ammerman, 2010: 88-90). During the subsequent warming phase of the Early Holocene (*c.*9500-5000 Cal BCE), rising sea-levels inundated vast areas of the coastal littoral around the eastern Mediterranean basin, ranging 2-40 km in width (Knapp, 2013: 77). Under acute stress from rising seas and loss of territory, as well as population expansion and increasing competition for resources (see discussions in Bar-Yosef, 2001: 133; Bar-Yosef Mayer, 2013: 92), mainland groups with a working knowledge of the sea would have been well aware of Cyprus on the horizon.

Figure 10c. Reconstruction of a hide-covered boat similar in shape and form to a coracle. Despite the lack of evidence for hide boats in the Mediterranean (Johnstone, 1980: 56-58), the necessary leather-working tools required for their construction – eyed needles and awls – would have been readily available in the early Neolithic. Lightly built and easily portable, hide boats may have been used for inshore fishing expeditions (Howitt-Marshall and Runnels, 2016: 146, fig. 3e. Drawn by Yannis Nakas).

Sea travel to Cyprus during the early Neolithic may have initially followed the form of foraging-style trips akin to the voyages undertaken during the preceding Akrotiri Phase, and based on the transfer of seafaring knowledge between groups of mobile fisher-foragers and communities of early farmers located in close proximity to the coastal margins on the mainland. Even so, the logistical challenges would have been quite different for well-established farming groups wanting to transport larger numbers of people, livestock, seed crops, and raw materials to the island. It has been previously argued that seafaring fisher-foragers may have acted as the 'ferrymen to land-lubber farmers' (Broodbank, 2006: 216; see discussion in Galili *et al.*, 2004: 97), providing the necessary means to transport small founder populations in significant numbers to constitute year-round settlement, but recent evidence no longer supports this view. It seems more likely that two separate but complementary seafaring ideologies co-existed at this time: one that was developed by mobile coastal foragers in response to crisis conditions on the mainland at the end of the Pleistocene (rapid climate change, population growth, and increasing pressure on resources), the other, more expansionist ideology, developed by groups of pioneer farmers wanting to exploit and colonize hitherto unoccupied lands (Broodbank, 2006: 216; Ammerman, 2010: 88-90). The successful transfer of founder populations to Cyprus, including new species of wild or managed animals (Horwitz *et al.*, 2004), required a significant degree of logistical planning quite unlike the more expeditious voyages carried out by lightly equipped groups of fisher-foragers.[8]

Over time, and for certain communities of agro-pastoralists living near the coast, seafaring may have formed an important part of a mixed subsistence pattern that included sowing and harvesting, herding, hunting, fishing, and game stocking. In the climatic zones of the eastern Mediterranean, the sowing of cereal crops is carried out in the autumn, before the first winter rains, followed by harvesting in the springtime. This would have left the warmer months of the year free for sea travel (April through October), although winter voyaging may have taken place during prolonged periods of fair weather and calm sea conditions (see Bar-Yosef Mayer *et al.*, 2015: 423-426). It could be argued that early Neolithic communities developed complex modes of cooperation and/or reciprocity, perhaps even sharing maritime knowledge, know-how and technology (such as boatbuilding; see discussion in Broodbank [2000] on the early Cyclades). Even within these communities, it is likely that only a certain number of individuals specialized in seafaring while others stayed back and maintained the village and surrounding farmlands.

Seafaring ideology, symbolism, and ritual

It has already been argued that during the initial settlement of Cyprus, people would have taken with them everything they needed to (re-)establish a new life for themselves on the island, including aspects of material culture, shared histories, memories and knowledge of their past lives ('heritage') on the mainland (Jones, 2008: 90). They rearranged their old ways of doing to adapt to their new island environment, establishing a new home for themselves. They encountered and engaged with a number of new and exotic materials on the island, including eye-catching picrolite, which ranges in colour from a distinctive light green to blue (Xenophontos, 1991). Its presence at *Aetokremnos* (*c.*11,000-9000 Cal BCE) (Reese, 1999b: 149-150), *Asprokremnos* and *Klimonas* (*c.*9000-8500 Cal BCE) suggests early experimentation, perhaps for its unique aesthetic – evocative of the changing tones of the sea. Significantly, a number of miniature, hollow cups (*micro-godets*) of picrolite incised with a similar vertical and horizontal hatching pattern on the outside have been uncovered at *Shillourokambos* (Guilaine, 2003b: 334, fig. 2d; 337-338; 2011: 1205, fig. 9) and *Arkosyko* (Şevketoğlu, 2018: 22-23, figs 16 and 17) (Fig. 10a-b). One theory is that these curiosities represent early boat models, reminiscent of hide-covered coracles (Fig. 10c),[9] and are emblematic of the role of sea travel in the early Neolithic lifeways of these communities (Guillaine, 2011: 1205-1209; Şevketoğlu, 2018: 21-25). The persistent use of picrolite continued throughout the EAN at *Shillourokambos, Ais Giorkis*, and *Arkosyko* (c.8500-7000/6800 Cal BCE), including the production of small ornaments (statuettes), oval/circular pendants, and barrel-shaped beads, items that may have been exchanged or traded for imported obsidian from the mainland (Peltenburg *et al.*, 2001a: 42), although direct evidence for such exports remains unknown. It was towards the end of this phase

8 Later depictions of animals being transported by boat on third millennium Cal BCE rock carvings from the Aegean island of Naxos provide pictorial evidence of this kind of activity taking place over the *longue durée* (Johnstone, 1980: 63, fig. 6.7).

9 The construction of hide (or skin) boats would have been well within the technological purview of humans in the Palaeolithic (Johnstone, 1980: 26-44; Greenhill, 1995: 91-96; McGrail, 2001; Simmons, 2014: 88-89, 92; Howitt-Marshall and Runnels, 2016: 145-146).

Figure 11. Backward-tilting head of a cat-like figure made of serpentine – the Tête de chat – located in Well 66 at Parekklishia Shillourokambos, Early Phase A (EAN 1) (Photograph by J. Coularou in Guilaine et al., 2011: 792, fig. 3. © Jean Guilaine / Jacques Coularou).

(after *c.*7600 Cal BCE) that a characteristically Cypriot culture began to crystallize (Knapp, 2013: 119).[10]

At *Shillourokambos*, excavators recovered two striking objects from the earliest phase of occupation (Phases A and B, *c.*8400-7600 Cal BCE): a backward-tilting human-feline carved head made of serpentine, 94 mm tall (Guilaine *et al.*, 1999: 5-10, figs 4-6; Guilaine and Briois, 2001: 51, fig. 9; Guilaine *et al.*, 2011: 791-792, fig. 3) (Fig. 11), and a similar anthropomorphic figurine made of lime plaster, standing at 55 mm (Guilaine, 2003b: 331, fig. 1b). Elsewhere at the site, the seemingly intentional burial of an eight-month-old domestic cat in close proximity to a richly adorned human burial (Middle-Late Phase, *c.*7600-7000 Cal BCE) seems an extraordinary coincidence (Vigne *et al.*, 2004: 259, fig. 1; Knapp, 2013: 94, fig. 19) (Fig. 12). An array of prestige objects was found in the human burial, including greenstone axes, polished stones, ochre, chipped stone tools, and a nearby pit containing 24 marine shells (Knapp, 2013: 94-95). Could the cat have been a companion in life? Indeed, the remains of at least four cats were discovered at the site, animals that may have been involved in the community's social relations, ostensibly as an effective means of pest control (Vigne *et al.*, 2004; Vigne *et al.*, 2013: 164), but also as conspicuous displays of wealth, or even icons (Frame, 2002; see further discussion in Jones, 2008: 128-130 regarding human-animal relationships in early Neolithic Cyprus).[11] Cats were introduced to the island from the neighbouring mainland along with most of the other animals at the site, including domestic dogs (*Canis familiaris*) (Vigne *et al.*, 2013), also present at the earlier site of *Klimonas* (Vigne *et al.*, 2017: 40). Similar examples of carved feline heads

10 The production of finely carved picrolite ornaments and ground stone vessels, the continuous use of circular stone architecture, long abandoned on the mainland, and the development of stone tools typically associated with farming and domestic activities rather than hunting (McCartney, 2002: 237), became the hallmarks of a distinctly Cypriot culture in the Late Aceramic Neolithic (LAN, *c.*7000/6800-5200 Cal BCE) (see discussions in Steel, 2004: 37-40, 45-63; Simmons, 2007: 229-263; 2017).

11 Based on the evidence for the simultaneous deposition of animal and human remains, Jones (2008: 128-130) argues that certain individual animals and humans were 'intricately bound together' in life – by shared experiences and companionship – and in death. Animals formed a 'crucial part of the world' that people created for themselves in the early Neolithic (Jones, 2008: 129), not just in terms of food and raw materials, but also kinship and ideology, e.g. embodiment and emulation.

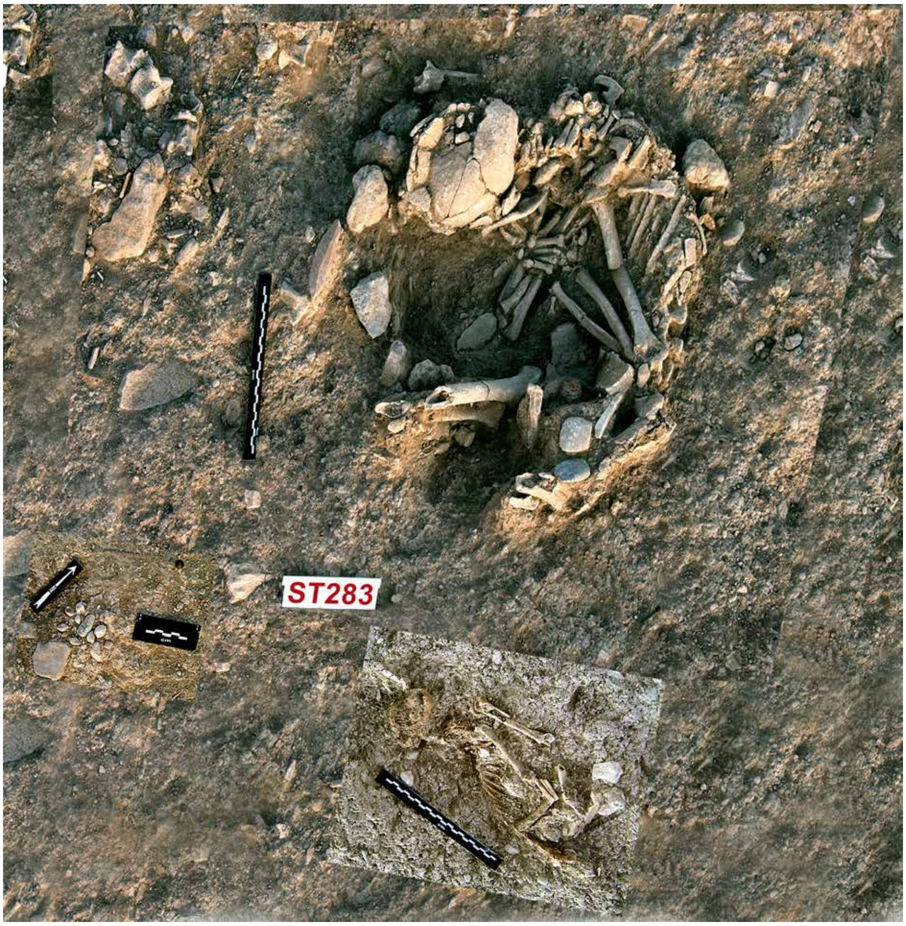

Figure 12. Cat and human burials at Parekklishia Shillourokambos, Middle-Recent Phase (EAN 2-3) (Photo montage by Patrice Gérard. © Jean Guilaine / Patrice Gérard).

have been recovered from PPNA levels at Jerf el-Ahmar in Syria and at PPNB Nevali Çori in eastern Anatolia (Knapp, 2013: 95); thus the cat grave and carved feline head at *Shillourokambos* may represent an imported ideology from the mainland (Guilaine and Briois, 2001: 51; Jones, 2008: 53), establishing a symbolic connection between cats and the earliest farming communities across Cyprus and southwest Asia.

It is possible to imagine that early mariners, whatever their region, place of origin, or socio-economic orientation (fisher-forager or farmer), adopted certain attitudes or beliefs about the sea, which, over time, developed into a specific seafaring ideology. Indeed, the experience of travelling across open sea, by its very nature dangerous and unpredictable, may have required them to observe or perform certain rituals or behaviours prior to embarking on a voyage to assure success in an economic sense (fishing, trade) and personal protection (*i.e.* safe return) (see Netting, 1972; Helms, 1988: 25-26, 81-82). These rites could have also formed part of the initiation process for younger members of the community seeking to consecrate themselves as apprentice mariners and played an important role in the transference of knowledge (*e.g.* navigation/wayfinding, sea routes). There is a significant body of literature that describes rituals relating to seafaring in the Pacific (see Hau'ofa, 1993; Rainbird, 2004) and elsewhere (*e.g.* Kirby and Hinkkanen, 2000; Ray, 2003; Westerdahl, 2005), but in what form or function these took place in the early Neolithic Mediterranean, if indeed they did, remains an open question. Nevertheless, the act of being on the sea and the ways in which the sea was perceived would have bound maritime-oriented communities together in ways that were distinct from those of the mainland (Rainbird, 2007: 50). Ultimately, it is conceivable that seafaring and maritime knowledge was an important means of reinforcing their own sense of identity.

Specialized voyager communities?

For the earliest settlers on Cyprus, the creation of a new world must have been made in direct observance (and interaction) with societies on the adjacent mainland. It is likely that the earliest stages of occupation at the end of the Pleistocene (Akrotiri Phase) entailed a process of landscape learning through repeated possibly seasonal visitation (see Dawson, 2014: 54-56) and the acquisition of new knowledge about the island (*i.e.* 'mobile maritime scouting' for landing sites, available food resources, access to freshwater; see Broodbank, 2006: 209). In the subsequent Early Holocene, mariners from the Levantine mainland gradually established Cyprus as a 'home away from home' (McCartney, 2010: 188; see also Boardman, 2001: 34; Peltenburg *et al.*, 2003: 94-95), a process that not only involved game stocking and the transfer of managed livestock (Horwitz *et al.*, 2004), but also, over the course of multiple visits, material storage, well-digging, and an increasing investment in the built environment (*e.g.* the construction of circular, timber-framed huts) (McCartney, 2010: 188-191).

Despite the steady march towards social and cultural insularity in the latter stages of the EAN (*e.g.* Watkins, 1973; Ronen, 1995; Finlayson, 2004; Steel, 2004: 63-65; cf. McCartney in Clarke, 2007: 84), maritime activity continued, albeit at a lower frequency. Driven by opportunity and reward, and their own sense of *communitas*, mariners continued to operate the exchange networks between the island and the mainland (see Monroe, 2011: 88 for related discussion on maritime *communitas* in the Late Bronze Age). In doing so, they continued to bring back non-indigenous materials to the island (McCartney, 2010: 192), as well as technological developments, most notably in the form of a chipped stone *chaîne opératoire* associated with the Levantine PPNB (*e.g.* Byblos and Amuq points) (Guilaine *et al.*, 1995: 16; 2000: 79, fig. 3.5-7; Peltenburg *et al.*, 2000: 848). Once established, these coastal-oriented groups developed a mixed subsistence pattern that included agricultural production, hunting, herding, and placed greater emphasis on marine resource exploitation – similar to the Mediterranean Fishing Village model seen in the southern Levant at the now-submerged late 8th-early 7th millennium Cal BCE site of Atlit-Yam (Galili *et al.*, 2002; 2004). Perhaps the best example of an MFV in early Neolithic Cyprus is *Arkosyko*, which also functioned as a gateway for obsidian arriving on the island from the mainland.[12]

Conclusions

Maritime lifeways in the early Neolithic

The precise role of mariners in the early Neolithic economic systems of the eastern Mediterranean will remain a topic of debate. Nevertheless, this study has further demonstrated that there were multiple socio-economic reasons and motivations to go to sea, and some coastal foragers maintained a distinctively maritime-oriented way of life for at least two millennia after the spread of farming. It has been argued that two maritime ideologies developed in the eastern Mediterranean in the Late Pleistocene and Early Holocene. The first was driven by groups of seafaring fisher-foragers who were already voyaging backward and forward to the island before the arrival of the first farmers, well-adapted to a semi-mobile, maritime way of life. The second was formed by incoming farmers, more adept at an agro-pastoral way of life already underway on the mainland, but actively voyaging during the warmer months as a means of bringing more people, livestock, raw materials, and higher-value goods to the island. It was from within these pioneer farming groups that 'master navigators' (Farr, 2010: 187) emerged as the long-distance seafaring specialists of the early Mediterranean, individuals with a broader understanding of the wider Neolithic world, not only in terms of physical geography and the knowledge of where to source exotic objects, but also of other social groups, belief systems, rituals, and traditions.

In both cases, the maritime experience may have been a source of mystification for people on land, and mariners themselves viewed as people on the edge of existence. They may have been looked upon with suspicion or fear, disappearing from view over the horizon in their boats for long periods of time, or regarded as erratic, reckless, and unreliable (see Hesiod, *Op*. 618-693; Zenner, 1991; Evers, 1994; and discussion in Monroe, 2011). At the same time, however, mariners would have been great storytellers (while speculative, see discussion of the 3rd millennium BCE harpist figurines of the southeast Cyclades in Broodbank, 2000: 253, 254, fig. 8.2), and purveyors of esoteric knowledge from strange worlds across the sea. From a practical point of view, maritime expeditions must have taken a great deal of time to organize, suggesting a high degree of logistical skill and leadership. As such, seasoned mariners may have been afforded respect and 'symbolic capital' (Farr, 2010: 187), and imbued with increased power or status within their respective communities, a view that is not fully compatible with the current consensus on the egalitarian nature of Neolithic society.[13] In the case of Cyprus, the first insular port of call in the spread of the Neolithic way of life from the Near Eastern core zone, communities on the island may have also viewed mariners as conduits to their genealogical origins from the mainland, associated with ancestral pathways and myths of origin (see Jones, 2008: 88-90; Simmons, 2014: 157).

12 Due to rapid sea-level rise in the Late Pleistocene and Early Holocene, it follows that further evidence of Mediterranean Fishing Village-type sites around Cyprus and the eastern Mediterranean basin will only be found underwater on what are today submerged coastal landscapes (see Ammerman *et al.*, 2011; Knapp, 2013: 80).

13 Craft specializations are often viewed as being more typical of urban societies in the Bronze Age, i.e. communities that were divided into groups with special interests and skills.

There are many aspects of this research that require further study. Parts of it have been highly speculative, loosely based around ideas drawn from ethnographic studies on long-distance (sea) travel in other parts of the world and in very different time periods. More research on Cyprus and the neighbouring mainlands, especially fieldwork in the coastal regions of Syro-Cilicia, is needed to resolve some of the propositions put forward here, most notably the concept of specialized voyager communities. To that end, further exploration of the coastal zone in search of campsites and early settlements, both on land and underwater (see Ammerman *et al.*, 2011; Ammerman, 2020), may shed more light on maritime lifeways in the early Neolithic. In the meantime, the ongoing investigation of early sites on Cyprus will continue to produce new evidence for the westward advance of farming, and the mechanisms by which the Neolithic way of life travelled across the sea to other islands and regions of the Mediterranean.

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The Effects of Coastline and River Changes on Anchorages, Harbours, and Habitation Patterns

The case of Akko

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At the ancient site of Akko/Acre, positioned on the northern side of the Haifa Bay, habitation patterns and anchorage locations changed over time. Causes for this are attributed to ecological and geomorphological fluctuations as well as the impact of human processes. The area is influenced by the silt deposited by the River Na'aman, and coastal sedimentation controlled by littoral currents. Akko/Acre is a UNESCO World Heritage Site and one of the oldest continuously inhabited sites in the area. This article reviews a variety of attempts using ground penetrating radar, electric resistivity tomography, coring, and limited archaeological excavations, to reveal the changing locations of anchorages and harbours, and link these to variations in habitation patterns.

Keywords: Akko/Acre, harbours, anchorages, coastal geomorphology, habitation patterns.

Tel Akko is one of the earliest settled sites in the coastal Levant and is presently located about 1.5 km east of the coast and the centre of current-day Akko (Fig. 1). The site is known by the local inhabitants not as Tel Akko but by another name, associated with a legacy of the European imperialism of the late 18th century: 'The Hill of Napoleon'. In 1799, Napoleon Bonaparte laid siege to the coastal site but failed to conquer its walled city. It is assumed that he used the tell as a gun emplacement, although he probably never climbed it himself (Artzy and Quartermaine, 2016). Tel Akko was closely associated with the River Na'aman, Belos (or Belus), as it was known in antiquity, which today is an almost artificial canal, the water within which is used up before it reaches the sea. However, in the past, it had a much more important role in the area, as did the sands transported by the sea along the coast and used for the production of glass (Pliny,

in: Demesticha, S. and Blue, L. *et al.* (eds) 2020, *Under the Mediterranean I. Studies in Maritime Archaeology*, Leiden: Sidestone Press, pp. 267-278.

Figure 1. Akko, with the tell in the centre (Photo M. Artzy).

NH 36: 190-191).[1] Although Pliny's account is dated to the 1st century CE, we assume that Akko sands were used for glass production in earlier periods, as well.

Furthermore, there are signs of human activity in the form of ceramics dating to *c.*3000 BCE at Tel Akko. In the middle of the MBIIa Period, slightly after 2000 BCE, major urbanization took place on the tell. This urbanization included a fortification in the form of an impressive rampart and at least one gate of this date in the northwestern corner of the site, named 'The Sea Gate' by its excavator, Avner Raban (Dothan and Raban, 1980). The tell then remained an urban site for at least 1.5 millennia, with multiple changes in the activities carried out there over the centuries. The rampart was renewed and altered to accommodate the changes in habitation patterns on the tell. In its third phase, still in the Middle Bronze Age, the rampart, in the north, reached a height of over 25 m and a width of 60 m (Artzy and Be'eri, 2010). Today, when viewed from above, the shape of Tel Akko is reminiscent of a crescent with its summit located in the centre of its northern edge, some 27 m above sea-level.

The name of Akko may appear in the Ebla tablet texts, dating to *c.*2400-2250 BCE (Matthiae, 1981: fig. 9). Akko is one of several coastal sites, including Byblos, Sidon, Dor, Ashdod, and Gaza, on the itinerary of a merchant from Ebla who travelled along the coast of the eastern Mediterranean, although no archaeological remains dating to the Early Bronze II or III periods, contemporary to the apogee of Ebla, have so far been located on the tell. Akko and its Semitic ruler were mentioned among other Canaanite rulers in the early 2nd millennium BCE in the Egyptian Execration Texts (Posner, 1940: 31-34). It was mentioned several times in the 2nd millennium BCE. In the Amarna letters, dated to the 14th century BCE, Akko's kings (father and son) and Akko itself are mentioned in missives sent to the Pharaohs in Egypt (Artzy and Quartermaine, 2016; Artzy, 2018). Akko is mentioned in the Old Testament as a city 'not inherited' by the Israelites, but one that they settled among the Canaanites (Judges 1: 31-32). In the 1st millennium BCE, it is mentioned in various sources, including by the Assyrians and the Persians, who used it as an anchorage (Artzy and Beeri, 2010). The area of Akko underwent several name changes over many centuries, but the original name remained Akko or similar (Artzy and Quartermaine, 2016). During these periods, Akko was already part of the Levantine-coast economic network, as attested by the discovery of imports from Egypt, Cyprus, the Syro-Lebanese coast, the Aegean, and beyond, and noted as a result of excavations carried out since the 1970s (Dothan, 1976). These imports indicate that Akko and Haifa-Akko Bay formed a strategic link between maritime trade and a terrestrial route leading eastward to the Jordan Valley and on to Transjordan (Dothan and Raban, 1980; Artzy, 2006; Artzy and Be'eri, 2010). One possibility to be entertained is that, at least in the 2nd millennium BCE, Akko functioned as the anchorage for Beth Shan (Beit She'an), serving Egyptian interests (Artzy, 2018).

The site, especially its northern edge, attracted the attention of archaeologists from the 1930s onward. In 1935, William Badè visited Tel Akko, intending to start

1 'That part of Syria which is known as Phoenicia and borders on Judea contains a swamp called Candebia amid the lower slopes of Mount Carmel. This is supposed to be the source of the River Belus, which after traversing a distance of five miles flows into the sea near the colony of Ptolemais …The river is muddy and flows in a deep channel, revealing its sands only when the tide ebbs … The beach stretches for not more than half a mile, and yet for many centuries the production of glass depended on this area alone…' (Pliny, *NH* 36: 190-191).

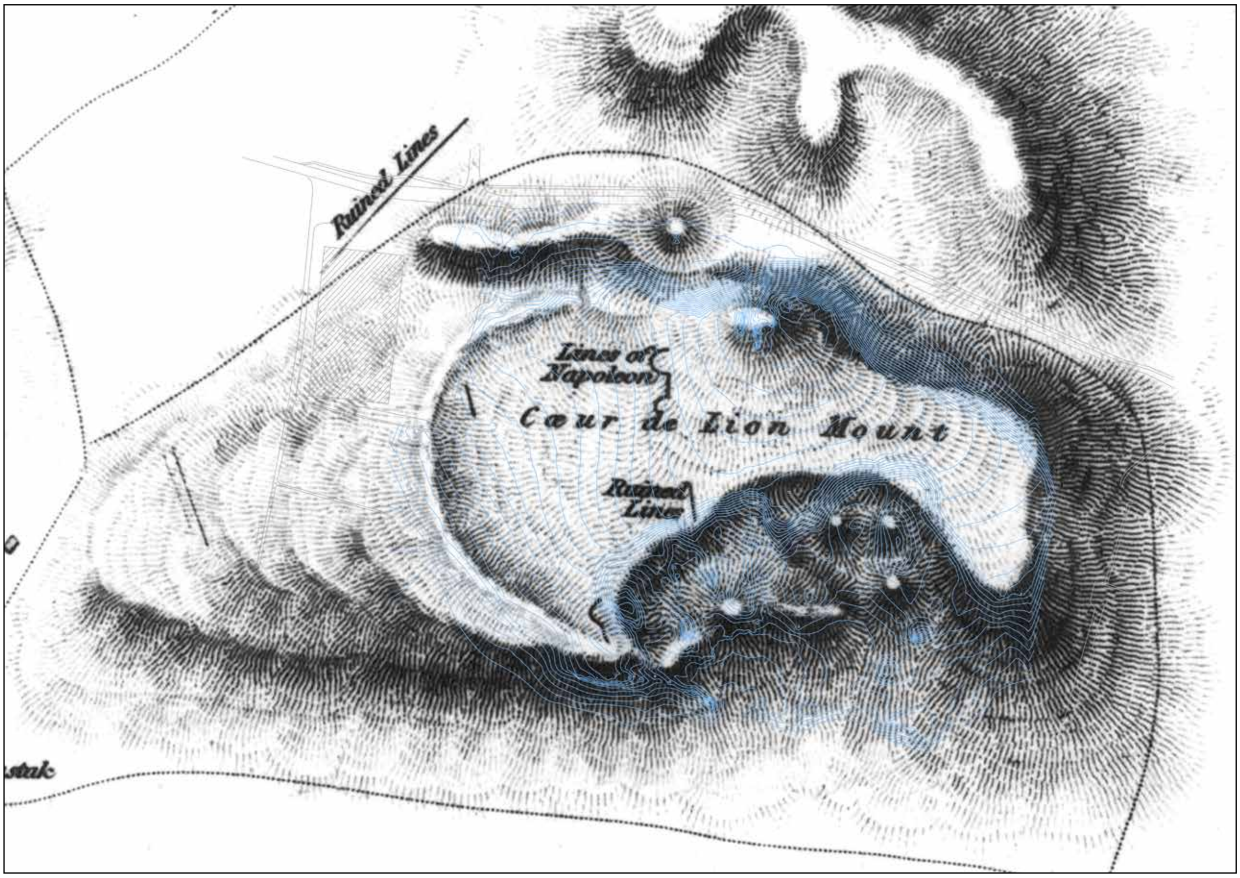


Figure 2. Tel Akko map superimposed on an 1841 map (Illustration J. Quartermaine).

excavation of the tell in 1936. He died shortly after: the photos from that visit are located in the archives of the Badè Museum at the Pacific School of Religion in Berkeley, California. It was only in the 1970s that the first excavations took place under the direction of Dothan, who had joined the ranks of the University of Haifa. Dothan's excavation was centred at first on the summit of the tell: only in later seasons did he expand towards the west, still concentrating on elements associated with the rampart. He sectioned the northern part of the rampart in an attempt to understand the ancient methods of construction of such monumental structures. At present, an educational project called Total Archaeology, directed by A. Killebrew and M. Artzy, is underway.

New studies indicate that the artificial rampart did not surround the site and that its shape was not oval or round as had been previously assumed (Artzy and Quartermaine, 2014). Questions as to its extent will have to wait for definitive answers, but methodical research presently being carried out on the landscape of the tell and its surroundings is slowly unravelling its construction techniques. What is now clear is that earth-removal works blamed on the British mandate in the 1940s were limited in scope. Indeed, the shape of the tell has been similar to the present form since as far back as the mid 19th century or before (Fig. 2). In a pit survey carried out by the Total Archaeology project, a stone rampart or retaining wall was noted in the inner basin dating to the Persian Period (Artzy and Quartermaine, 2014).

While some archaeological questions have been answered by past projects, the present Total Archaeology research programme promises to reveal many more. These mainly relate to the habitation patterns on the tell and how the geomorphological evolution of the bay and the river affected them, and the subsequent relationships between coast and sea both south and west of the tell. Hence, we aim to understand more about the shifting positions of the anchorages and harbours of this coastal site.

Tel Akko and its settlement history

The earliest noted settlement at Tel Akko is dated to the Early Bronze Age I period. It was found on a *kurkar* outcrop situated on the border of the inner southern depression of the tell, facing southeast, in Area S (Fig. 3). The data from the Total Archaeology project and an unpublished minor survey carried out during the Dothan project in Area S mainly concern the ceramics found, rather than on any substantial architecture or clear stratigraphy. A concentration of Early Bronze I ceramics, as well as slight remains of walls in that area, indicate that some habitation activity took place there. The first interventions, substitutions, and transformations of the pristine ecosystems at Akko, promptly followed the earliest architectural structures, dated from the Middle Bronze Age IIA (*c.* 4000 BP). As the city rapidly developed with ramparts, buildings, industrial areas, and massive fortification, changes in the ecology also took place (Kaniewski *et al.*, 2013; 2014). An outstanding feature of the recorded urban environmental history of Akko/Acre is that the area rapidly shifted from resilient Mediterranean open forest to an open shrub steppe between *c.*3900 and 3300 years ago. In the same study, it was noted that during the first millennia of human occupation, there was a sharp decrease in agricultural productivity at 3250-3200 BP. This is associated with a slackening of the economy and reduction in habitation, showing that a drier period may have constrained the rate of urban growth and the economy. The period is also associated with sea-level rise.

A working hypothesis is that, at least in the earlier periods, the abandon of a given area of habitation was related to the position of the river estuary on the southern edge of the tell, or the coast, or both. This agrees well with the archaeological remains on the tell as very few of the excavated areas, if any, have a continuous chronological stratigraphy from the latest to the earliest periods. The changes in the outline of the bay followed ecological fluctuations. Whether the changes are human induced, due to fluctuating precipitation, the influx of sediment from the River Na'aman, or sedimentation from the littoral zone, all are parameters for understanding and trying to reconstruct the spatio-temporal transformations in the area. A salvage excavation, Area T (Fig. 3), carried out by the Israel Antiquities Authority (IAA), directed by Abu-Hamid and Artzy on the southwestern foothill of the tell, showed that, at least during the second part of the 1st millennium BCE, an active coastline was present (Fig. 4) (Artzy, 2012). As noted above, research undertaken more recently (Morhange *et al.*, 2016; Giaime *et al.*, 2018), supports the fact that the bay and the estuary were located southwest of the tell.

Geomorphology

Coastal Israel and the eastern Mediterranean, in general, have seen dynamic geologic, ecologic, geomorphic, and environmental changes over the past 11,000 years. These changes have been documented by a number of comprehensive overview studies along the northern Israeli coast (Sivan *et al.*, 1999; Sivan *et al.*, 2001; Kadosh *et al.*, 2004; Sivan *et al.*, 2004a; Sivan *et al.*, 2004b; Cohen-Seffer *et al.*, 2005; Zviely *et al.*, 2006; Avnaim-Katav *et al.*, 2012), all of which document near-shore coastal processes and changes in sea-level that have modified and actively shaped the coastline (Barkai *et al.*, 2018). The major phases of erosion, deposition, and accompanying transformations in the coastal landscape have dynamically altered the environment, and these changes have been accompanied by vacillations in marine, intertidal, and more protected coastal areas along the shore. Previous studies that focused on the coastal plain south of Mount Carmel and the modern city of Haifa have shown that some of the most dynamic changes have occurred in the past 6000 years, after sea-levels stabilized near their present level (Zviely, 2006; Zviely *et al.*, 2006). Geomorphic studies suggest that for this 6000-year period, relative sea-level stabilized near the present mean sea-level, which allowed coastal progradation in the bay of Haifa. The area was a coastal marsh or embayment, but periodically these environments were inundated with sediment as aeolian dunes prograded seaward (Zviely, 2006; Zviely *et al.*, 2006).

Pertaining to the Akko area, the River Na'aman meandered on the southern outskirts of the tell, where it changed its course numerous times, depositing clay in the vicinity of the site. Sediment influx and coastal processes and shoreline changes contributed to coastal progradation, especially on the eastern and southern part of the tell. This is made evident by the changes of habitation patterns on the tell itself as well as the area between the tell and the present 'Old City' of Akko, near the modern coast and the modern fishing harbour. Geomorphological studies have contributed to the general understanding of the area (Inbar and Sivan, 1984; Sivan *et al.*, 1999; Kadosh *et al.*, 2004; Sivan *et al.*, 2004a; Zviely *et al.*, 2006). Renewed studies are rechecking some of the earlier conclusions (Morhange *et al.*, 2016; Giaime *et al.*, 2018). Electric resistivity tomography (ERT) tests are presently being carried out by a team from the Worley Parsons Company in Canada headed by P. Bauman: Ground Penetrating Radar (GPR) is being carried out by H. Jol and Y. Salmon: and coring analysis and Optically Stimulated Luminescence (OSL) are being carried out by G. López.

The formation of Tel Akko is of special interest when looking at the habitation patterns. The coastal area has undergone extreme changes over the millennia. Zviely *et al.* (2006) have shown that the area was inundated in the early Holocene. The sandstone *kurkar* ledges in the southern depression noted by A. Raban (1991), were probably islands at that time, formed in the process of the inundations and the receding coastline, or the eroded evidence of once-elongated *kurkar* ridges. While some of these 'islands' are small *kurkar* hills, ERT tests carried out by P. Bauman and his team (Artzy, 2012), showed that

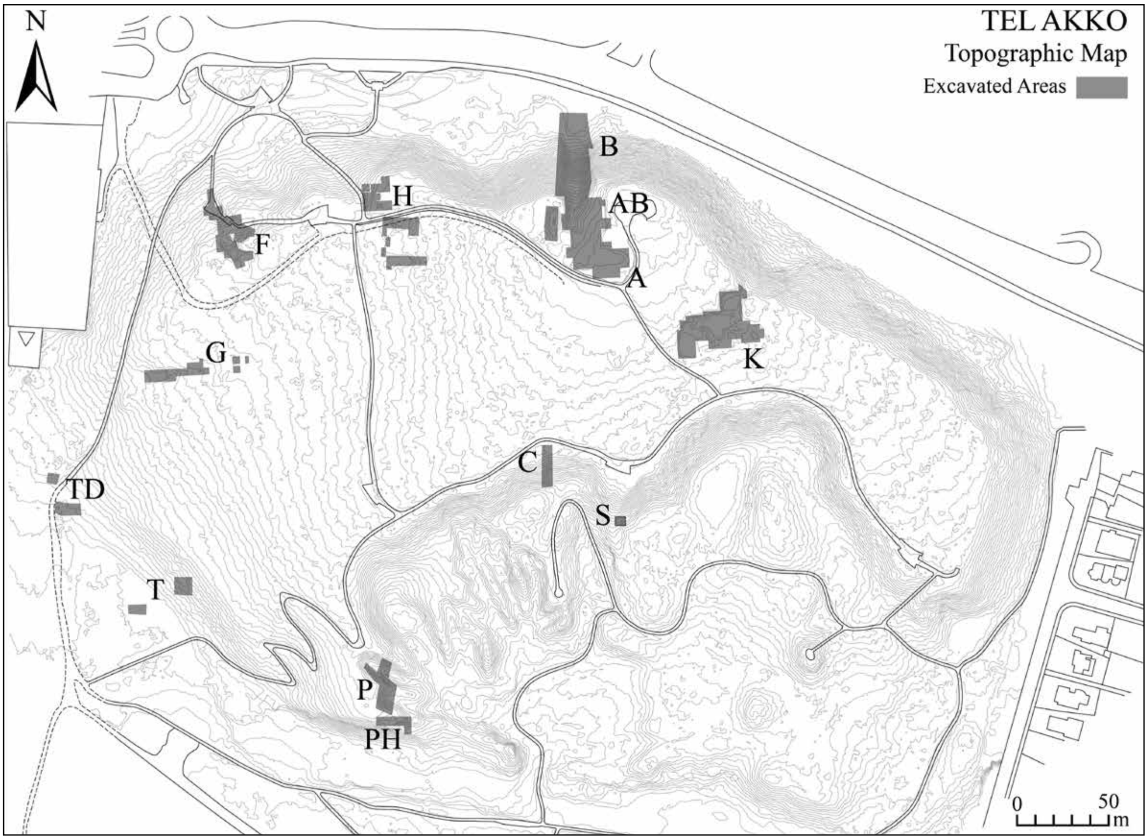


Figure 3 (above). Tel Akko excavated areas (Map J. Quartermaine).

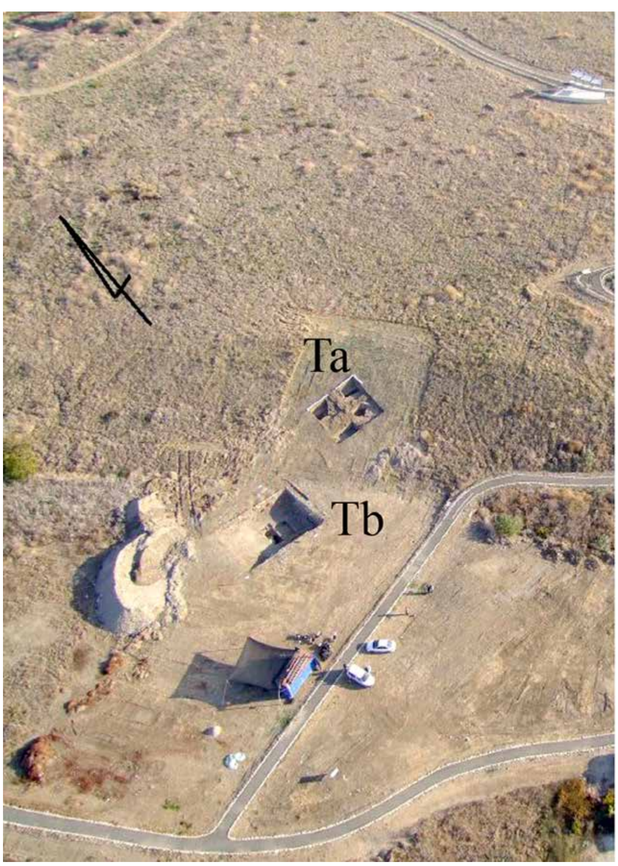


Figure 4. An active coastline below Tel Akko was seen in Area T excavations (Photos A. Abu-Hamid and M. Artzy).

some of these residual 'islands' do not protrude above the present land surface and are rather large, especially one situated on the northern side of the tell, near its summit. The highest part of the MBA rampart inclines towards the buried *kurkar* 'island' or a large sand dune and was most likely supported by it. A similar pattern of residual 'islands' can be observed in the Achziv area, just north of Akko, where they are situated in the sea near the shore.

The exact causes of changes in the Akko area, whether related to anthropogenic environmental disruption, changes in sediment influx along the coast, or climate change, or a combination of these, have yet not been determined. It is apparent that this coastline has seen very dynamic environmental changes in the past and will continue to do so in the future, as can be seen by comparing a map drawn by Joseph Treidel in 1925-1926 to the recent coastline; it is apparent that changes in sea-level and reduced sediment transport are causing areas on the coast to be inundated anew (Artzy, 2012).

a.

b.

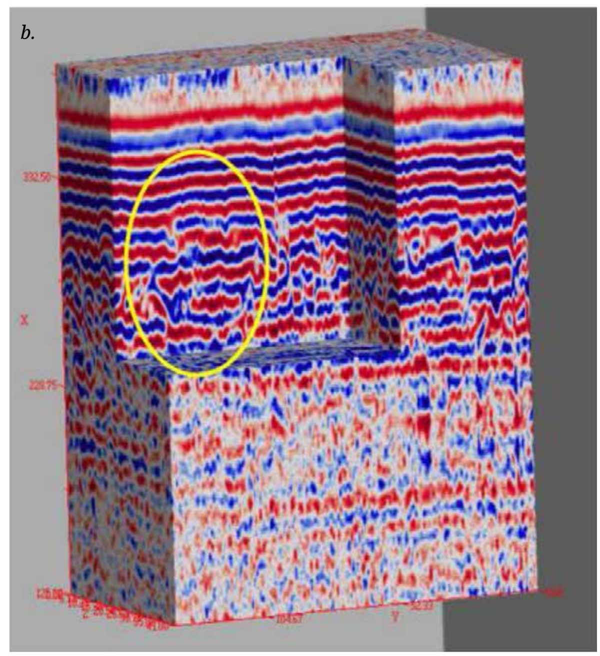
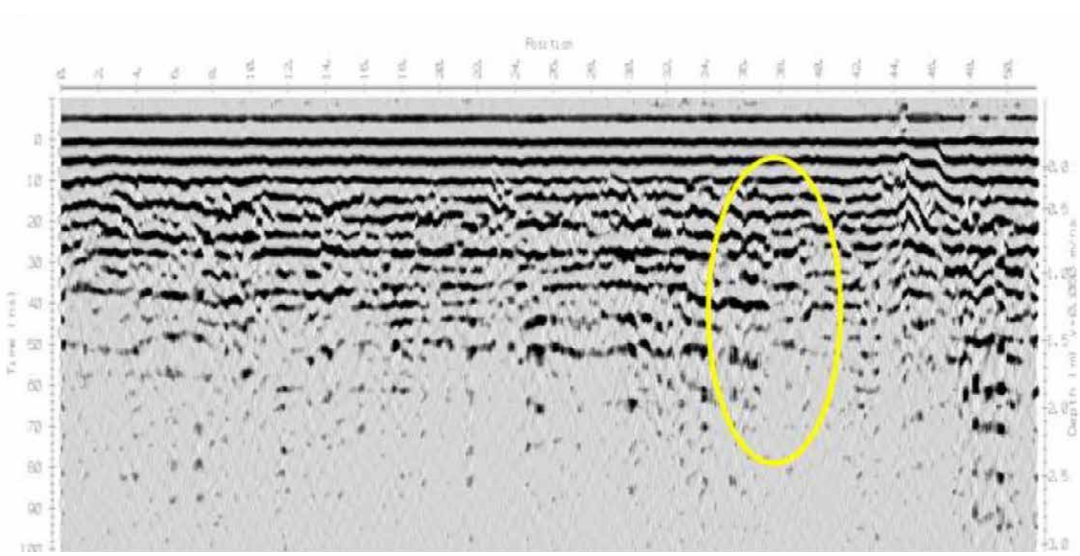


Figure 5. a) Ground Penetrating Radar grid data collected on the southern portion of Tel Akko using a Sensors and Software pulseEKKO system with 225 MHz antennae; b) three-dimensional rendering of the collected grid data using Golden Voxler software showing the subsurface stratigraphy, with the yellow oval highlighting the possible area where the kurkar plateau drops off/ is eroded; c) two-dimensional transect highlighting the horizontal to sub-horizontal, continuous to semi-continuous subsurface reflections, which are truncated at approximately 37 m along the transect. The area outlined in yellow shows where we interpret the kurkar plateau is truncated. A coring programme has confirmed the significant change in kurkar depth below the surface in this location of the tell (Prepared by H. Jol).

c.



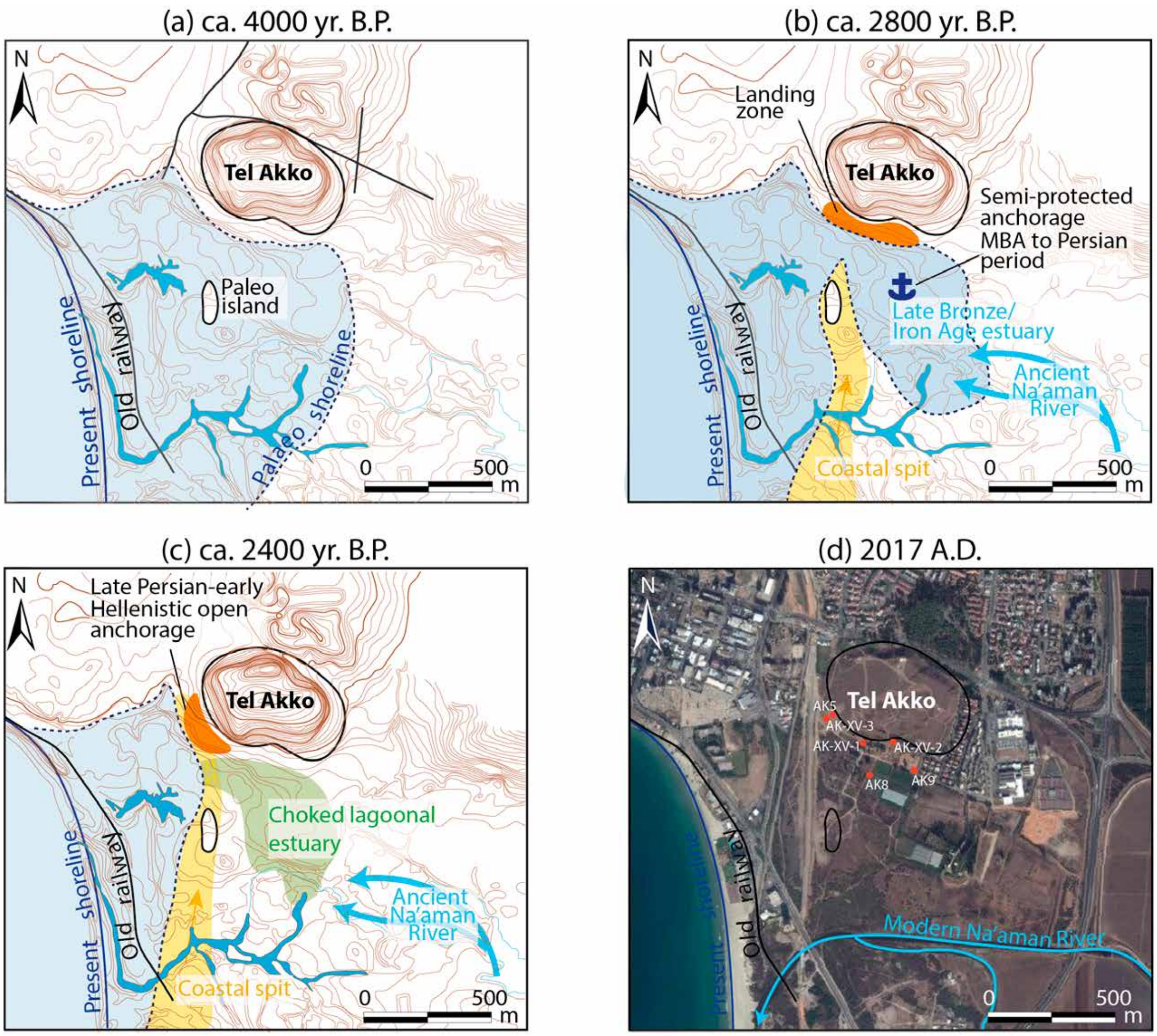


Figure 6. Proposed changes in the bay (Prepared by M. Giaime).

The search for the anchorages

For the Bronze Age, the 2nd millennium BCE, Raban proposed an inner harbour in the inner basin of Tel Akko (Raban, 1991). This suggestion followed a model he proposed in which he showed that many of the coastal sites of the Bronze Age were situated near river estuaries. In his 1991 article Raban states that:

> …sea level, stabilized at a relatively high level, flooding the low lagoonal areas around the tell, i.e., the extracting activity might have helped keep the area at the foot of the tell to the south and south west deep enough for navigation, all the way to the anchorage that lay within the protection of the city's rampart. (Raban, 1991: 32)

This hypothesis was based on the fact that most of the southern Levant's coast lacked protective bays, and thus many of its anchorages were dependent on rivers. There is no doubt that Akko played a major role in the eastern Mediterranean maritime trade in the early 2nd millennium BCE (Dothan, 1976; Marcus, 1998).

Our studies, which included coring in Raban's 'inner harbour', negate the inner-harbour theory. We found that the bedrock, the *kurkar*, is far too high and hence the water column too shallow for any boat, even a barge, to enter the area – even at the high sea-level

Raban suggested. The research, along with GPR surveys and coring, showed that, just beyond the depression, a rapid drop in the *kurkar* was noted (Fig. 5), precisely in an area where the bay or river could have been present in the Middle and likely Late Bronze Ages, and that boats could have sailed from the coast towards the tell, but not into the depression (Artzy *et al.,* 2014). Detailed sediment-core analyses substantiated this possibility (Morhange *et al.*, 2016; Giaime *et al.*, 2018). Raban (1991) also published interesting results following his archaeological excavation in Area P at Tel Akko in the 1980s. Among the architectural remains is a massive structure that he interpreted as a gate. If we accept his interpretation, this monument would have been the entrance gate to the site from the sea, lagoon, river, or estuary present at the time, an important addition to understanding Bronze Age Tel Akko as a true coastal site. The limited number, state, and typological identification of ceramics retrieved from some of the sediment cores collected in this southern area of the tell (Fig. 6) indicate that in the 2nd millennium BCE, activities took place in this area associated with the bay below the tell (Giaime *et al.,* 2018).

The Phoenician/Persian harbour?

This brings us to the question as to where the 1st millennium Phoenician or Persian harbour was situated. For many years, the accepted notion was that the mid 1st-millennium harbour was built somewhere near the modern small harbour of Akko. It was surveyed and partially excavated by Linder and Raban in the mid 1960s (Linder and Raban, 1965; Raban, 1993b; 1993c). Work was concentrated on a tower, named the 'Tower of Flies', which is still a landmark feature in Akko bay. Raban dated the construction of the tower, built in the Phoenician style, to the mid 6th century BCE and felt that the construction of the harbour was part of Persian king Cambyses II's effort to conquer Egypt. Raban (1986) further stated that only minor modifications were made in the later Hellenistic period. There is no doubt that the tower was, at its base, constructed in the 'Phoenician manner', but the dating of such a construction could be as late as the Hellenistic period. Dredging carried out by the IAA team headed by Ehud Galili collected pottery dating mainly from that period (Galili *et al.*, 2010). Further archaeological data from the area surrounding the assumed harbour indicated that it was not developed until the Hellenistic period (Artzy, 2012). 'Phoenician-type' harbours continued to be constructed in the southern eastern Mediterranean well after the Phoenician Period. One example is the harbour at Amathus, Cyprus (Empereur and Verlinder, 1987; Empereur, 1995; Empereur *et al.*, 2018) that, despite showing some Hellenic elements, was still mainly constructed in the Phoenician style in about 300 BCE. Raban noted similarities in the construction of the two harbours (Raban, 1993b). Cambysis, in the 6th century BCE, may have stopped in Akko on his way from Tyre to Egypt, but Akko's importance to the Persians is attested only in the 4th century BCE, at the time of Artaxerxes II (Gambash, 2012; 2014).

In Dothan's archaeological project at Tel Akko in the 1970s and 1980s, rich remains from the later Persian Period (late 5th-4th century BCE), as well as numerous imports from the Aegean world, were found (Artzy and Be'eri, 2010; Dothan, 1976; 1985a), especially in Area F (Raban, 1993a). On the summit of the tell, a Phoenician *ostracon*, the longest ever found, was unearthed (Dothan, 1985b). More Phoenician *ostraca*, not yet published, were found in a later project and in other areas on the tell. The extent of the Phoenician or Persian settlement area on and around the tell indicates a major expansion, due probably to the Persian interest in Akko's strategic coastal position in their quest to conquer Egypt. This phenomenon was corroborated by the results of the present Total Archaeology project.

Historical records describe Akko as one of the sites where the Persian army and mercenaries, especially Greeks from Western Anatolia and the Islands who were under Persian command, gathered (Gambash, 2012; Gambash, 2014; Diod. Sic. XV.41). Akko was indeed a major hub in the eastern Mediterranean trade network during that period. The wealth of imports found on the tell further accentuates the problems associated with having the harbour 2 km from the main habitation area of the period, namely on the tell: a partial testimony is the many Aegean stamped-handles found on the tell and in its vicinity (Finkielsztejn, 2000). The town moved down to the peninsula, the old city of Akko/Acre, sometime in the 3rd-early 2nd century BCE. The coins found on the tell date only up to the early part of the 2nd century BCE. Following its abandonment, the tell was not inhabited during the ensuing centuries, including the Roman period, until the Crusader times in the 12th century CE, when the Templar Order built a fortress, named Toron, on its top where gardens and vineyards were tilled (Artzy, 2015).

While no clear architecture and a minuscule number of ceramics dating to the Roman period have been found on the tell, some Crusader-period ceramics were noted (see Antaki-Masson, this volume) alongside later Hellenistic finds (2nd century BCE), north of the peninsula (Abu-Hamid, 2012). In these areas, following salvage excavations carried out by the IAA Roman and early Byzantine finds were reported (Feig, 2011; Tatcher, 2011; Abu-Hamid, 2013). A part of a Roman road, likely connecting the city with Damascus, was also noted (Finkielsztejn, 2007). A large Roman cemetery was found in the northwestern foothill of the tell (Tepper, 2010). It was of no surprise that in an underwater excavation carried out by J. Sharvit of the IAA, Hellenistic harbour installations dating to the 3rd-1st

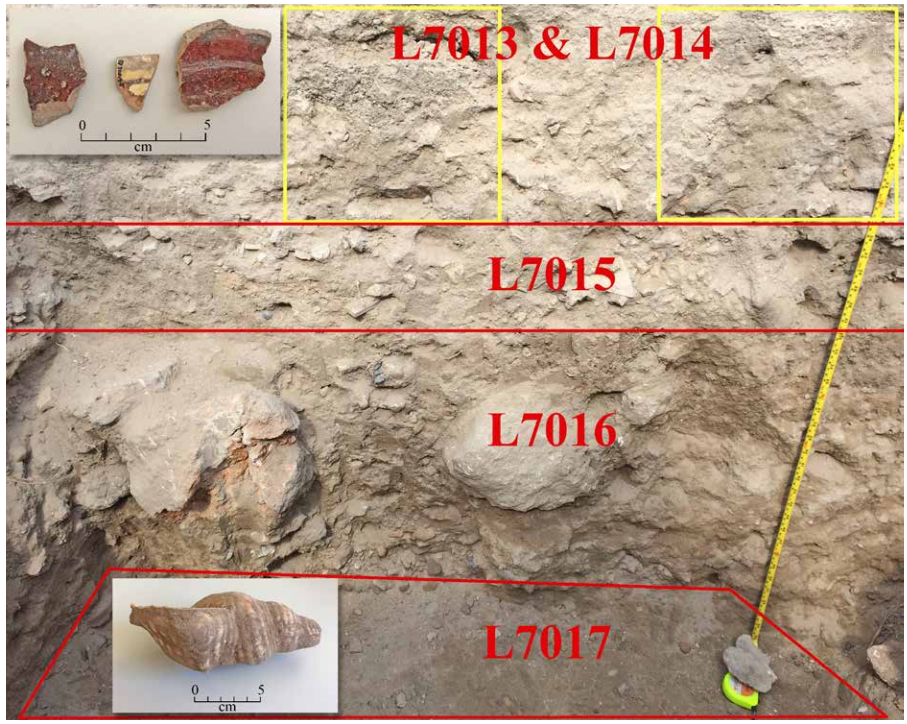


Figure 7. Area TD section (Photo M. Artzy. Prepared by R. Stidsing).

centuries BCE were located (Sharvit *et al.*, 2013). A lecture delivered at the American Schools of Oriental Research Annual Meeting in 2018, on the pottery found in constructed harbour installation, corroborate the later Hellenistic dates (Ratzlaff, 2018: 83; Constantine, 2018: 82-83).

Following the salvage excavation in Area T, mentioned above, and more recent studies (Morhange *et al.*, 2016; Giaime *et al.*, 2018), it was decided to attempt to locate an anchorage or a harbour in the southern and southwestern areas below the tell. Searching for the position of the possible anchorage used in the 2nd millennium BCE Bronze Age was impossible, due mainly to the depth of excavation necessary to locate it of at least 8 m. It was then decided to try to locate the possible Phoenician or Persian anchorage, or a proto-harbour. The excavation took place west of Area T where an active beach area was located (Artzy, 2012; Morhange *et al.*, 2016; Giaime *et al.*, 2018). However, no construction attributable to the period has yet been found, although the area did reveal an interesting stratigraphy (Fig. 7). About the first 0.5 m of soil was refuse from the modern city – a dump. Below it, starting from the bottom, the lowest *locus*, contained remains which we associate with the Persian and Late Persian periods, namely 5th-4th centuries BCE. Ceramics from *loci* 7016 and 7015 were datable to the Persian or Late Persian and Early Hellenistic time and are likely a human-generated fill; on top of these *loci*, further signs of fill were noted in *loci* 7013 and 7014, just below the modern refuse. In these *loci*, there were tree negatives about 0.5-1 m diameter, semi-circle-like pits (in section) with changed mixed-matrix, in which no stones were found. Alongside the ceramics associated with the fill, Crusader-period 13th-century CE ceramics were found. Historical records of the crusaders, published by Rey (1889: 10-13) mention orchards extending from the northern banks of the Na'aman River to the southern outskirts of the tell, which were cultivated by the Genoese. The Crusader sherds found in the tree-root negatives are the remains of this cultivation.

Conclusion

Vicissitudes in habitation zones within the Tel Akko and its environs dating from the earliest periods of activity, namely the Early Bronze and Middle Bronze periods, were noted during the archaeological excavations. The use of geoscientific methods, such as ground penetrating radar, electric resistivity tomography, bio-sedimentological analyses of cores, and radiochronology (Carbon 14 and OSL), has added to the spatio-temporal understanding of the evolution of the landscape modifications.

With the advent of urbanism in the early part of the 2nd millennium BCE, an impressive defensive rampart, especially on the northern part of the tell, was constructed. An entrance was left in the defences on the southern part of the tell where an anchorage functioned. The anchorage depended on the coast and the estuary of the Na'aman River, in an area that is now landlocked. Over the millennia, climatic and geomorphological changes, in both the river and sea transport of sediments, were involved in the modification of the area south and southwest of the tell, which in turn affected the habitation patterns and the anchorages, proto-harbours, and harbours in the Akko area. While the 2nd- and most of the 1st-millennia-BCE anchorages were in the general area of the tell, by the 3rd-2nd century BCE, the tell was mostly abandoned and maritime activity was relocated, roughly to the area where Akko/Acre's fishing harbour is located today. While underwater harbour constructions have at times been associated with the Phoenician expansion to the Akko/Acre peninsula, almost no signs of habitation earlier than the 3rd and 2nd centuries BCE were noted there. The harbour/anchorage utilized by the Phoenicians and the Persian army and their mercenaries was still in the close vicinity of the tell itself, likely below its protected southwestern confines. Remains on the tell, from Dothan's excavations of the 1970s and 1980s and Total Archaeology project show it was an important centre for maritime contact during the Phoenician, Persian, and early Hellenistic periods. Following that time, the 2nd millennium BCE and the first part of the 1st millennium BCE, the southern estuary was infilled by sediments and no longer accessible and a move to a peripheral habitation took place for a short period. Following its abandonment, habitation was renewed only in the Crusader period, when the tell was peripheral to urban Saint-Jean d'Acre. The Templars constructed a fortress on the tell with gardens and vineyards surrounding it. Below the tell, in its southern confines, completely landlocked, were orchards tilled by the Genoese Crusaders.

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Aegean Navigation and the Shipwrecks of Fournoi

The archipelago in Context

Peter B. Campbell and George Koutsouflakis***

More than 50 shipwrecks have been identified in Greece's Fournoi archipelago, making it the Mediterranean's largest known concentration of ships lost while under way. This paper examines how these vessels came to sink in a relatively obscure location. It examines Aegean navigation and Fournoi's role in north-south and east-west sailing routes. The assemblage of wrecks is not the product of the usual processes discussed by maritime archaeology, such as ship traps, hazardous environment, or abandonments, but a function of the large volume of ship traffic that passed the islands as a result of the Aegean's navigational landscape.

Keywords: Aegean, shipwreck, navigation, maritime landscape, Greece, Mediterranean.

The Fournoi archipelago lies several miles to the south of the large eastern Aegean islands of Samos and Ikaria. Composed of 20 islands and islets within an area of 178 km^2 (69 sq miles), the archipelago has often been overlooked among the major city-states in its proximity. The islands were never home to settlements larger than villages; however, despite its relative anonymity, Fournoi is a significant part of the Aegean's navigational landscape.

A collaborative survey by the Hellenic Ephorate of Underwater Antiquities and RPM Nautical Foundation from 2015 to 2018 located more than 50 shipwrecks, and a considerable area remains to be surveyed. Based on the spatial distribution of the shipwrecks and their cargoes, it is evident that these ships were lost while under way since they do not display abandonment behaviours that commonly characterize large assemblages of wrecks (Richards, 2008). The Fournoi dataset represents the largest known concentration of shipwrecks lost while under way in the Mediterranean. The sites are still undergoing study; however, this article seeks to provide context for how such a large number of ships were lost by examining Fournoi's role in navigation.

Traditional navigation relies on a maritime landscape that combines landmarks and sea features. Several environmental factors limited the routes of sailing vessels, such as winds, currents, and the land (Morton, 2001). These factors forced vessels to follow certain routes, creating high-traffic areas. The Fournoi archipelago is one such area since it occupies a chokepoint created by the islands of Ikaria and Samos: this maritime constriction has not been previously noted by scholars. It is through understanding this navigational context that it is possible to interpret how more than 50 ships came to wreck at Fournoi.

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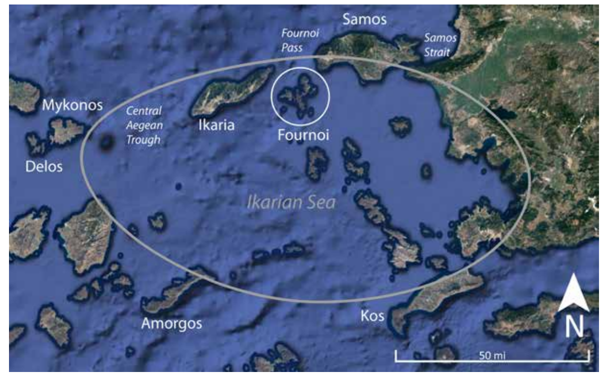
Figure 1. Map of the Aegean, left, and the Ikarian Sea, right, with Fournoi indicated (Image courtesy of GoogleEarth: Landsat/ Copernicus 12/31/2016).



Background

The Fournoi archipelago is located in a section of the Aegean known as the Ikarian Sea (Homer *Il.* 2.145; Herodotus 6.95; Pliny *NH* 4.51; Strabo 10.5.13), which is delineated by the islands of Samos and Ikaria to its north, the coast of Asia Minor to the east, the Cyclades to the west, and Kos to the south (Fig. 1). The Ikarian Sea was notorious for its dangers in antiquity (Homer *Il.* 2.140-45; Horace *Odes* 1.1.15). Nevertheless, a number of major cities lie in the vicinity of the sea, including Claros, Colophon, Corycus, Didyma, Ephesus, Erythrae, Heracleia, Iassus, Lebedos, Miletus, Notium, Priene, Samos, and Teos. Of the 12 city-states that formed the Ionian League, Fournoi lies within a day's sail of all but Clazomenae, Smyrna, and Phocaea. Ships sailing between the Ionian cities, or travelling west to the Greek mainland, would pass Fournoi.

The ancient name for the archipelago is *Korseai, Korsiai, Corassiae,* or *Corsia*. In *Geography*, Strabo writes of 'the *Corassiae*' on three occasions, indicating that the name refers to the island group (10.5.13), though spelling it *Corsia* on one occasion (14.1.13). Pliny mentions the archipelago on two occasions, likewise referring to 'the *Corassiae*' in the plural (4.23.2, 5.37.1). Stephanus of Byzantium, writing in the 6th century CE and drawing on a much older text by Hecataeus of the 6th/5th century BCE (FGrHist 1 F 143), calls the islands *Korseai* (Stephani Byzantii 173). Agathemerus also mentions the islands in his *Sketch of Geography* (2.479). Perhaps the most useful text is the *Stadiasmus Maris Magni*, a periplus dating to the 1st century CE that may contain sections that are considerably older (Arnaud, 2017: 17). The *Stadiasmus* gives an account of sailing the Aegean and includes instructions for the area around Fournoi. The archipelago is mentioned three times, and distances are given between the archipelago and surrounding locations (*Stadiasmus* 281, 283, 284). The *Inscriptiones Graecae* provide 25 inscriptions found on Fournoi dating from the 4th century BCE to the 2nd century CE, including five that mention the islands by name (*IG* XII 6, 2, 1203, 1204, 1205, 1208, 1214).

Several ancient terrestrial sites have been identified on the islands, all of them relatively small in comparison with counterparts on the surrounding islands or Asia Minor. J. Theodore Bent visited Fournoi in the late 19th century and wrote:

> There is a small group of islands called the Fournoi near Samos, the principal of which is now called Krousae, the ancient Corassia, and on the hill close to the harbour are considerable remains of an Hellenic town built on a marble rock which has been much cut and adorned; under the highest point stood a colossal statue the holes for the feet of which are still visible with an inscription around the base so obliterated that scarcely any letters can be deciphered; this was the case too with numerous rock-cut inscriptions and ornamentations which covered this rock. On the coast of Corassia about 10 miles from the town is the base of an Hellenic marble temple with a well-preserved approach, but on the top two small Byzantine churches had been erected, and in digging here we failed to find any inscription or further trace of antiquity. (Bent, 1886: 143-144)

The first settlement Bent mentions is today the main village on the island, named Fourni and identified as the ancient village of Korseai. It dates between the 3rd century BCE and 2nd or 3rd century CE (Dunst, 1974; Zapheiropoulou, 1981; 1983; 1988; Viglaki-Sophianou, 2006: 155). It includes a Hellenistic fortification dating to the same period as the watchtower at Drakano on Ikaria. The second settlement that Bent refers to is the northern village of Chrysomilia, which includes the foundations of a tower and temple (Rehm, 1929: 20). On the eastern side of the archipelago is the village of Kamari, which dates to the Roman period (Zapheiropoulou, 1988; Viglaki-Sophianou, 2006: 155). The island was a source of marble with the largest quarry located at Petrokopio (Lazzarini, 2000). This quarry was exploited possibly as early as the Archaic period (Cramer, 2004: 243) and through the 2nd century CE, mostly for use in Asia Minor (Rehm, 1929: 20; Viglaki-Sophianou, 2006: 155). Inscriptions from the islands were collected by Albert Rehm and published by Günter Dunst (Rehm, 1929; Dunst, 1974).

Based on the physical evidence from Korseai, Chrysomilia, and Kamari, as well as inscriptions, Fournoi was inhabited from the 4th century BCE through the Late Roman Period. However, Fick (1905: 54) argues the etymology of 'Corassiai' to be Carian, a reminder that the Carians controlled the area before the Ionian Greeks (Strabo 14.1.3; Thucydides 1.4-1.8), though no earlier settlement has been found. The archipelago would have had navigational significance in the Archaic period for ships sailing from Asia Minor to Black Sea colonies such as Miletus' colony of Apollonia Pontica (Rehm, 1929: 20). It is therefore likely that the islands had garrisons to control the channel between Samos and Ikaria. Indeed, Korseai was likely a Milesian colony before Samos took control of the eastern Aegean as described by Herodotus (Haussoullier, 1902; Rehm, 1929). Herodotus (3.39) writes that '[Polycrates] had taken many of the islands, and many of the mainland cities', which likely included Fournoi since that would have allowed them to control the north-south passages between Samos-Anatolia and Ikaria-Samos.

While evidence is sparse for most periods, the islands were likely inhabited – or at least exploited – since the Archaic period (Fick, 1905: 54; Cramer, 2004: 243), with the greatest population occurring during the Hellenistic and Roman periods. In the 3rd century BCE, during the period known as the Ptolemaic thalassocracy, Samos was a major naval station (Hauben, 2013: 39). The acropolis at Fourni and the watchtower at Chrysomilia were likely built at this time. The base for a statue of Augustus was found at the Korseai acropolis and indicates the inclusion of the islands in the Roman Empire (*IG* XII, 6 2: 1205). Roman interest in Fournoi – similar to Miletus, Samos, and the Ptolemies – likely related to control of the channel. According to the *Notitia Dignitatum*, which dates to *c.*395-413 CE (Dilke, 1987: 244), Fournoi was likely administrated under the Asianam VII region, which included Lycia, Caria, undefined 'Insularum' (*Notitia Dignitatum* 7.1). Samos took on new significance in the Byzantine period when the Karabisianoi Theme was based there (Nesbitt and Oikonomides, 1994: 150). The flow of ships and goods to Samos appears to have increased traffic around Fournoi, and there may have been a garrison and signalling team on the islands at this time, though direct evidence is unavailable.

A new name for the archipelago, Φούρνοι (Fournoi), is first attested in the 10th century CE. The earliest-known source to use this name is the *Stadiodromikon* of the *De Ceremoniis*, likely dating to the failed Byzantine expedition to Crete in 949 CE (Huxley, 1976: 300). The new name – *Fournoi* in Greek, *Furnus* in Latin, and *Fornelli* in Italian – variously appears on subsequent maps. The name is typically translated by early modern visitors as 'ovens', but rather than a reference to cooking or heat, the name is, according to these visitors, a reference to the shape of the archipelago's bays, which resemble traditional Mediterranean ovens. An 18th-century visitor explained, 'all the Isles… are call'd Fourni, because the Greeks, as we said before, fancy their Ports, which are better than ordinary, to be shaped like an Oven' (Tournefort, 2014: 302). The Byzantine Greek origin is still unclear, but certainly this later visitor interpreted the name to reflect the maritime significance of the archipelago and this information may have come from the local pilots.

The maritime cultural heritage of Fournoi

While Fournoi's terrestrial archaeological sites show small-scale settlements of limited durations, the maritime archaeology reveals extensive connectivity in nearly every period. The survey conducted from 2015-2018 combined ethnographic sources, systematic diver-based survey, and remote sensing. Beginning with sites reported by sponge divers, fishermen, and free divers, the team began systematic diver surveys in the areas of the reported sites (Viglaki-Sophianou *et al.*, 2019: 146-225). These surveys confirmed a number of reported sites and located many additional ones. In 2017, a multibeam geophysics survey was conducted on the east side of the islands and a remotely operated vehicle (ROV) was used to inspect sites. The survey has documented shipwrecks, anchorages, and hundreds of isolated finds including a number of anchors.

Shipwrecks

Over the four seasons of survey in Fournoi, 58 shipwrecks were identified (Table 1; Fig. 2). Distributed throughout the islands, the largest concentration is located on the east side in the Ag. Menas Channel between the large island of Fourni and the small island of Aghios Menas (Fig. 2). The sites are typified

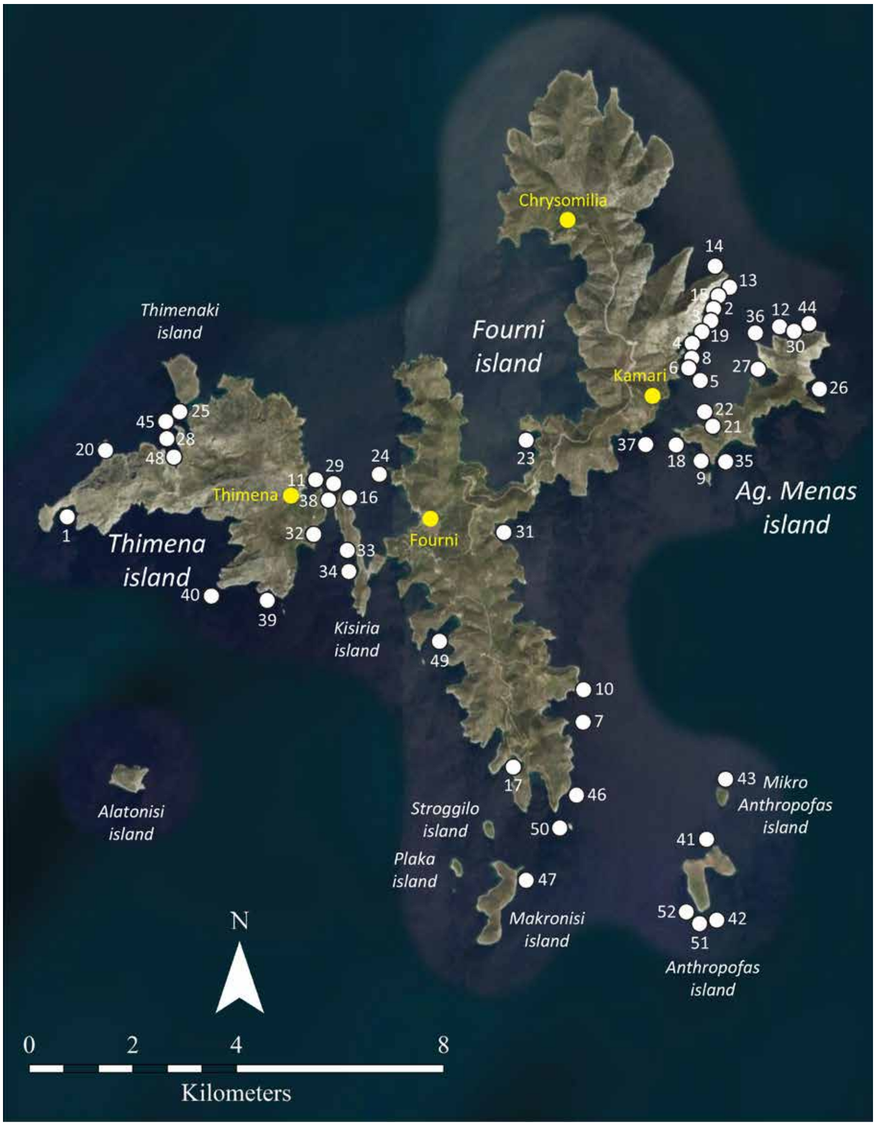


Figure 2. Map of the Fournoi archipelago and the locations of the identified shipwrecks (Image courtesy of GoogleEarth: Landsat/Copernicus 12/31/2016).

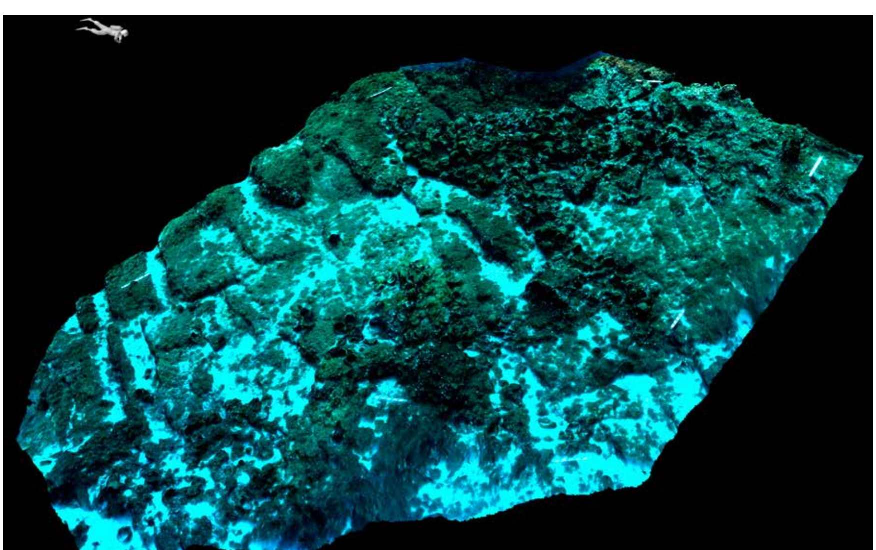


Figure 3. Wreck 4 is an example of a typical site found along the Fournoi coast, with a main concentration of amphorae and scatter along the slope (Image courtesy of EUA/RPMNF; Kotaro Yamafune).

Site	Location	Amphora type or cargo	Approximate date	Coherence	Depth (m)
1	Thimena	Benghazi Late Roman 1 and 2	5-7th CE	Scattered	5-9
2	Fourni	Benghazi Late Roman 1, 2, and 10	5-6th CE	Scattered	10-25
3	Fourni	Sinope Type C III-2	4-6th CE	Concentrated	23-25
4	Fourni	Benghazi Late Roman 13	6-8th CE	Concentrated	13-20
5	Fourni	Benghazi Late Roman 1 and 2	5-7th CE	Scattered	5-8
6	Fourni	Benghazi Late Roman 1 and 2	5-7th CE	Scattered	5-8
7	Fourni	Chian amphorae, pithoi, and louterion	4th BCE	Scattered	34-37
8	Fourni	Benghazi Late Roman 1 and 2	6-7th CE	Scattered	6-40
9	Ag. Menas	Benghazi Late Roman 3 and 4	4-6th CE	Scattered	12-13
10	Fourni	Benghazi Late Roman 1 and 2	5-6th CE	Scattered	6-25
11	Thimena	Benghazi Late Roman 1	4-5th CE	Concentrated	12-15
12	Ag. Menas	Zeest 104, Zeest 91b, Torone III, and unidentified Pontic	3-4th CE	Scattered	15-50
13	Fourni	Samian/Klasomenian and Lesbian	6th BCE	Intact	34-39
14	Fourni	Benghazi Late Roman 1	5-6th CE	Scattered	16-28
15	Fourni	Zeest 72, Zeest 104, Zeest 91b, Kapitän 2	3-4th CE	Intact	44-50
16	Kisiria	Benghazi Middle Roman 18	1-3rd CE	Scattered	12-15
17	Fourni	Fineware, lamps, and glassware	1st CE	Concentrated	4-7
18	Ag. Menas	Koan	1st-2nd CE	Scattered	28-35
19	Fourni	Benghazi Late Roman 1	5-7th CE	Scattered	8-13
20	Thimena	Günsenin 16	11-12th CE	Concentrated	47-52
21	Ag. Menas	Koan	1st BCE	Intact	40
22	Ag. Menas	Glazed plates	18-19th CE	Scattered	10-20
23	Fourni	Historic wooden vessel with stone cargo	18-19th CE	Intact	36
24	Fourni	Phocean Red Slip Ware plates	5-6th CE	Scattered	5-20
25	Thimena	Unidentified E Mediterranean amphora type	4-5th CE	Scattered	12-37
26	Ag. Menas	Koan and fineware	3-2nd BCE	Scattered	12-30
27	Ag. Menas	Rhodian, Koan, Knidian, and Greaco-Italic	3-2nd BCE	Scattered	26-44
28	Thimena	Koan and Nikandros group	2nd BCE	Concentrated	12-34
29	Kisiria	Günsenin 1	10-12th CE	Scattered	17-23
30	Ag. Menas	Koan	1st BCE	Concentrated	35-50
31	Fourni	Cooking pots	1-3rd CE	Scattered	38-42
32	Thimena	Roof tiles and bricks	17-18th CE	Intact	6-8
33	Kisiria	Mendean	5-4th BCE	Scattered	6-10
34	Kisiria	Globular	7-8th CE	Scattered	28-44
35	Ag. Menas	Benghazi Late Roman 1	4-5th CE	Scattered	18-30
36	Ag. Menas	Stone	4-7th CE	Concentrated	23-24
37	Fourni	North Aegean	6-5th BCE	Scattered	4-9
38	Kisiria	Knidian	2-1st BCE	Scattered	16-22
39	Thimena	Milesian	6th BCE	Scattered	28-39
40	Thimena	Chian and Knidian	3-2nd BCE	Scattered	12-25
41	Anthropofas	Günsenin 11	10-11 CE	Concentrated	32-39
42	Anthropofas	San Lorenzo 7	3-4th CE	Scattered	36-44
43	Mikro Anthropofas	Benghazi Middle Roman 18	1-3rd CE	Scattered	10-25
44	Ag. Menas	Benghazi Late Roman 1	5-6th CE	Scattered	11-18
45	Thimena	Africana IIIA and Almagro 51C	3-4th CE	Intact	57-64
46	Fourni	Globular, Benghazi Late Roman 2 and 13	7-8th CE	Scattered	15-40
47	Makronisi	Unidentified Late Roman	4-7th CE	Scattered	15-35
48	Thimena	Cretan, Agora M 94, and miniature Dressel 5	2-3rd CE	Scattered	15-33
49	Fourni	Historic wooden vessel	20th CE	Intact	38
50	Fourni	Chian	4th BCE	Scattered	12-38
51	Anthropofas	Pithoi, hydriae, and tableware	4-2nd BCE	Concentrated	15-25
52	Anthropofas	Dressel 38	1-2nd CE	Scattered	17-35
53	Ag. Menas	Benghazi Late Roman 1	5-6th CE	Intact	31-34
54	Thimena	Phoenician and Aegean	4th BCE	Scattered	16-50
55	Fourni	Knidian	2-1st BCE	Scattered	8-22
56	Thimena	Benghazi Late Roman 1	5-6th CE	Scattered	23-30
57	Fourni	Granite	Early Modern	Concentrated	2-4
58	Thimena	Bricks	10-14th CE	Scattered	4-17

Table 1. Sites located during the Fournoi Underwater Survey.

by amphora scatters down the cliffs of the island (Fig. 3). The sites date from the late Archaic period (550-480 BCE) to the 19th century CE. For comparison to other Aegean islands and navigational passages, the 58 shipwrecks represent 23% of the known shipwrecks in Greek waters, based on Ephorate of Underwater Antiquities records. However, the Aegean is lacking systematic survey in many areas, so the full context of the Fournoi statistics is not known at this time.

The shipwreck sites are defined by: 1) being located in a discrete area; and 2) containing a coherent assemblage of more than a dozen artefacts. A 'discrete area' is defined as an area the size of a vessel on a flat, sandy bottom or an area consistent with impact scatter on rocky cliffs. A 'coherent assemblage' refers to a homogenous type of cargo (such as Ottoman roof tiles or Late Roman 1 amphorae) or a mixture that is consistent with a cargo in date and type (such as one-third Late Roman 1 amphorae and two-thirds Late Roman 2 amphorae). While an interpretation is necessary to determine both discrete areas and coherent assemblages, these criteria distinguish wrecks from other types of sites, such as anchorages. Anchorages have large quantities of amphora fragments scattered over a broad area, but these do not provide a coherent assemblage since they contain a mixture of types not commonly transported together and range in date over many centuries. In contrast, wrecksites contain intact and fragmentary amphorae of the same date range. Some scatters located during the survey have not been included in the wreck tally since they do not meet these definitions or the threshold.

Each site is documented using photomosaics and photogrammetry. A representative sample of amphorae or other artefacts has been raised from each site for study, and these are undergoing conservation in Athens. The authors are currently preparing a journal article that will present an overview of each shipwreck.

Anchorages

Fournoi's many bays, promontories, and islands offer protection in various conditions; however, six areas identified by the survey show repeated use as anchorages. These anchorages are typified by assemblages of ceramics of different types and time periods that have been discarded from ships at anchor. The locations of the anchorages suggest that they were used to wait out unfavourable winds at various times of year – either the Etesian (NW) or a southerly wind. A number of anchors have been found, with dates spanning the Archaic period to the modern day. Of particular note are three Archaic stone anchor stocks, including two that are approximately 1.9 m in length. The survey located dozens of anchors lying off the coast of Kamari that date from the Roman period through to the Early Modern period, suggesting it was the major anchorage on the east side of the archipelago.

Kamari offers protection from the Etesian wind, as do the cliffs of Asprokavos on the east coast of Fourni main island, the bay on the west side of Fourni main island south of the modern town named Kambi Fournon, and the southernmost bay, Vlychadha Bay. During fieldwork from 2015-2018, the authors witnessed vessels putting into these anchorages during periods of foul weather. Besides the evidence of anchorage, Asprokavos includes six shipwrecks that appear to have been caught in contrary winds, either at anchor or in transit.

Protection from the southerly wind is found in two bays on the north coast of Thimena across from Thimenaki, Ag. Agridhio and Ag. Nikolaos, as well as in Pighadhi Bay on Ag. Menas island. Pighadhi Bay was used as protection from the southerly wind by three vessels in Tournefort's account, though one was wrecked and the other two attempted to double Samos once the gale reached a certain strength (Tournefort, 1718: 332). The interior of the bay includes a Hellenistic shipwreck of Koan amphorae, and a stone Archaic anchor stock was found on the southern side of the bay. The promontory to the south includes two wrecks of vessels that may have been trying to get into Pighadhi Bay but struck the promontory before they could turn into the shelter.

Many of the other bays have isolated finds, but not the sustained finds from a wide timeframe that these six locations demonstrate. Toponyms of bays requiring further survey, such as Tourkolimnionas – which translates as Turkish Harbour – suggest that more anchorages may be identified as the project continues.

In addition to these anchorages, the settlements on Fournoi occupy excellent anchorages, typically one north-facing and one south-facing to provide two harbours for protection from the winds. The villages of Fourni, Chrysomilia, and Kamari each have two harbours (Fig. 4). In fact, Fourni may have three if one includes the anchorage of Kambi Fournon, located in walking distance over a ridge, which provides access to the southern part of the island. The village of Thimena might be considered to have two harbours as well, if one counts both Thimena Bay and Keramidou Bay, though transfer between the two by sea requires travel through a narrow channel separating the islands of Fourni and Thimena. It is therefore unsurprising that the three anchorages first mentioned are those with evidence of ancient settlements.

While Fourni and Chrysomilia appear to have been important during the Classical and Roman periods, Kamari – also inhabited during these periods – appears to have had its peak during the Late Roman Period.

The term 'harbour' should be used cautiously in this context, as these are unlikely to have been areas of exchange. Instead, these were most likely anchorages

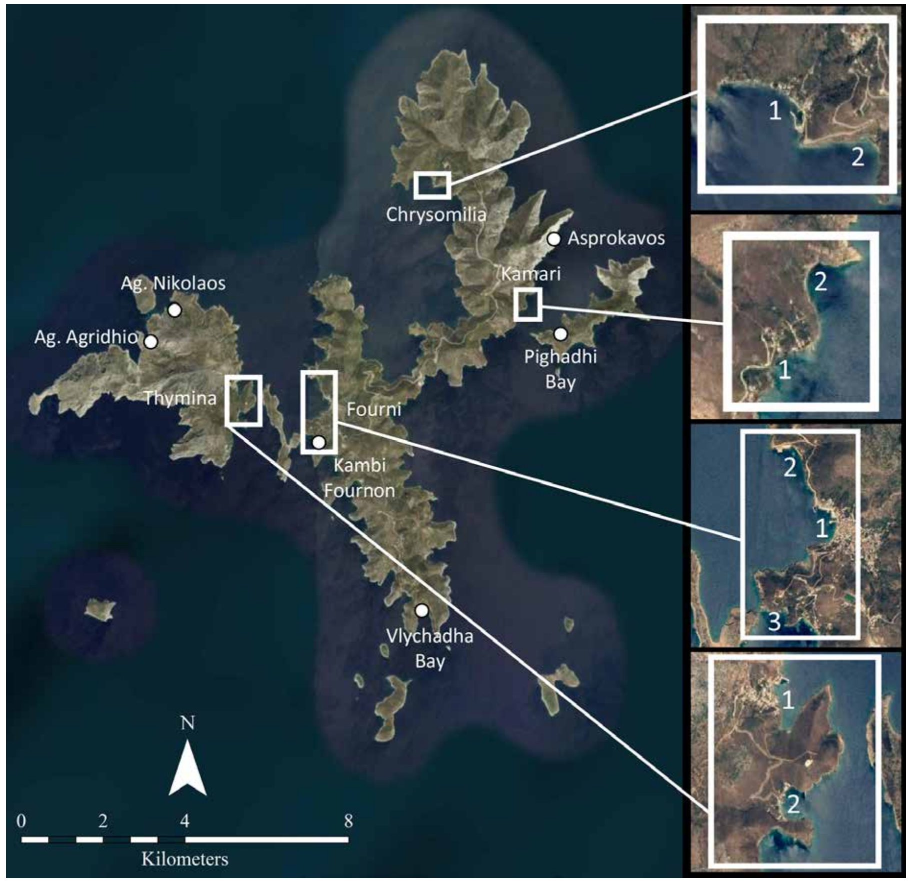


Figure 4. Map of the locations of the four villages with double harbours indicated by squares and the six anchorages identified during survey indicated by points (Image courtesy of GoogleEarth: Landsat/Copernicus 12/31/2016; CNES/Airbus 6/28/2016).

for respite from the winds during passage through the region; however, the presence of the villages indicates that some small-scale exchange may have occurred. A single harbour exposed for a significant portion of the year to a dangerous wind would not make a location suitable for a long-term settlement: it was the availability of two harbours for protection for vessels that determined the locations of villages.

Navigation in the Aegean

The quantity of wrecks found at Fournoi is best understood through the significance of the Fournoi Pass maritime chokepoint. A 18th-century account by Joseph Tournefort summarizes it, stating:

> All the Ships coming down from *Constantinople* into *Syria* and *Egypt*, after resting at *Scio* [Chios], are obliged to pass through one of these Straits. The same must they do, that go up from *Egypt* to *Constantinople*. Here they meet with good Harbours, and it would be too long a Course for 'em to pass toward *Mycone* and *Naxia*: so that these Boghas [straits] are very proper places for the Corsairs to spy what Ships pass to and fro. (Tournefont, 2014: 306)

The landscape of the Aegean is such that Fournoi straddles a maritime chokepoint and ships are, as Tournefort puts it, obliged to pass the archipelago. Historical sources, maps, interviews with traditional mariners, and environmental data provide the context for navigation around Fournoi.

The islands of Samos and Ikaria divide the eastern Aegean in two, forming the basin known as the Ikarian Sea (Fig. 5). The maritime chokepoint they create is most easily navigable through the strait known today as Stenon Fournon or Fournoi Pass (National Geospatial Intelligence Agency, 2011: 233). In the past it was known by a variety of names such as the Grande Borghas or Great Samos Strait (Tournefort, 1718: 306; Sonnini, 1801: 307), distinguishing it from the small strait between Samos and Asia Minor (Fig. 5). This narrower passage is today known as the Samos Strait.

Passage through the Fournoi Pass is, therefore, the most effective route north-south, and the archipelago also offers safe anchorage, unlike Ikaria and Samos. Ikaria island has no safe harbour; Strabo refers to it as harbourless (Strabo 14.1.19), although there are roadsteads for offshore anchoring under certain wind conditions (Roberts, 1699: 162). The local bishop described the wariness of mariners, stating:

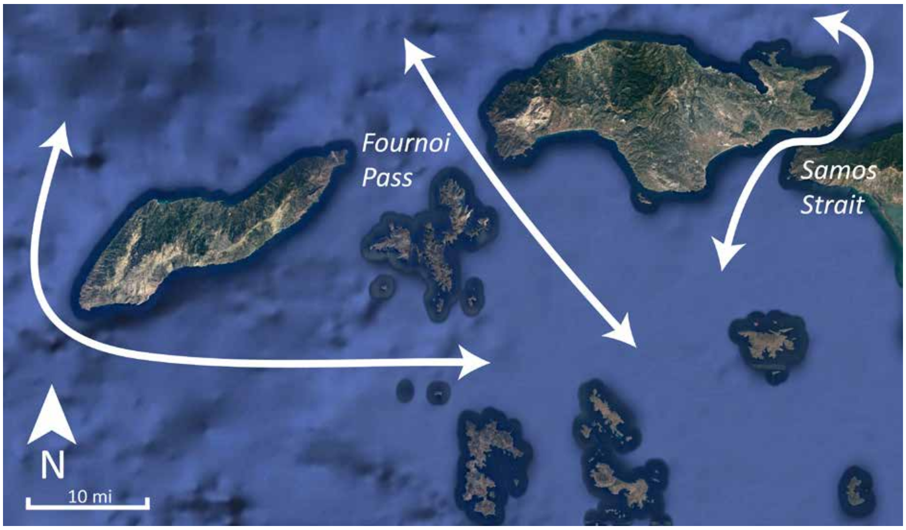


Figure 5. The three north-south sailing routes in the eastern Aegean (Image courtesy of GoogleEarth: GoogleEarth; Landsat/Copernicus 12/31/2016).

> [Ikaria] has not one Port or Road for great Ships, but only two small Creeks for little Boats… And when 'tis fair, they lade and unlade their Vessels with all possible speed, at the Shore of *Icarus*, and so retire, for fear of a Storm (Georgirenes, 1678: 55-56).

Rather than anchor at Ikaria, mariners preferred Fournoi's many safe anchorages.

> The Island [of Ikaria] wants Ports, as *Strabo* has observ'd…The good Ports of these Quarters are in the Isles of *Fourni* (Tournefort, 2014: 302).

Western Samos is similarly dangerous in adverse weather with nowhere to shelter: Tournefort states that in the event of bad weather, ships travel to Fournoi (1718: 313). The 16th-century-CE Piri Reis map series for Samos shows four anchorages with none in the west (Piri Reis, fol. 79b). The modern pilot directions state: 'Nisidhes Fournoi is a group of islands, islets, and rocks which provide shelter to small craft [*i.e.* 65 ft (20 m) or less] with local knowledge' (National Geospatial Intelligence Agency, 2011: 233). The Fournoi Pass directs maritime travel past Fournoi, but the archipelago is also the safest place in the region for vessels to anchor.

Besides the constriction and the safe anchorages, there is the wind, which also conspires to increase ship traffic around Fournoi. The northwestern Etesian wind, known as the Meltemi today, is the primary summer wind in the Aegean. It is strong but consistent, allowing mariners to sail effectively. Significantly, it is remarkably consistent at Samos; in fact, it is as consistent as the trade winds. Biel notes that the wind blows for 90% of the time during the summer months at Samos, consistency which is 'hardly exceeded in the most steady trade-wind regions of the Earth' (1944: 14). This makes the route through Samos important for the summer trading season.

However, there are times when the Etesian wind is too strong. Semple (1931: 580) writes that the Aegean winds, 'In August … attain such violence that sailing vessels for weeks at a time cannot beat against them but have to tie up behind islands'. In the area of Samos, where the northwest wind is so dominant, shelter in the lee of Ikaria and Samos is at times necessary. For example, a voyage in 1599 attempted the Fournoi Pass after a visit to Samos; however, no headway could be made against Etesian wind and they had to remain anchored behind Samos for several more days before continuing north (Bent, 1893: 42). Fournoi offers safe anchorage to wait out winds (Tournefort, 1718: 332) and it is a safer option than Ikaria (Georgirenes, 1678: 55-56).

Another potential danger in the Fournoi Pass is its current. The Mediterranean Pilot states, 'The current in this passage always sets N and causes a confused sea' (National Geospatial Intelligence Agency, 2011: 233). Modern environmental modelling demonstrates the complexity of the water-flows in the area, which causes a strong northward current (Korres and Lascaratos, 2003: 218). Clarke noted that large waves continually roll through the pass and make it difficult for ships to travel through the strait when the wind comes from the north (Clarke, 1813: 240). A pilotage account observed that sailing vessels were unable to make headway when the current and winds were in opposite directions, and instead had to take the Samos Strait (US Hydrographic Office, 1916: 304). While the archipelago often offered safe anchorage, the winds and currents could offer dangers as well.

To summarize, the Fournoi Pass is a constriction within the Aegean landscape affecting vessels under sail. It is formed by the islands of Samos and Ikaria, and the Fournoi archipelago lies across the passage. There are few anchorages at Ikaria or western Samos, but Fournoi offers numerous possibilities. The winds during the sailing season are among the most consistent in the world, providing predictable passage. However, currents converge at the Fournoi Pass and can cause heavy seas and occasionally difficult passage if the wind is against them. As the following sections will explore, this area lay at a critical juncture for vessels sailing north-south from the Black Sea to Rhodes and the Levant, as well as east-west from Asia Minor to the Greek mainland.

Navigational routes

There are three options for vessels travelling north-south in the eastern Aegean (Fig. 5). First, a vessel could pass the western cape of Ikaria; however, here Cape Papas bears the full force of the Etesian wind and places the Ikarian shore dangerously on the ship's lee. Second, a vessel could take the eastern route through the narrow Samos Strait that separates the island from the mainland. But sailing this route requires a tack through a dog-leg, which can be time-consuming and which made the channel notorious for piracy. Bishop Georgirenes wrote that it is 'a great Nest of Pirats, whom no Ships that come into this Strait can escape' (Georgirenes, 1678: 3). Third, a vessel could pass through the large channel between Samos and Ikaria, the Fournoi Pass: this central channel provides the most direct and safest route, and it appears to have been most commonly used. '[T]he great Bogaz of Samos, which is nearly two leagues wide, is to the west, between this island [Samos] and the small *Fournis* islands… formerly called *Corseæ insulæ*. It is a passage very frequented by the ships sailing from Constantinople to Syria and Egypt, and there they find good anchorages' (Sonnini, 1801: 307, translation by authors). It is this channel that brought traffic to Fournoi. While most vessels sailing this route may not have stopped, the excellent anchorages provided respite for those who did.

The north-south route that passed Fournoi was part of an arterial network that connected the Black Sea and Aegean to Cyprus, the Levant, and North Africa. The key stops in the Aegean were Tenedos, Mytilene, Chios, Samos, Kos, and Rhodes (Avramea, 2002: 83-84). Evidence of this route is found from antiquity to the Early Modern period in the form of archaeology, historical sources, and maps.

While the Fournoi Pass is the preferred route, it nevertheless can be difficult and this difficulty may explain some of the wrecks at Fournoi. The winds that come down the heights of Ikaria and Samos and through the strait can have great force, while the currents around the islands are confused:

> Having cleared the *Chian*, or *Erythræn* Straits, we sailed along the *Ionian* coast for the channel separating the stupendous heights of *Samos* from the lower land of *Icaria*. This marine pass is at present generally known in these seas by the appellation of the *Samian Boccaze*. It presents a bold and fearful strait, in the mouth of which is the small island of *Fourni*. A very heavy sea rolls continually through this channel, so that, with contrary wind, even a frigate can scarcely effect the passage. (Clarke, 1813: 240-241)

When these difficult conditions prevail, Fournoi is an attractive place to anchor and wait them out. Tournefort gives an account of seeking shelter in Pighadhi Bay at Ag. Menas island during a southerly gale (Tournefort, 1718: 333). As a 17th-century mariner recorded:

> This Island of *Samos* makes two Boaks, or Channels, to wit, the great and the small: The great one is made by three uninhabited Isles, named the *Furnoes*. They are very high and bold to, and he that's well acquainted may ride under them, *viz.* between them, with his Anchor in 50 Fathom [91 m], and Sheat-Cable fast on the Rocks: I have lain there several Times my self, with hard Storms. (Roberts, 1699: 161)

The role of the Fournoi Pass as a chokepoint attracted pirates (Georgirenes, 1678: 54-55; Roberts, 1699: 132). The large volume of merchant traffic was easy prey for the corsairs' fast-rowed vessels (Ormerod, 1997: 19).

> [Samos] lay directly on the coasters' route between (Egypt and) South Asia Minor and Constantinople, and at all unsettled periods in the Aegean, the Fourni, like the Spalmadori (Oenussae) and Moskonisi groups, which are similarly situated with regards to the straits of Chios and Mytilene respectively, became a recognized haunt of the pirates who preyed on this traffic. (Hasluck, 1911: 169)

Bishop Georgirenes wrote in 1678:

> Three Miles distant from the Island [Ikaria], on the South-side towards *Patmos*, lye some small Islands uninhabited; but know by the name of *Furny*, and furnish'd with good Harbours, capacious enough for all sorts of vessels. Here the *Corsairs of Malta*, and other *Christians*, us'd to lay in wait for Ships that trade from *Scio* [Chios] to *Rhodes.* (Georgirenes, 1678: 54-55)

Pirates travelled annually to Fournoi from as far away as France, Italy, Malta, and Sardinia to hunt ships (Georgirenes, 1678: 4); the occasional Englishman would join as well (Roberts, 1699). We are fortunate to have accounts

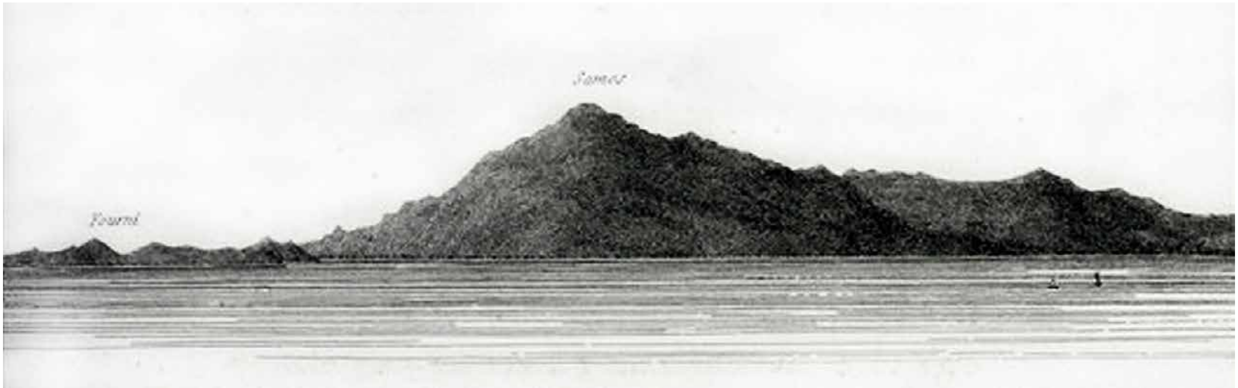


Figure 6. The 19th-century seascape of Fournoi and Samos drawn by Edward Clarke (1813: 367).

by both the pirates and mariners who sailed by Fournoi. An Englishman named Roberts published an account of his time with pirates in 1696. He wrote that the pirates would winter in the Cyclades and gather at the beginning of March,

> And then they go for the Furnoes, and lie there under the high Land hid, having a watch on the Hill with a little Flag, whereby they make a Signal, if they see any Sail: they slip out and lie athwart the Boak of Samos [Fournoi Pass], and take their Prize. (Roberts, 1699: 132-133)

After starting the season at Fournoi, the pirates would then travel throughout the Levant and Egypt in a sort of pirating season designed to maximize prize taking based on shipping rhythms. After the summer in the Levant, they returned to Fournoi for the autumn, 'From hence [the Levant] toward the Autumn they come lurking in about the Islands, to and fro about the Boakes [straits] again, until they put in also to lie up in the Winter,' – mid December, he wrote previously (Roberts, 1699: 132).

A passenger described the tense experience of sailing past Fournoi, writing:

> How very different were the reflections caused, upon leaving the deck, by observing a sailor with a match in his hand, and our Captain busied in appointing an extraordinary watch for the night, as a precaution against the pirates, who swarm in these seas. Those wretches, dastardly as well as cruel, the instant they board a vessel, put every individual of the crew to death. They lurk about the Isle of *Fourni*, in great numbers; taking possession of bays and creeks the least frequented by other mariners. After they have plundered a ship, and murdered the crew, they bore a hole through her bottom, sink her, and take to their boats again. (Clarke, 1813: 245)

Clarke included a sketch (Fig. 6) of the seascape in his book from the perspective of looking north towards Samos and Fournoi (Clarke, 1813: 367).

Pirates were a present danger for those travelling in the Ikarian Sea until relatively recently. Concern for pirates apparently even extended to archaeologists working at Fournoi in the 1880s (Rehm, 1929: 22).

Pirates were not alone in monitoring ship traffic from Fournoi. The archipelago was key to controlling the channel through sea power, and the acropolis on Fournoi's Aghios Georgios Hill, and the watchtowers at Chrysomilia and eastern Ikaria at Drakano were used to control the straits (Viglaki-Sophianou, 2006: 155). Fournoi had limited natural resources, so the impetus for Fournoi to change hands from Miletus to Samos (to Athens?), then later from the Ptolemies to the Romans, had to do with control of this critical strait. The control exerted by Samos in the Archaic period likely had to do with Polycrates' exertion of sea power in the Aegean: he blurred the lines between piracy and sea power (Herodotus 3.39). It is interesting to note that when the Samians were forced to flee west they settled at Zancle, which also dominates a constricted passage: the Straits of Messina (Herodotus 6.22). The location must have seemed familiar and the coins they struck at Zancle indicate that sea power continued to be a consideration for them (Campana and Morello, 2012).

Fournoi is also significant for east-west navigation (Fig. 7). Accounts from the Classical period to the modern day describe the route from Delos/Mykonos to Fournoi/Ikaria (*Stadiasmus* 281; Thucydides 3.39; Strabo 14.1.13). The central Aegean trough that divides the Cyclades from the Eastern Sporades and Dodecanese is the most dangerous area of the Aegean, as there are no islands there to provide a barrier to the winds. As a result, storms move quickly through this area. The passage from Mykonos to Ikaria is the shortest crossing-route in the Aegean and it has drawn mariners in every period.

Figure 7. The primary east-west crossing-route in the Aegean, connecting Delos/Mykonos to Ikaria/Fournoi (Image courtesy of GoogleEarth; Landsat/Copernicus 12/31/2016).

The second crossing-route to the south (*Stadiasmus* 282; Nikolas Vlavianos, pers. comm.) – from Naxos to Kalymnos offers protection behind Amorgos, Levitha, and several other islands – is more than twice as long, 105 km versus 46 km.

The east-west route past Fournoi appears more often than the north-south route in ancient periploi and itineraries explored in the following section. Both Delos and Fournoi offer safe anchorage along major east-west and north-south navigational routes. Delos, of course, had additional religious significance (Constantakopoulou, 2010: 38). The anchorages in the northern bays of Thimena and of the main village of Korseai likely relate to east-west travel due to their orientation in regard to the sailing routes and the winds.

The more than 50 shipwrecks at Fournoi are not a function of trade with the villages on islands, but an indicator of the high volume of trade that passed through the Fournoi Pass. The whole Aegean navigational landscape conspired to send traffic by the archipelago, via this maritime chokepoint. The constriction drew admirals seeking to exert sea power and pirates seeking prizes. Mariners, understanding its significance, embedded meaning into the place through the archipelago's name, conveying to those who followed that the islands' natural bays offer anchorage for vessels passing through the strait.

Fournoi in maps, itineraries, periploi

The corpus of maps, itineraries, and *periploi* that survive from antiquity provide, perhaps unsurprisingly, a mixed record of Fournoi. The major island of Samos is nearly always recorded, while less-populated islands such as Ikaria are less-frequently mentioned. Fournoi is missing from some key texts such as the *Periplus* of Pseudo-Scylax, Ptolemy's *Geography*, and the *Chorographia* of Pomponius Mela, but it appears in other major works. As a minor archipelago in terms of population, resources, and economy, the relatively frequent appearance of Fournoi is indicative of its navigational significance.

Stadiasmus Maris Magni

The periplus *Stadiasmus Maris Magni* is among the most complete ancient sailing guides. This compilation of sailing data dates to the 1st century CE, though recent scholarship argues that sections may date to as early as the 4th century BCE (Arnaud, 2005: 17).[1] The text describes sea routes by listing the distances between physical locations. Fournoi plays a prominent role in Aegean routes, though secondary to centres like Delos and Rhodes. The *Stadiasmus* provides the distance from Delos to Fournoi and two sailing routes along Fournoi (*Stadiasmus* 281, 283, 284).

The first section mentioning Fourni is the west-east route from Asia Minor to the Greek mainland.[2] This route from Asia Minor passes Fournoi on the way through the Cyclades towards Attica. The second section is a route from Kos to Euboea that includes a section of travel

1 The text used for this study is Müller's 1855 translation, which is problematic for a number of reasons identified by Arnaud (2005: 17). Arnaud has a new translation forthcoming (Neue Jacoby, vol. V, H.J. Gehrke, ed., Leiden: Brill) which should be consulted in the future.

2 'A Myndo (*ad Sunium?*) Atticæ navigator stadiis 1500. Navigabis autem per Corsicas insulas; tum trajicies inter Lerum et Calydnam; linquensque a dextra Orobidem (seu *Erebinthum, Lepinthum*) tene in Amorgias; deinde Donusam et Naxum et Cythnum a dextra habe' (*Stadiasmus* 281).

between Patmos to Fournoi and Fournoi to Delos (*Stadiasmus* 283). The route travels from Kos to Leros and then to Patmos. From there, the mariners go on to Fournoi and from there to Delos.[3] A copyist appears to have made a mistake with the distance of 400 stades between Patmos and Fournoi, which Müller and Haussoullier argue is meant to be 100 stades (Haussoullier, 1902: 141; Müller, 1855: 499). The distance between Fournoi and Delos is given as 750 stades, and this is restated in the following section of the *Stadiasmus,* which lists distances between Delos and other islands (*Stadiasmus* 283, 284). Given that the *Stadiasmus* lists Fournoi rather than Ikaria, it may be advocating anchorage at Fournoi rather than at the Ikarian roadsteads.

Examination of the two routes reveals the role that Fournoi plays within the navigational landscape. The passage across the Aegean, for which the periplus gives two possible routes 'through the islands', the first being a southern route from Levitha to Amorgos and the second being Fournoi to Delos (*Stadiasmus* 282, 283). Significantly, for the latter route the *Stadiasmus* does not list Ikaria to Mykonos, but specifically names Fournoi to Delos (*Stadiasmus* 283).

Strabo's Geography

Strabo's *Geography* dates to the 1st century CE. In it, he mentions 'the *Corassiae*' on three occasions and *Corsia* on another (10.5.13, 14.1.13). Strabo gives an account of the Ikaria Sea, though he misplaces Fournoi and Patmos to the west of Ikaria.

> Near by are both Patmos and the Corassiae; these are situated to the west of Icaria … after it is named the sea that lies in front of it, in which are itself and Samos and Cos and the islands just mentioned – the Corassiae and Patmos and Leros. (Strabo, 10.5.13).

He also gives an account of travelling from Mycale in Asia Minor to Sounion in Attica, giving the distance as 1600 stades. He states, 'the voyage one has at first Samos and Icaria and Corsia on the right, and the Melantian rocks on the left; and the remainder of the voyage is through the midst of the Cyclades islands' (Strabo 14.1.13). This brief description would not be much use to mariners but likely was reported to Strabo as the route based on visual landmarks. The Melantian rocks are located across the central Aegean trough, to the south of Mykonos. Strabo's description is nearly as simple as stating to travel due west from Mycale; however, this route connecting Asia Minor to the Greek mainland appears to have been important in every time period.

Agathemerus's Sketch of Geography

The *Sketch of Geography* by Agathemerus dates to approximately the 1st or 2nd century CE (Diller, 1975: 59). Agathemerus gives an account of distances from Alexandria, Egypt, to the River Don in the Black Sea (1.4). He lists distances between major landscape features such as promontories, islands, rivers, and cities. In the Ikarian Sea, the route is from Cos to Arcitis (Arkioi?) and then Corsaie (Agathemerus, 1.4.18). From there, the route goes to Samos and into the Aegean Sea with the next landmark being the Argennon promontory in the Chios Strait. In the next section, he lists the same route, but 'from city to city' (Agathemerus 1.4.19). In this case, he jumps directly from Cos to Samos, which confirms that the settlements on Fournoi were minor and the archipelago was likely more of a navigational point, similar to a promontory, than a destination, like the cities listed in the latter route.

The Peutinger Table

The Peutinger Table is the most complete extant Roman map. This 13th-century-CE parchment is a copy of a 4th-century-CE map; the 4th-century version is thought to build on a 1st-century-CE original (Dilke, 1987: 238). For example, Pompeii, destroyed in 79 CE, is included on the map, indicating a 1st-century connection, while Constantinople and Antioch are given prominence, which is the reason for the 4th-century date.

The Aegean section of the map includes a number of islands (Fig. 8), though not in geographical order. The choice of islands included is confusing, as it includes economically important islands (such as Crete, Lesvos and Chios) and those significant for navigation and travel (Milos, Ikaria and Delos, for instance). There are apparent mistakes, such as an island named Mycale, which takes the name of the promontory in Asia Minor (Miller, 1916: 604). It is therefore unclear how familiar the mapmaker was with the Aegean islands, or what we should infer geographically from the map.

Near the islands marked *'Delo.'* (Delos) and *'Icaria.'* (Ikaria) is an island abbreviated as either *'Corss.'* or '*Corsa.*'. This name has been interpreted as an abbreviation of *insulae Corasiae* (Miller, 1916: 604), and the inclusion of 'Korseai' on the Peutinger Table corresponds with Fournoi's likely role under Roman Aegean hegemony as a base of sea power. The acropolis above the village of Fourni continued to be used as a watchtow-

3 A Co ad Lerum stadia 320. A Lero ad Parthenium *Leri* stadia 60. A *Parthenio* Leri insulæ ad Patmi Amazonium stadia 200. Ab Amazonio ad Corsiam stadia 100. A Corsia ad Delum stadia 750. A Delo ad Syrum stadia 150. *A Syro ad Andrum insulam stadia* 150. Ab Andro *extrema* ad Gaurium portum stadia 80. A Gaurio ad [*Pœonium*] *Andri* promontorium stadia 50. Ab eo promontorio ad [*Gerœstum*] proxime promontorium stadia 150. A Geræsto ad Carystum stadia 120. A Carysto ad Petalias insulas stadia 100' (*Stadiasmus* 283).

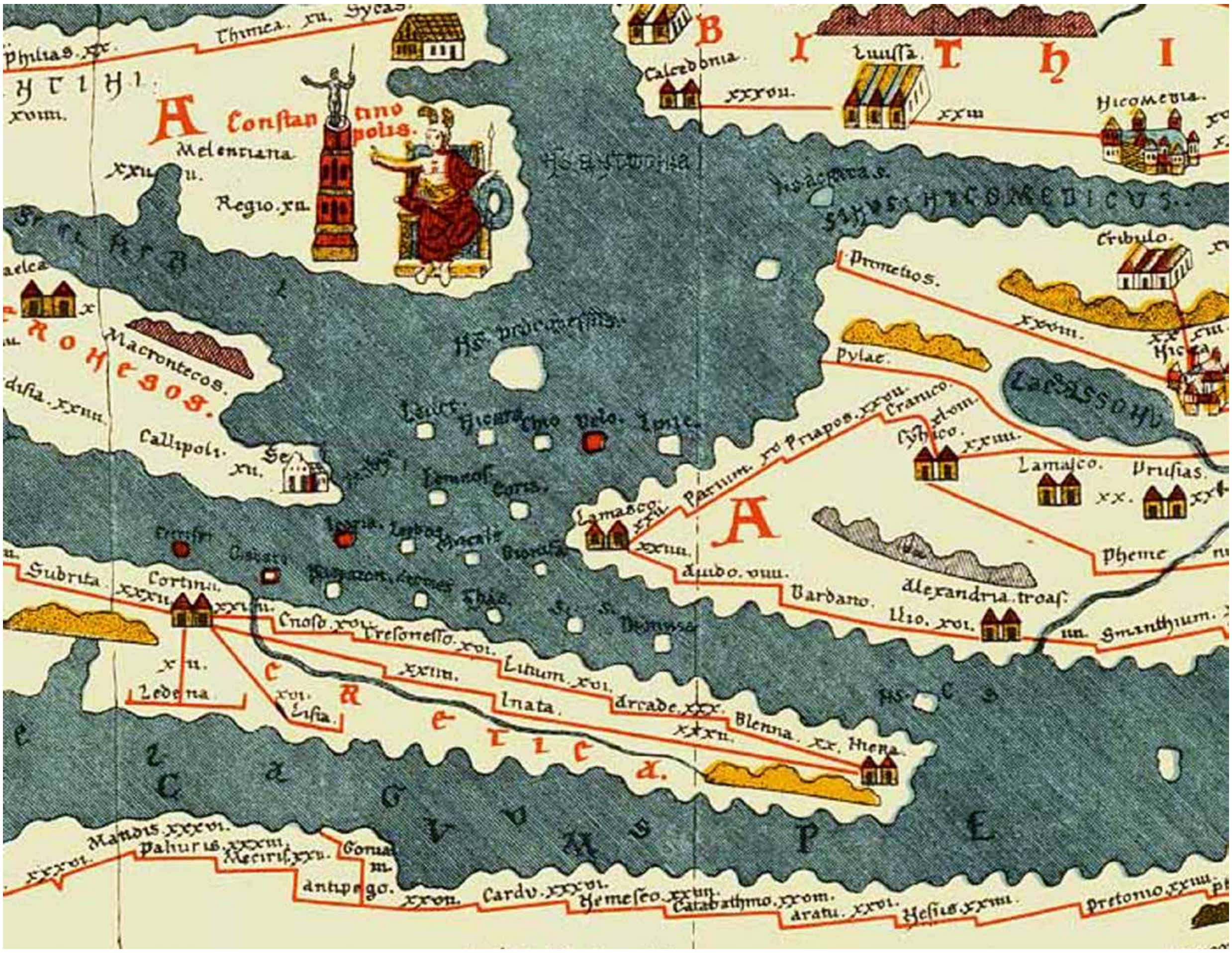


Figure 8. The Aegean section of the Peutinger Table with Crete to the bottom and Constantinople at the top; an island nearly directly in the middle is named Corss or Corsa next to Delo or Delos (Image courtesy of Austrian National Library).

er to control the strait. The 1st-century-CE origin of the map is contemporary with the base for a statue of Augustus found on the acropolis (*IG* XII, 6 2: 1205).

Antonine Itinerary

The *Antonine Itinerary* was prepared for the travels of an emperor during the 3rd century CE (Dilke, 1987: 235). The itinerary is divided into two sections, land and sea. In the sea section, there is a list of islands for *'In mari quod Thraciam et Cretam interluit'*, which includes the island '*Carsa*' (*Itinerarium Antonini Augusti* 1.3). Likely related to *Corsa* in the Peutinger Table, this may be a phonetic corruption of Korseai. The itinerary lists the route from Delos to Mykonos and passage to Ikaria as the main east-west crossing-route. The emperor for whom the itinerary was prepared – likely Caracalla in 214-215 CE (Dilke, 1987: 235) – would have encountered Fournoi while travelling along this route.

Ravennatis Anonymi Cosmographia

The *Ravennatis Anonymi Cosmographia*, among the most comprehensive sources, provides a compendium of place-names dating to *c.*700 CE and includes a list of Aegean islands (5.21). One island is named *Cyrise* or *Curse* depending on the source text (*Ravennatis Anonymi Cosmographia* 5.21.15). It is listed between '*Cirros*' (Syros?) and Delos, though the list is not necessarily in any geographical order. Pinder and Parthey posit it may be Cythera (1860: 395 n. 15), but Müller argues that *Curse* is a corruption of Korseai (1855: 499).

The name Korseai often appears corrupted, typically phonetically (*e.g. Corsia, Carsa, Corsa, Curse*). Phonetic corruption is common for place-names (Joyce, 1866). For example, boğaz in Turkish became boghas in French and Paphos in Greek became Bāfus in Arabic (Tournefort, 1718: 306; Rapoport and Savage-Smith, 2014: 476). In fact, a phonetic derivative of the name Korseai appears on 15th- and 16th-century-CE maps as *Cursia* (Ortelius, 1570: 146.1; Laurenbergio, 1650; Piacenza, 1688: 206).

The Stadiodromikon of the De Ceremoniis

The *Stadiodromikon* found in *De Ceremoniis aulae Byzantinae* (2.45) lists distances and locations from Constantinople to Crete. It follows a catalogue of military and ships from three expeditions (*De Cerimoniis* 2.678), suggesting that the *Stadiodromikon* is an itinerary for Constantine VII Porphyrogenitus's failed expedition to Crete in 949 CE (Huxley, 1976: 295).

> [From Constantinople] to Herakleia, 60 miles; from Herakleia to Tapeukia, 12 miles; from Tapeukia to Tenedos, 18 miles; from Tenedos to Mytilene, 100 miles; from Mytilene to Chios, 100 miles; from Chios to Samos, 100 miles; from Samos to Phournoi [Φουρνοι], 30 miles; from Phournoi to Naxia, 70 miles; from Naxia to Ios, 30 miles; from Ios to Thera and Therasia, 20 miles; from Thera and Therasia to Ta Christiana, 20 miles; from Ta Christiana to Dia, 80 miles; from Dia to Crete, 12 miles; in all 792 miles. (*De Cerimoniis,* 2.678)

While it is less than 4 miles between Fournoi and Samos at the narrowest point, it is approximately 30 miles from Pythagoreio on Samos to the village of Fourni-Korseai. It is unknown which locations were the start and end points of the day's sail, but the *Stadiodromikon* may be accurate when describing sailing distances rather than geographic distances. This would have been a half-day sail, which probably meant Fournoi was the staging point for a day's journey to Naxos. Significantly, sources dating to after the *Stadiodromikon* often use derivations of the name Φουρνοι, such as Fournoi, Furni, Fornelli, etc.

Piri Reis's Book on Navigation, portolans, and later maps

The *Book on Navigation* by Admiral Piri Reis was originally prepared for Ottoman Sultan Süleyman I in 1525 CE. The book became a compilation over several centuries as items were added. The 17th-century copy used in this study is currently in the collection of the Walters Art Museum (manuscript W.658) and it draws on geographical information from the 11th-16th centuries CE. Fournoi appears in maps of Europe, the Mediterranean, the Ikarian Sea (Fig. 9a), Samos, Ikaria (Fig. 9b), and Fournoi itself (Fig. 10) (Piri Reis, fol. 63b, fol. 64a, fol. 79b, fol. 81b, fol. 82b, fol. 83b).

The most significant is a map of the Fournoi Pass oriented with north to the right side (Piri Reis, fol. 82b; Fig. 10), which depicts the western half of Samos and the eastern half of Ikaria, together with the entirety of the Fournoi archipelago. It shows a large fleet of ships under way through the pass with the Etesian wind. It includes the islands of Fourni, Thimena, and Agios Menas, in addition to the small islands and islets of Thimenaki, Alatonisi, Makronisi, Plakaki, Petrokaravo, and Anthropofas. It even indicates the reef between Plakaki and Makronisi islands. The map shows two vessels without their sails set, denoting anchorages, at Kambi Fournon and Kamari. These two anchorages correspond with archaeological survey-finds and locations given by modern Mediterranean pilots (US Hydrographic Office, 1916: 304). Also notable is the watchtower at Drakano on Ikaria, which is a significant navigational feature in the pass.

Paul Kahle translated the Turkish text into German. The islands of Thimena and Fournoi are listed on the map as *gezīre-i-huršyd* and *gezīre-i-furna* (Kahle, 1926: 62). The section on Fournoi reads:

> [The isles of Huršyd and Furnaz] were in earlier times the residence of the monks, but are now empty spaces. The islands were inhabited in the historic period, however, and the remains of ruined buildings are known on the islands. The Islands, which we call Huršyd, the infidels call Qursije [Korseai], and Furnaz was called Lipis.[4] When it was necessary for one to sail to these islands with a large ship, the middle between the two islands is 40 fathoms deep. In any case one should wait until after the Island of Fourni to weigh anchor in the middle of the Bogaz [strait]. It is a good and nice harbour. If one lies the middle between the south-facing island and Huršyd, it is a good place to anchor. At the area between Huršyd and Furnaz across from Huršyd to the north, at a distance of an arrows flight there is a spring with drinkable water. This spring is not known by all. One follows the way to the north as the arrow flies to find this water. (Kahle, 1926: 62, English translation by Scott Tucker)

This account illustrates how Fournoi continued to be recognized as a safe anchorage into the Ottoman Period.

The Piri Reis map of Ikaria, oriented with north to the left side, also includes Fournoi (Fig. 9b). A ship is shown anchored at the Drakano roadstead, easily recognizable

4 It appears that the Ottoman text flipped the two Greek names, since in European maps of the period 'Lipsi' appears on the western island (Thimena) and 'Cursia' appears on the eastern island (Fourni) (Ortelius, 1570; Mercator, 1596: 269).

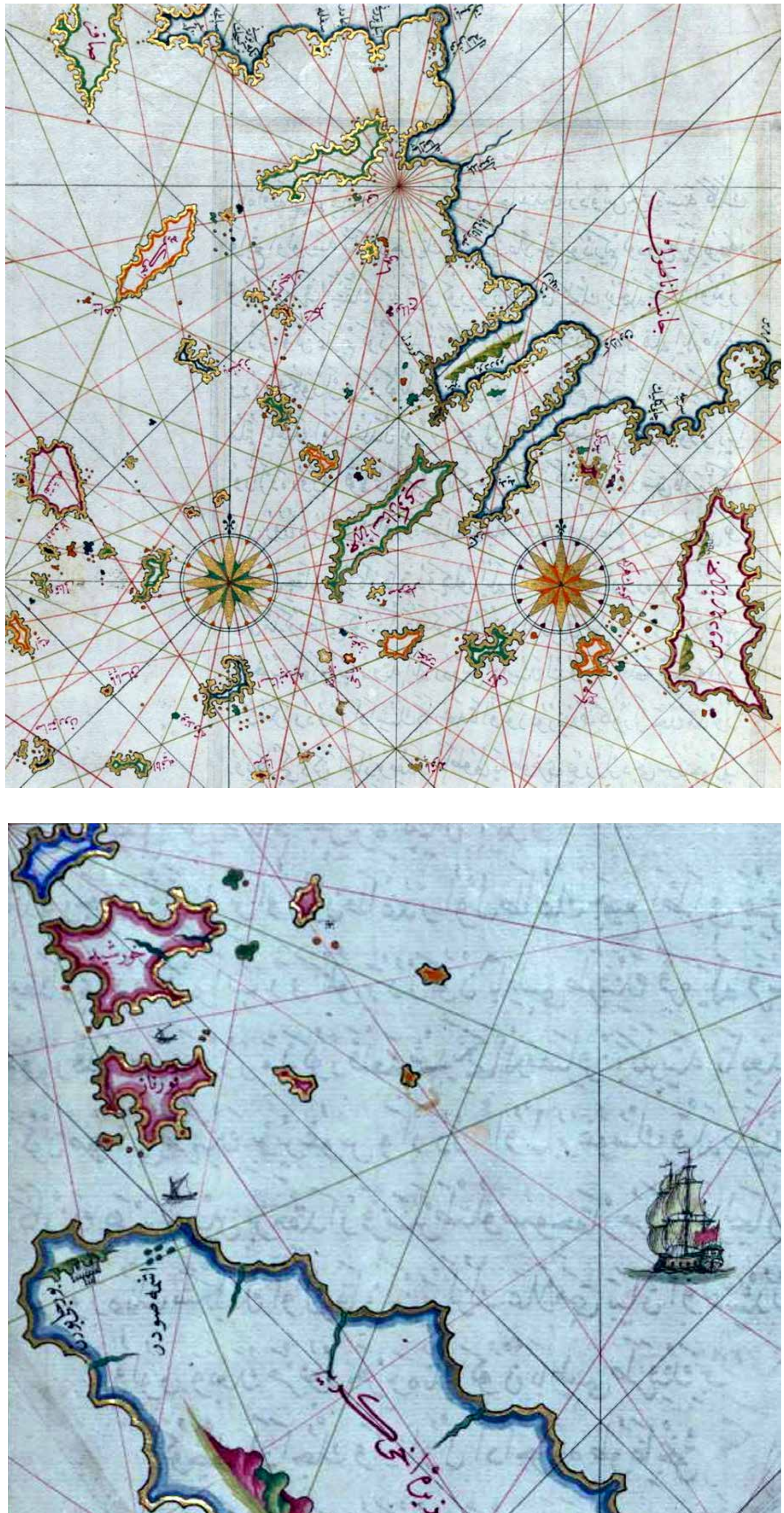


Figure 9. The Piri Reis map of the Ikarian Sea showing a) Fournoi between Ikaria and Samos and b) Ikaria with the tower at Drakano, a ship at anchor at the Drakano roadstead, and a ship at anchor at Fournoi at either Keramidou or Thimena (Image courtesy of Walters Art Museum).

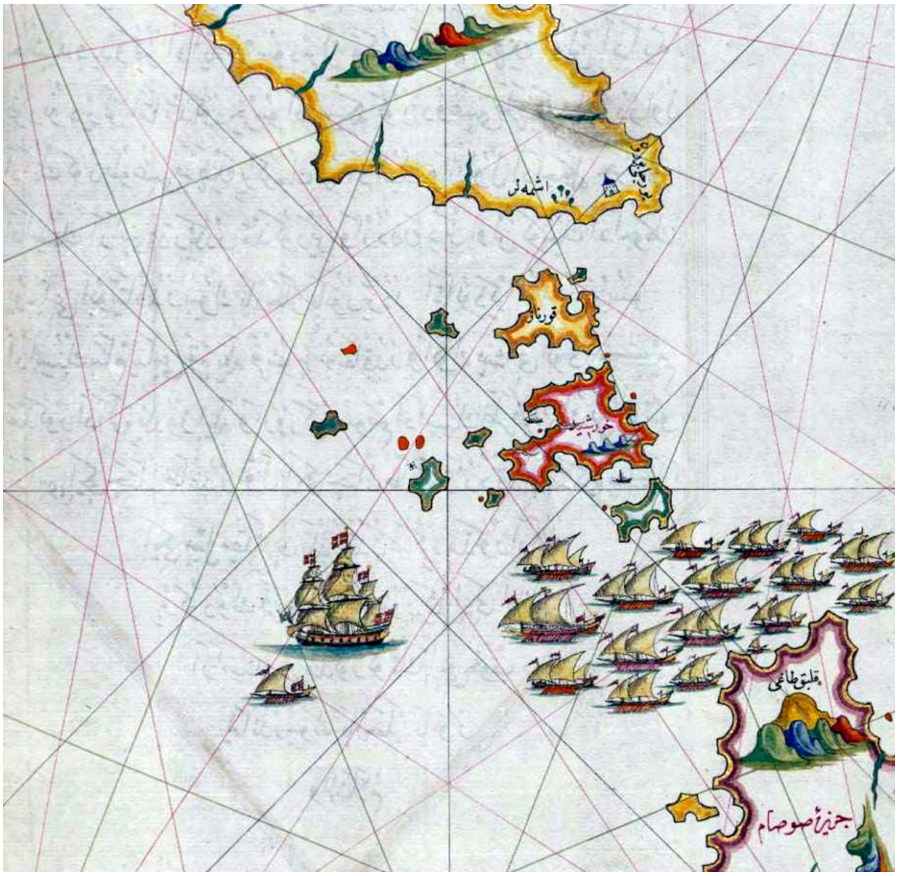


Figure 10. The 1525 Piri Reis map showing the Fournoi Pass (Image courtesy of Walters Art Museum).

from the depiction of the Drakano tower. Another ship is shown anchored at Fournoi, between the islands of Fourni and Thimena. This may be the anchorage that the previous text refers to. While the map is not precise, the anchorage appears to be the western bays of either Keramidou or Thimena harbours. The most likely bay is Keramidou, because it is protected from both the northwest and southerly winds. It remains a safe harbour today, though one in which it is necessary to anchor vessel bow and stern, perpendicular to shore. During the survey, the remains of an Ottoman-period ship were found here, which perhaps lends support to the interpretation that the bay featured is Keramidou.

Maps by European cartographers at this time likewise depict Fournoi. Of particular note are portolan charts, which were created for navigation (Campbell, 1987). In the collection of portolans known as the *Vallard Atlas*, Fournoi appears on the maps of Europe and of the Aegean (Vallard, 1547: 8, 15). On the Aegean map, the archipelago is labelled as 'Fornoli' and 'Crusia' (Fig. 11). The Vallard map is less precise than the Piri Reis map, but it nevertheless would have been useful for planning navigational routes. Then, around the 16th century CE, there was an increase in printed maps which are meant not for navigation, but rather as reference material. A Venetian map by Benedetto Bordone from 1528 has a simplistic depiction of the archipelago that would not have been useful for navigation (Bordone, 1528). It lists the name *Fornelli* and describes the archipelago in the Ikaria section. A map with a similar name and description is found in Antonio Millo's *Isolario* dating to 1582 (Millo, 2006). A map dating to 1570 by Abraham Ortelius (Fig. 12) uses the names *Fornoli* and *Cursia* (Ortelius, 1570), as does Gerardus Mercator's map of the Aegean from 1596 (Mercator, 1596: 269).

It is not until the modern period that accurate depictions of the archipelago appear in pilots and maps. In the 19th century, Clarke included a sketch of the Fournoi Pass among a list of key straits (Clarke, 1813: 367). The sketch shows the profiles of Fournoi and Samos as one approaches the channel from Patmos (Fig. 9), and it corresponds with his account of the tense passage through the strait and the concern of the ship's crew about pirates (Clarke, 1813: 245). Pilot accounts such as this were used by mariners until the close of the age of sail.

The inclusion of the pass in this account is an indication of the importance of Fournoi in Aegean navigation in the period just prior to the widespread introduction of powered vessels. Across time, periploi, itineraries, maps, ethnographic accounts, watchtowers, and archaeology all

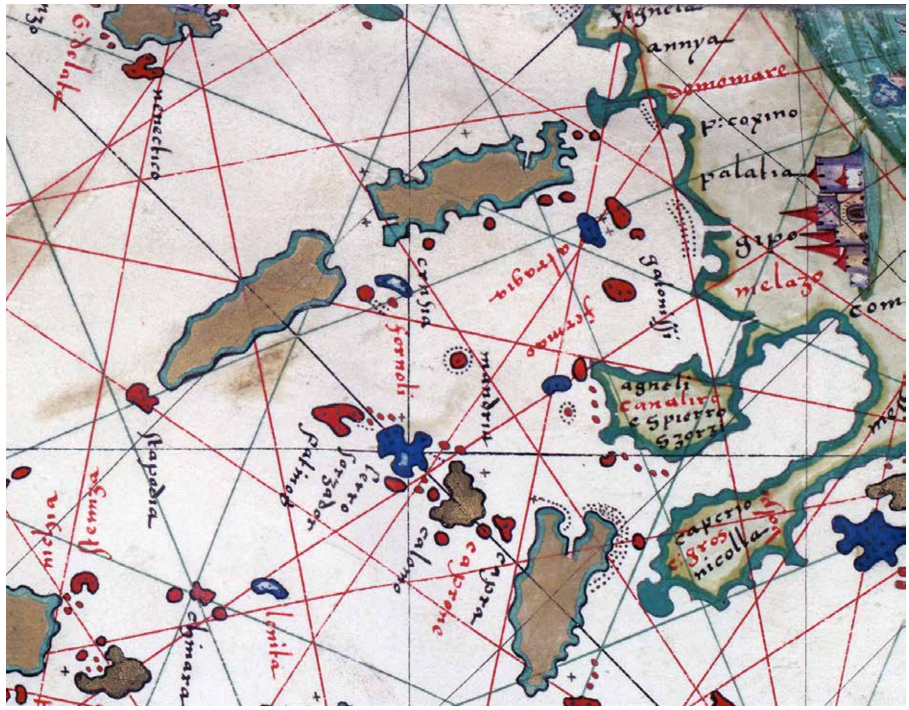


Figure 11. A portolan of the Aegean in the 1547 Vallard Atlas showing Fournoi listed as 'Fornoli' and 'Crusia' (Vallard, 1547: 15).

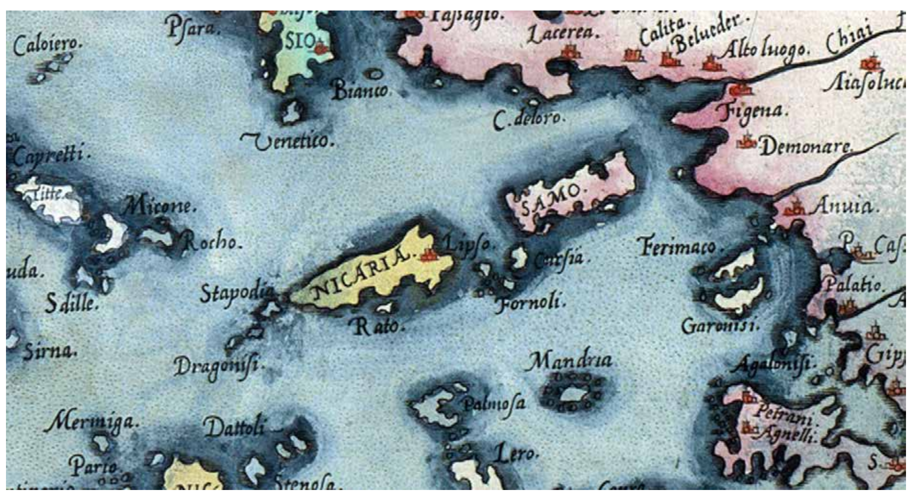


Figure 12. The Fournoi archipelago labelled as 'Fornoli' and 'Cursia', as well as the name 'Lipso', which is found on several maps, on a 1570 map by Abraham Ortelius.

indicate the navigational importance of Fournoi. The archipelago was situated along the primary north-south route through the Aegean, as well as a major east-west route.

The importance of the Fournoi Pass declined with powered vessels, construction of artificial harbours, and safe passage through the Samos Strait. But even today, the Mykonos-Ikaria passage is commonly used, though fewer vessels cast anchor at Fournoi.

Discussion

The sinking of more than 50 ships in the Fournoi archipelago is a function of the large quantity of ship traffic directed there by the Fournoi Pass chokepoint. North-south traffic in the eastern Aegean passed this way and Fournoi was located on one of two major east-west routes in the Aegean, a well-travelled route attested in every time period. As a result, the large number of shipwrecks at Fournoi cannot be attributed to the usual processes discussed in maritime archaeology. The archipelago was never home to major settlements, meaning these vessels were not part of a major trade-network feeding cities. Nor were they an abandonment complex for discarded vessels, or older vessels re-used as harbour structures as we find in major ports like Portus, Pisa, Yenikapı, or Thonis-Heracleion (Testaguzza, 1970; Sedge, 2002; Kocabaş, 2014; Robinson, 2018). With the exception of four sites, the vessels did not strike hidden obstructions like the island of Yassıada or the reefs of the Chios Strait. Instead, this is a site-type defined by the navigation landscape.

This is significant because it suggests this type of site can now be sought in other areas. Straits have already been studied in the context of chokepoints bounded by land, but rarely have chokepoints been discussed as created by the navigational environment through the convergence of land, winds, and currents. This means that large assemblages of ships lost while under way may remain to be discovered. Large abandonment assemblages have contributed greatly to our understanding of ship construction; however, these often comprise aged vessels discarded once past their prime. In contrast, the Fournoi assemblage comprises vessels lost during their use-lives. An assemblage of 50 wrecks provides more information than a lone wreck's information about trade and exchange based on its cargo: the spatial patterning of the sites at Fournoi reveals clues to navigation and sailing habits, because these vessels were neither loading nor unloading, but were operating underway.

Conclusion

While the Fournoi archipelago was not in the foreground of most major historical events in the eastern Mediterranean, the corpora of historical sources and maps, military structures, toponyms, and shipwrecks all suggest it was an archipelago of significance in the Aegean's navigational landscape prior to steam power. The identification of the Fournoi Pass as a maritime chokepoint is a significant discovery.

Chokepoints for powered vessels have been considered since Mahan's seminal work *The Influence of Sea Power upon History* (1890); now, however, following the findings from Fournoi, one must consider how significantly different the sailing navigational landscape is for powered vessels and for sailing vessels. The advent of steam power allowed vessels to use the central Aegean trough, a difficult place for sailing vessels, and the Fournoi Pass became less relevant. But there is little doubt that in the age of wind-powered vessels the Fournoi channel would have served as a constriction complying with Mahan's theory.

Ancient sailing vessels, with their shallower draught and reliance on the winds, would have had more chokepoints to contend with. It may be possible to identify areas similar to Fournoi. Gibraltar, the Dardanelles and Bosporus, Messina, and Kerch straits are obvious constrictions that have been studied in this regard, but Fournoi demonstrates that more-open regions can also become constricted – by islands, winds, and currents. Other sites of this type might be Croatia's Lošinj-Cres strait, Strait of Bonifacio, and the Flegrean Islands in Italy. Indications of frequent use may be found in the presence of fortifications to control traffic and significant piracy.

To conclude, historical sources, maps, ethnographic accounts, and environmental data indicate that there was a large volume of ship traffic in the area of Fournoi. The spatial patterning and temporal distribution of the shipwrecks at Fournoi show more than 50 ships wrecked due to a wide variety of individual causes, rather than a single cause. The archipelago is not a naturally dangerous place for ships; in fact, mariners appear to have preferred to use the bays of Fournoi for anchorage than those of nearby Ikaria or western Samos. The broad temporal span of the wrecks suggests that these vessels were not lost in a single event, but rather were a function of single-loss events, attributable to a variety of causes, over 25 centuries. The Fournoi shipwrecks are best understood in this navigational context.

Acknowledgements

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Istros, Black Sea Coast, Romania

A geoarchaeological perspective on the location of the harbour(s)

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Istros, founded during the 7th century BCE, is one of the oldest Greek colonies on the shores of the Black Sea. On the southern margin of the Danube delta, what was an ancient maritime city is now a landlocked archaeological site. Even though archaeological investigations have continued since 1914, the location of the harbour(s) remains unknown. Efforts to find a harbour are hindered by the complex geomorphological evolution of the Danube delta and by the long human occupation history of the site. However, a new perspective is offered by a geoarchaeological approach, combining coring with geophysical and archaeological investigations.

Keywords: Istros, ancient harbour, Black Sea, geoarchaeology, paleo-environment, coastal geomorphology.

Inhabited since the Neolithic, with traces of occupation since the Upper Palaeolithic, the Black Sea (Fig. 1) is a peculiar geographical unit, in which a variety of cultural environments developed, so it is almost impossible to speak about a 'collective culture of the Black Sea', in the way we speak of 'Mediterranean culture'. Nonetheless, both the Black Sea and the Mediterranean together represent the cradle of European culture, as their shores have provided favourable environments for human settlements since prehistory. Called Pontos Euxeinos by the Greeks, its shores were highly attractive and thus occupied early in the period of Greek colonization (8th century-5th century BCE), with Miletus the most active metropolis. On the western Black Sea coast, the present-day territory of Romania, numerous *poleis* and *emporia* were founded, among which the best known are Istros (Histria, Istria) – the topic of this paper – Tomis (present-day Constanța), and Callatis (present-day Mangalia). From the 1st century CE, the western Black Sea shore came under Roman and later Byzantine domination (Suceveanu and Barnea, 1991; Avram, 1998), and then passed, during the Middle Ages, under Genoese (Ciobanu, 1969; Balard, 1983) and later Ottoman (Brătianu, 1999) control. Remains of the succession of these various cultures are still visible and well preserved in many cases, including at Istros, as the area has been practically unoccupied during modern and contemporary periods, and so the taphonomic conditions are favourable.

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Figure 1. Satellite view of the Black Sea (Source: NASA).

Main aims

Our research aims to characterize the evolution of the landscape of Istros and to investigate the anchorage locations from the Archaic to the Late Roman Period. The area around Istros had a complex geomorphological evolution, at site level as well as at a regional scale. Additionally, the site's long occupational history creates a complex situation that makes it difficult to clearly identify structures and the position or positions of any harbours. This complicated setting requires a multidisciplinary approach, involving archaeology, history, geography, geophysics, and bio-sedimentology to: better contextualize the archaeological records; identify harbour structures; and characterize the environmental constraints and potential in the development of Istros.

Geoarchaeological research on the western Black Sea coast: state of the art

During the past three decades, geoarchaeological research on the Black Sea coast has been poorly implemented in comparison with the Mediterranean for various reasons including an overly conservative archaeological approach and a weak collaborative network between geosciences and archeo-sciences (Baralis *et al*., 2016: 4-5). However, in the past few years, a new research agenda has emerged. We are witnessing not only increasing collaboration between the various disciplines, but also international participation, which offers a solid framework for multidisciplinary research. In this respect, we can mention the Archéologie du Delta du Danube geoarchaeological research project, started 10 years ago, which studies the paleoenvironmental changes at the Neolithic site of Taraschina, located in the middle of the Danube delta (Carozza *et al*., 2010). There was also the Pont Euxin project (ANR 2009-2013), headed by Alexandre Baralis, which analysed the spatial organization of Greek colonies on the western Black Sea coast with special regard to Argamum (Orgamé, Romania) and Apollonia Pontica (Bulgaria) (Baralis *et al*., 2010; Bony *et al*., 2013; Baralis and Lungu, 2015). In 2015-2016, another multidisciplinary research programme, headed by Christophe Morhange, titled Geoarchaeology of Mediterranean deltaic environments. A comparative approach, was funded by A*MIDEX-GEOMED. It saw multidisciplinary research in four archaeological sites on the Romanian coast: Halmyris, Babadag, Enisala, and Istros (Fig. 2) (Giaime, 2016; Bivolaru *et al*., 2018; Giaime *et al*., 2018). The latest multidisciplinary project, initiated in 2016, is Environmental Change and Geoarchaeology in the Danube Delta since 6000 years, which focuses on the development of several archaeological sites in direct connection with the evolution of the Danube delta (Fig. 2).

At a national level, a series of interesting geomorphological investigations with a special focus on Istros has been undertaken in the Danube delta by a team of geomorphologists from the University of Bucharest (Preoteasa *et al.,* 2012; Vespremeanu-Stroe *et al.,* 2013).

Despite all these projects, no ancient harbour on the Romanian Black Sea coast has been identified with certainty. Still, we have some indications for: possible harbour structures at Orgamé (Bony *et al*., 2013; 2015); a

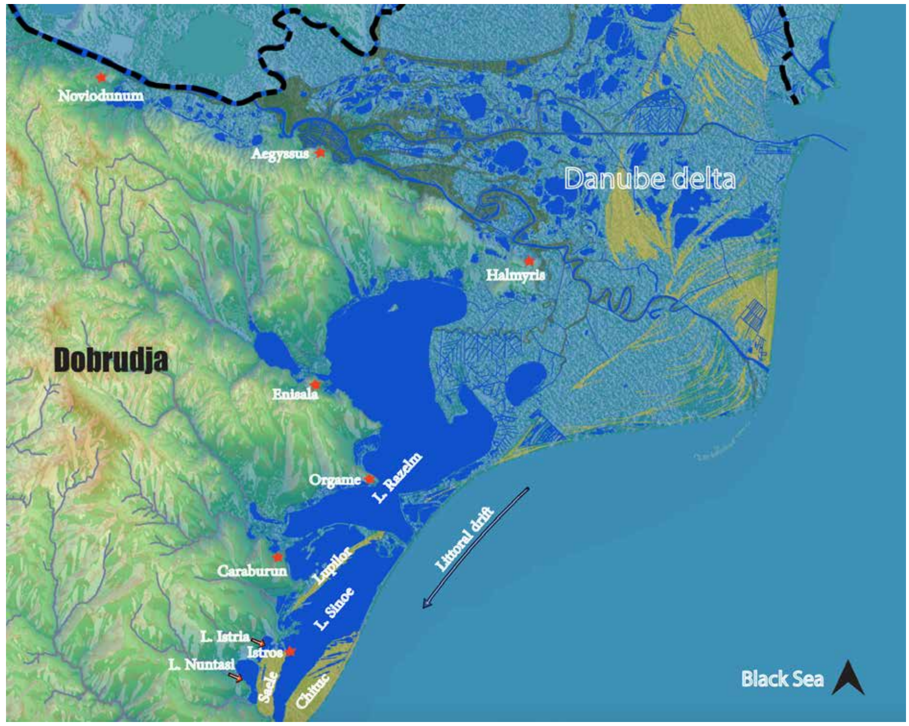


Figure 2. Istros and Danube delta localization within Dobrudja region. Present-day Dobrudja was part of the historical region of Scythia until the 1st century CE when it became Moesia Inferior under Roman rule (Credit: with permission after Stănică and Honcu, 2017. A. Bivolaru).

fluvial harbour at Halmyris (Giaime, 2016; Giaime *et al.*, 2018); and a harbour basin at Istros (Höckmann *et al.*, 1998; Bivolaru *et al.*, 2018). Only further geoarchaeological investigations can shed light on these preliminary discoveries.

Methodology

Our research is the first holistic approach undertaken at Istros, bringing together archaeology, coastal geomorphology, and geophysics. Our paper describes the results from two drilling campaigns, followed by vertical gradient magnetometry and ground penetrating radar (GPR) investigations, and archaeological excavation. The present scientific approach is based on field and laboratory work and applies procedures and techniques relevant to a high-resolution paleo-environmental reconstruction and ancient harbour-basin identification. Details of the use of each method are presented in the following paragraphs.

Geographical setting

The Black Sea is the biggest anoxic basin in the world with a surface area of 423,000 km^2 of which 90% is the deeper basin, with oxygen completely absent starting at 190-200 m depth. After the reconnection with Mediterranean Sea *c.*9000 BP (Soulet *et al.*, 2011), the Black Sea and Mediterranean responded synchronously to glacio-eustatic changes (Brückner *et al.*, 2010). The Black Sea coastline is sinuous, with few promontories running offshore and numerous gulfs. The western coast is largely lowland with few cliffs, and beach-ridge plains separate the lagoons (*limanuri*) from the sea. The western Black Sea has a wave-dominated coast, a condition enhanced by the very low tidal range of 0.18 m (Medvedev *et al.*, 2016). The most important geomorphological feature of the western Black Sea coast is the Danube delta, the second largest delta in Europe, which is an active factor in shaping the shoreline. The Danube delta defines the mosaic-like morphology of the northwestern Romanian shore. The western part of the delta is characterized by a flat area of fluvial and lagoonal origin with a series of levees, while its southeastern part is constituted of marine sand bars, coastal dunes, and shallow lagoons.

Geomorphology of Istros' area

Istros is located in the Dobrudja region, in the Razelm-Sinoe lagoon system on the southernmost beach-ridge unit of the Danube delta (Fig. 2). The Vadu-Istros area is at the end of a littoral cell, and so is strongly affected by sedimentary deposition, as it acts as a trap for the sediments. In the context of general sea-level stabilization since 6000 BP and deltaic progradation (Anthony *et al.*, 2014), the area has seen extremely important geomorphological changes and is defined by beach-ridge plains such as Chituc and Saele (on which Istros is located), coastal barriers (Lupilor), and shallow lakes (Sinoe to the east, Istria and Nuntași to the west) (Fig. 2).

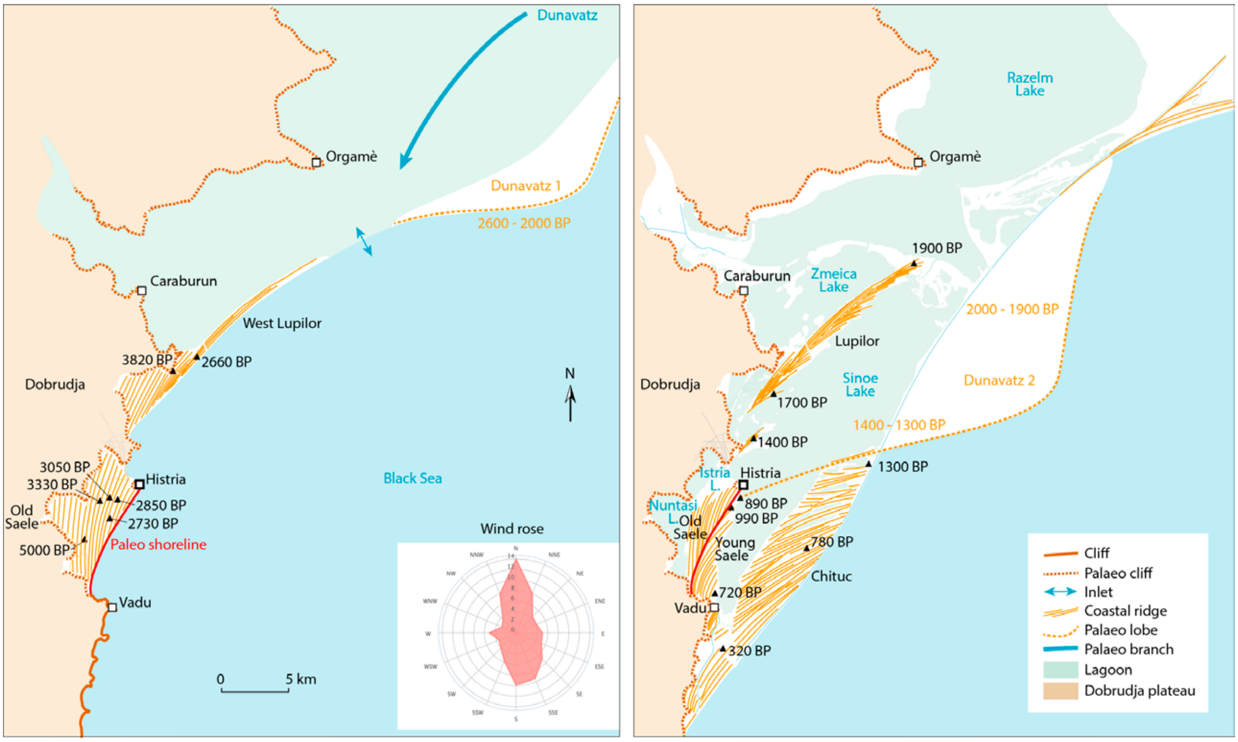


Figure 3. Geomorphological evolution of the area surrounding Istros since 5000 BP. The evolution of the Lupilor, Saele, and Chituc beach-ridge plains is directly related to the change in Dunavatz lobes (Modified after Vespremeanu-Stroe et al., 2017 by P. Pentsch).

The region around Istros has seen a lot of subsidence, notably on the Romanian shoreline where it stands at 4 mm per year (Polonic *et al.*, 1999; Vespremeanu-Stroe *et al.*, 2013). As such, under the influence of neo-tectonism and eustasy, archaeological layers dating to the period of Greek colonization can be found at a depth of 4-5 m (Dimitriu, 2010).

The Danube delta sedimentary input and the strong northern longshore current both play a role in the 'dead-end' of the littoral cell, typified by coastal progradation – the advance of the land into the sea.

The deltaic input and the littoral drift created the Saele beach-ridge plain, which is 9.5 km long, and 3 km wide (Fig. 3). Saele is made up of two distinct geomorphological units: Old (West) Saele and Young (East) Saele (Hanganu, 2012: 58-60; Preoteasa *et al.*, 2013: 566; Vespremeanu-Stroe *et al.*, 2017: 545-546). The beach-ridge plain of Old Saele is Optically Stimulated Luminescence (OSL)-dated to *c.*1350-850 BCE and is almost 2 km wide (Hanganu, 2012: 58-60; Preoteasa *et al.*, 2013: 566). It connects the continent to the greenschist island where Istros' Acropolis is located. It has continuously and mistakenly been labelled a tombolo since so-termed by Vasile Pârvan in 1915, but none of the geomorphological processes involved in the formation of a tombolo is present here.

The Old (West) Saele ridge existed when Istros was founded – as attested by radiocarbon and OSL ages (Hanganu, 2012; Preoteasa *et al.*, 2013; Bivolaru *et al.*, 2018; Vespremeanu-Stroe *et al.*, 2017), as well as by the archaeological indicators, such as archaic structures built directly on the sand. Istros lost its access to the sea when the Young Saele and Chituc beach-ridge plains formed as a strandplain. Although their development is a long-term process, these coastal ridges are younger than previously thought, as the OSL dates show (Vespremeanu-Stroe *et al.*, 2016). The dating indicates that the evolution of the Young Saele-Chituc strandplain took place 1300-720 BP (Vespremeanu-Stroe *et al.*, 2013, Vespremeanu-Stroe *et al.*, 2016).

The beginning of the Young Saele-Chituc formation corresponds to the second half of the 7th century CE, when Istros was abandoned. However, the city's decline cannot be related only to a single long-term geomorphological process. Numerous cities and fortresses in the Dobrudja region were abandoned in the 6th-7th century CE amid a generally unstable geopolitical situation; at Halmyris, for example, the same association of environmental and geopolitical factors led to its abandonment in the 7th century (Giaime *et al.*, 2018).

In modern times, the dams built on the Danube (especially the Iron Gates I and II dams), have caused the

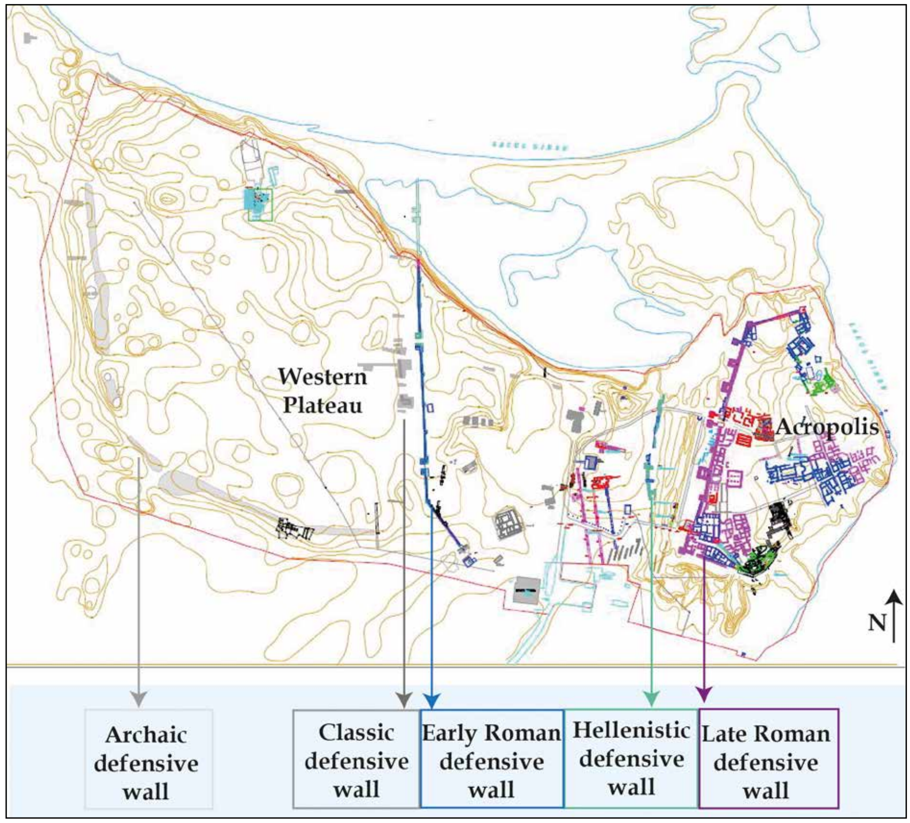


Figure 4. Main archaeological structures corresponding to the five occupational phases. Modified after Mehedințeanu 2003 (Credit: A. Bivolaru).

river's sedimentary load to fall from a multi-annual average value of 50 million tonnes per year to less than 25-35 million tonnes per year (Panin and Jipa, 2002). Therefore, the sandy barrier separating the Razelm-Sinoe area (Istros included) from the Black Sea has begun to erode (Dimitriu, 2010).

Istros: historical and archaeological context

Istros was a Milesian colony, founded during the second half of the 7th century BCE in the context of the Great Greek colonization. The city is one of the oldest Greek foundations on the Black Sea coast and was inhabited without interruption for 1300 years until the 7th century CE when it was abandoned as a result of general socio-political instability in the area. From its foundation, the city comprised two nuclei, the Acropolis and the Western Plateau (Fig. 4). Istros's long history can be divided into five main periods:

1. The Archaic period (7th century-6th century BCE): layers from this period have been identified on the Acropolis, where the Sacred Area is located (Alexandrescu, 2005; Avram and Bîrzescu, 2012; Avram *et al.*, 2013), as well as on the Western Plateau, where habitations (Dimitriu, 1966) and pottery kilns (Coja and Dupont, 1979: 18-33) were discovered. Along with these, a segment of the archaic defensive wall was discovered on the western part of the plateau (Coja, 1986: 98; Angelescu, 2005: 57-64; Suceveanu, 2005) (Fig. 4). Structures dating from this epoch were also identified in the centre and the southern part of the Acropolis (Bottez, 2015). Interestingly, there are no archaeological features from the Archaic period between the Classical defensive wall and the Western Plateau, a distance of 450 m.

2. The Classical period (5th-4th century BCE) was characterized by a flourishing economy. Around 450 BCE, Istros started to mint its own coins (Talmațchi, 2011). In addition to the previous occupation areas, new ones were built on the Western Plateau, as well as a new defensive wall for the Acropolis that encompasses a smaller area than the archaic wall (Fig. 4) (Angelescu, 2005: 65-71).

3. The Hellenistic period (4th century-1st century BCE), although initially prosperous, was later marked by geopolitical instability. The city was engaged in local conflicts (the war between Scythians north of the Black Sea and the northern Thracians), as well as regional (the wars between the Hellenistic kingdoms) (Pippidi, 1967). From the early 4th century BCE, a

double defensive wall was built in Istros; one wall protected the Acropolis and enclosed a surface of about 10 hectares (Preda and Doicescu, 1966), and the other followed almost the same trajectory as the archaic wall (Fig. 4) (Angelescu, 2005: 70).

4. The Early Roman period (1st-3rd century CE) marks the end of Istros's autonomy. Despite this, the city became prosperous once again in the 2nd century CE, as demonstrated by its archaeological material. Another defensive wall was built (Fig. 4) (Florescu and Cantacuzino, 1954), west of the Hellenistic one, while the Sacred Area was abandoned and a residential district built over it (Avram *et al.*, 2013). During this period, the city gained two bath complexes (Suceveanu, 1982), as well as the civil basilica in what is now called the Main Square. After a period of stability ensured by Emperor Trajan, Istros was confronted with increased barbarian pressure, starting with the Marcomanic Wars during the reign of Emperor Marc Aurelius. The peak of this conflict was during the second half of the 3rd century CE, when a Gothic invasion caused the city's most violent destruction (SHA, *Max. Balb.* 16.3 mentions the *excidium Histriae*) (Doruțiu-Boilă, 1985: 133-134).

5. The Late Roman Period (4th-7th century CE) represents the last phase of occupation at Istros. After the destruction in the 3rd century CE, a new, last defensive wall was built enclosing about 7 hectares (Fig. 4) (Domăneanțu, 1990). A final period of prosperity is attested archaeologically during the 6th century CE (Suceveanu, 2007). Then the city fell into decline, ending in its abandonment.

The problem of the ancient harbour(s): archaeological indicators and contemporary research

Even though some secondary archaeological indicators attest the existence of a harbour, no archaeological structures yet discovered at Istros can be clearly related to a typical component of a harbour complex (breakwaters, moles, quays, etc.).

Epigraphic and numismatic sources

To date, we have 12 inscriptions mentioning the existence of the harbour (ISM I, nos. 10, 20, 25, 28, 32, 48, 64, 65, 112, 173, 178, and 179). The oldest is dated 300-200 BCE and the most recent in the 2nd century CE. Most of the inscriptions, including the one from the 3rd century BCE, are proxeny decrees (Cojocaru, 2016), which grant non-citizens unlimited access to the harbour. One inscription from the 2nd century BCE mentions the existence of an Istrian fleet that offered naval support to Apollonia Pontica (present-day Sozopol, Bulgaria) in its war with Messambria (present-day Nessebar, Bulgaria). A second brief mention of the Istrian fleet is made in another inscription from the 3rd century BCE. The existence of a fleet implies the existence of ship-maintenance structures adjacent to the harbour, such as shipsheds (Blackman *et al.*, 2013: 3). Accordingly, one can presume the existence of such structures at Istros (Höckmann, 2001).

The inventory of inscriptions from the Hellenistic period ends with a secondary reference to the harbour. It is dated to the 2nd century BCE and mentions the cult of Aphrodite Pontia. Considering ancient sources (Demetriou, 2010: 70-81) and archaeological discoveries, the temples and sanctuaries of Aphrodite Pontia are located in the vicinity of harbours (Pippidi, 1983; Demetriou, 2010). Pausanias informs us of the existence of temples dedicated to Aphrodite Pontia on the shores of Epidauros, Limera, Tainaros, Aigion, and Patras (Demetriou, 2010: 70-81). The cult of Aphrodite with her marine epicleses (Pontia, Euploia, Pontica, Nauarchis, and Ourania) has also been attested at Olbia, Pantikapeion, Phanagoria, and Cyzicus (Pippidi, 1983) (Fig. 1).

The last two inscriptions, dated in the 2nd century CE, relate to the harbour and mention the 'remaking' of the harbour under the supervision of a Pontarch. We can interpret 'remaking' as a series of dredging and maintenance works to ensure access to a harbour (Pippidi, 1983: 314), or to relocate it, both due to siltation.

Another indirect proof of the harbour(s) existence is the discovery of two coins, dated to the reigns of Elagabalus (218-222 CE) (Pippidi, 1967: 229; Preda and Nubar, 1973: No. 719, 130; Varbanov, 2005: No. 658) and Alexander Severus (222-235 CE) (Fig. 5), (Severeanu, 1931: 16-17; Varbanov, 2005: No. 668). On their reverse is a rectangular tower, which can be interpreted as a lighthouse, along with a river god (Danubius). Analogies for this representation are found in the Roman world

Figure 5. Roman coin depicting Alexander Severus on the obverse, the god Danubius and a possible lighthouse on the reverse (Severeanu, 1931: 16-17; Varbanov, 2005: no. 668). (Credit: I. Varbanov).

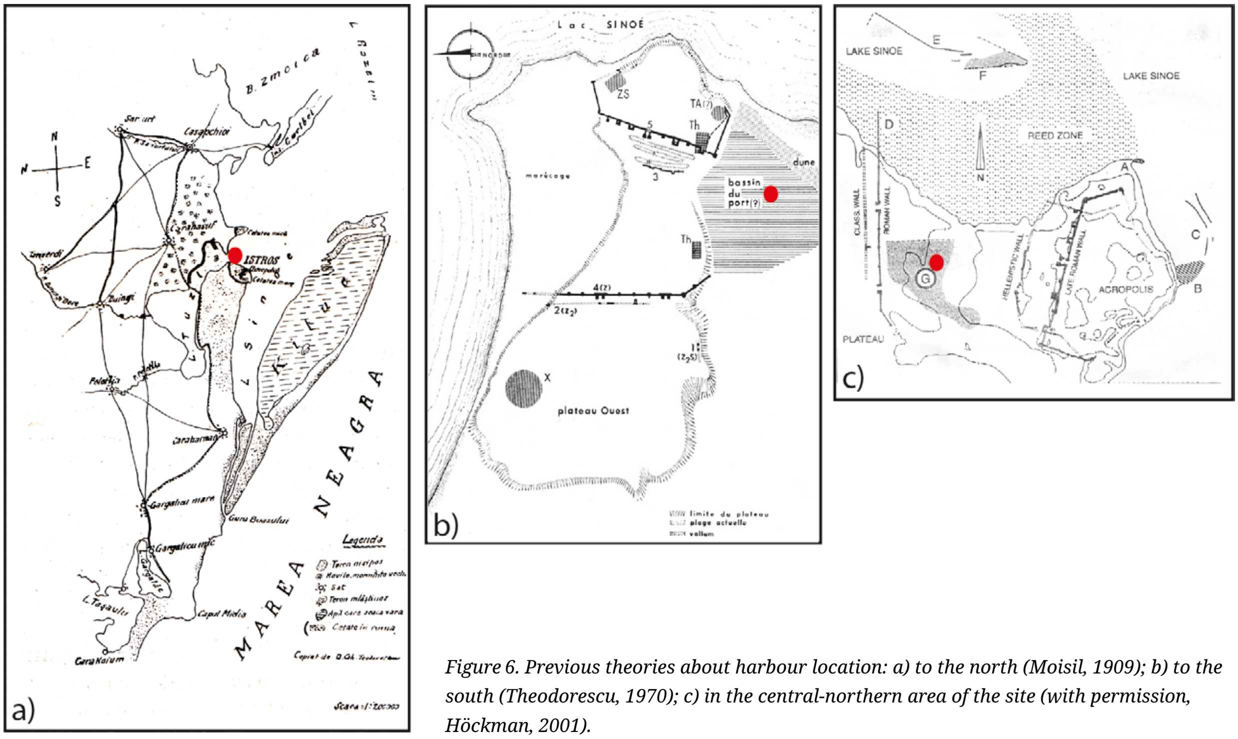


Figure 6. Previous theories about harbour location: a) to the north (Moisil, 1909); b) to the south (Theodorescu, 1970); c) in the central-northern area of the site (with permission, Höckman, 2001).

(Redde, 1979), and a similar parallelepiped tower with three levels and lateral openings is attested in Coruña, Spain (Dabîca, 2011: 217).

Modern studies

The problem of the ancient harbour(s) at Istros has attracted the attention of researchers for more than a century. Constantin Moisil (1909) remarked on a possible submerged harbour in the northern side of the site (Fig. 6a). In a report of 1915, Vasile Pârvan, the archaeologist who started excavations at Istros, mentioned the existence of a possible harbour basin in the small natural depression located in the middle of the site. In the rainy season, this became a shallow, marshy area with access from the north; when it dried, it left a layer of salt – hence the name Sărătură (trans. salted area) (Pârvan, 1915). In an article in 1916, Pârvan presented a series of structures located north of the site, which he interpreted as harbour structures (Pârvan, 1916: 198). No precise geographical indications, drawings, or maps were offered by the author, so it is hard to pinpoint these structures. In the 1950s, Vasile Canarache suggested the harbour could be in the northern part of the site (Canarache, 1956), founding his theory on the discovery of a 200 m-long structure, oriented SW-NE, in Lake Sinoe. In the 1970s, a new theory was elaborated by Dinu Theodorescu who, based on indirect archaeological evidence, placed the harbour on the southern side (Fig. 6b) (Theodorescu, 1970). Considering the information provided by aerial photos, Alexandru Ştefan supported Theodorescu's theory about the harbour's position to the south, but he did not exclude the possibility of a NE location (Ştefan, 1987), a theory also advocated by Octavian Bounegru (1988). Bounegru (2003) postulated the possibility of two harbour basins, located south and north. In the light of geophysical investigations, Olaf Höckmann (Höckmann *et al.*, 1998; Höckmann, 2001) postulated that the harbour was in the central-northern side of the site (Fig. 6c), without denying the probability of a southern location as well. Marcu Botzan (1989) suggested a 'race to the sea' – that the harbour was relocated in response to the coast's progradation – basing his theory on a series of ample fluctuations of the Black Sea's mean level between the 9th century BCE and the 7th century CE. Although a possible relocation of the harbour basin should not be rejected, strong regressions and transgressions affecting the Black Sea mean level have been ruled out by recent studies (Porotov, 2007; Brückner *et al.*, 2010; Fouache *et al.*, 2012).

In search of the harbour(s): the current multidisciplinary approach

The geomorphological situation and the harbour(s) issue

The dramatic metamorphosis of the landscape around Istros during the past two millennia hinders the discovery of any harbour, harbours, or harbour basins. Therefore, we must understand the geomorphological evolution of the landscape – the aforementioned beach-ridge plains (Saele and Chituc) – and of the Danube delta, the dominant factor in this transformation. In recent years, a team led by Alfred Vespremeanu-Stroe (University of Bucharest) has conducted a series of geomorphological research missions in and around Istros, providing new insights. The researchers have identified a former deltaic lobe in front of the current Periteașca beach-ridge plain (Fig. 2). The lobe was created by a palaeo-branch of the Danube, the Dunavatz, from around 2600 BP (Fig. 4), (Vespremeanu-Stroe *et al.*, 2013; Vespremeanu-Stroe *et al.*, 2017). Around 2000-1900 BP, the Dunavatz changed direction, moving southwards and creating another deltaic lobe, 16-20 km south of the first, abandoning the first lobe (Fig. 3) (Vespremeanu-Stroe *et al.*, 2013; Vespremeanu-Stroe *et al.*, 2017). The new deltaic lobe grew fastest around 1400-1300 BP, extending downdrift close to Istros's northern coast (Fig. 3) (Hanganu, 2012: 65-67; Preoteasa *et al.*, 2013: 566-569; Vespremeanu-Stroe *et al.*, 2017: 545). A high sedimentary input has been observed after 1400-1300 BP, related to the erosion of the second deltaic lobe. The increase in the supply of sediment led to the formation of the Young (West) Saele and the Chituc strandplain (Fig. 3).

The different alignments of Young Saele (east-west) and Old Saele (northwest-southeast) can be explained by the rapid silting-up of the littoral cell, caused by the erosion of the lobe and by local neotectonism (Hanganu, 2012: 65-67; Preoteasa *et al.*, 2013: 566-569; Vespremeanu-Stroe *et al.*, 2017: 545). The neotectonism caused the emergence of a contact ridge between Old Saele and Young Saele, which explains the age hiatus between the two geomorphological units (Fig. 3) (Hanganu, 2012: 103-104; Preoteasa *et al.*, 2013: 567-568). This ridge maintained Istros' access to the sea until the 6th century CE. Furthermore, neotectonism is at the origin of the Sinoe, Istria, and Nuntași lakes. Lake Sinoe was formed after the subsidence of the Young Saele-Chituc strandplain, which evolved as a geomorphological feature at least 950-660 BP (Hanganu, 2012: 70; Preoteasa *et al.*, 2013: 567). The new data, especially the OSL ages, which show the same chronology (1300-700 BP) for Young Saele and Chituc (Hanganu, 2012: 69-70; Preoteasa *et al.*, 2013: 569; Vespremeanu-Stroe *et al.*, 2017: 545), oppose previous theories that suggest the formation of the Chituc beach-ridge plain caused the transformation of the former Sinoe gulf into a lake (Bleahu, 1963; Coteț, 1966; Panin *et al.*, 1983; Panin, 2003).

Coring campaigns and bio-sedimentological indicators

Drilling campaigns and bio-sedimentological analyses were undertaken to define the paleoenvironmental evolution of the site and to reconstruct the location of the harbour or harbours in relation to the past natural conditions. The coring campaign used a percussion corer (Cobra TT). The first coring campaign took place at Istros in 2015, when four long, continuous cores were extracted (Fig. 7). In 2017, using the same technique, an intensive drilling campaign yielding 23 long continuous cores was undertaken. Extraction tubes 40-70 mm in diameter were used. The cores were 2-7 m long. Bedrock was reached at 2-2.5 m below the surface on the southern side of the greenschist island, and up to 5 m below the surface on the northern side. The cores were altitudinally benchmarked relative to the present local Black Sea standard sea-level using a GPS. Core description (texture, macrofauna, organic remains) and sampling were undertaken during fieldwork. The sedimentological description (composition, texture, and colour) and the sampling of cores were carried out directly in the field. Depending on the sediment, the sampling was performed at intervals of 50-100 mm. Bio-sedimentological analyses were undertaken in the sedimentology laboratory of the CEREGE, based on the methodology detailed in Marriner and Morhange (2007). The general sediment texture, including gravel (>2 mm), sand (50 µm-2 mm), and silty clay (smaller than 50 µm) fractions, was determined by wet sieving. Ostracoda were picked from the >160 μm fraction and identified to species level, when possible, using reference manuals (Athersuch *et al.*, 1989; Meisch, 2000) and scientific papers (such as Frenzel and Boomer, 2005; Opreanu, 2005; Briceag and Ion, 2013; Williams, 2012; Salel *et al.*, 2016). Macro-fossils larger than 1 mm were also identified and assigned to assemblages according to the Mediterranean classification system (Doneddu and Trainito, 2005; Poppe and Goto, 1991; 1993).

The chronology is based on 30 Accelerator Mass Spectrometry (AMS) radiocarbon determinations performed at the Poznan Radiocarbon Dating Centre and at Ro-AMS (IFIN-HH, Bucharest), on charcoal and marine shells (Table 1). We calibrated the ages using Calib 7.1 (Stuiver and Reimer, 1993) and IntCal13 and Marine13 curves (Reimer *et al.*, 2013). For dated shell samples we used a local marine reservoir age of 498 ± 41 14C years BP years (Siani *et al.*, 2000). The discovery of numerous fragments of ceramics allowed us to obtain a high-precision relative chronology for the stratigraphic units through the study of the ceramics typologies. These results confirmed the robustness of the radiocarbon chronology.

Based on the bio-sedimentological analysis of 13 cores (Fig. 8), on chronostratigraphy and in-field observations, we propose a preliminary model for the location of the harbour basin. An initial anchorage, corresponding to the Archaic period, might have been possible on the southern part of the island, on a protected beach, taking into account the NE direction of the storm winds

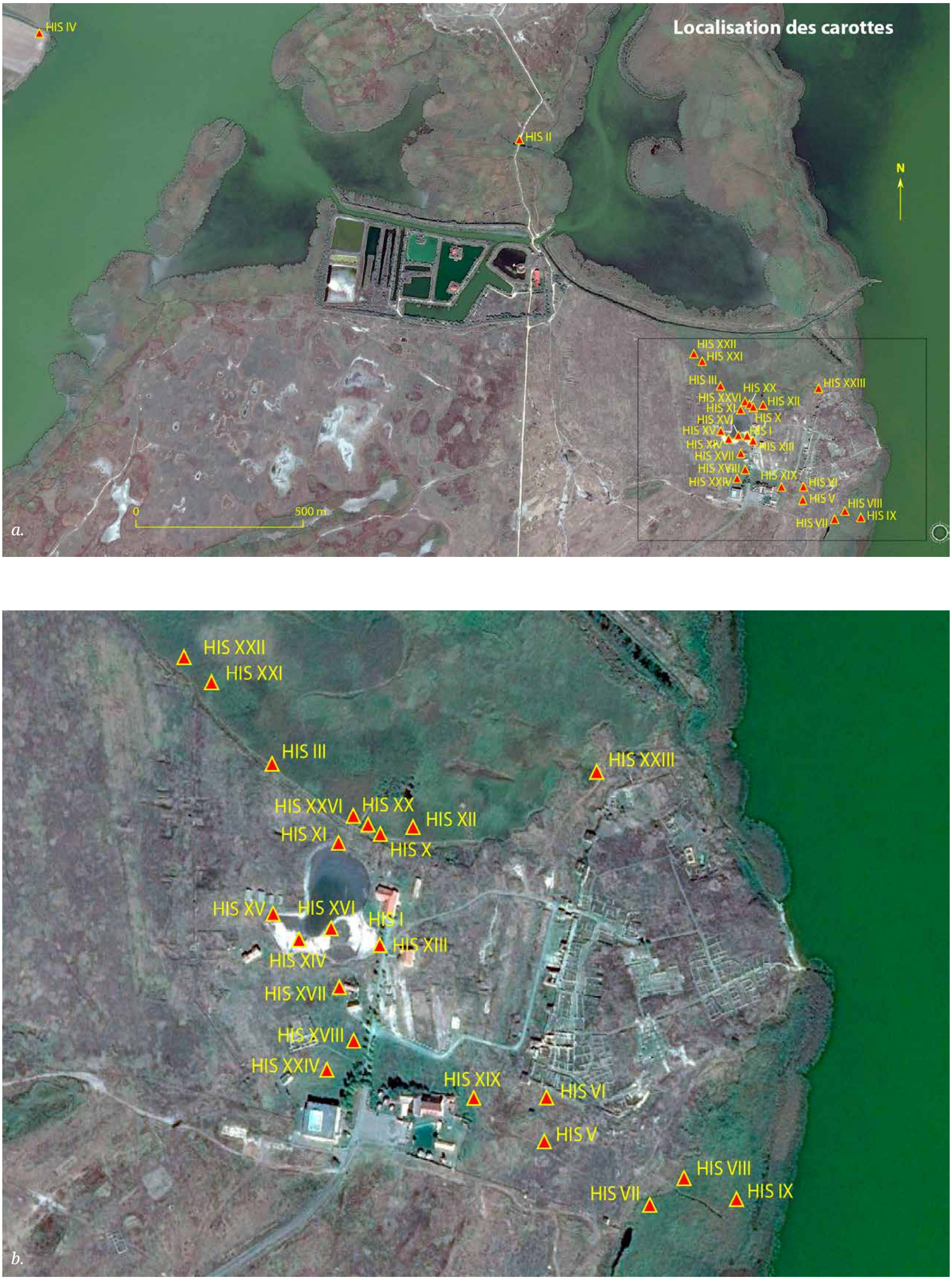


Figure 7. a) Location of coring; b) core locations on the archaeological site (Credit: P. Pentsch).

(Zăinescu *et al.*, 2017), as well as the prevalence of northern wind. The possibility of a second anchorage beach on the northern side of the island is not excluded, as the bio-sedimentological composition of cores HIS XXIII and of the upper unit of HIS XXVII, located in its northwestern corner, is similar to that of cores taken in its southern part (HIS V and HIS IX) (Fig. 8). This sedimentological fraction is defined by coarse yellow bioclastic sand, that together with the low abundance of biological indicators, translates to an energetic environment, such as an exposed beach. A finer sedimentary sequence, characterized by fine micaceous grey sands and silts, was identified in the central-northern part of the site (cores HIS I, HIS XIII and HIS XV). This calm and protected depositional environment, facilitating the accumulation of fine sediments, could also correspond to a harbour basin. Access to the open sea could have been realized via a southern channel, as indicated by the bio-stratigraphy of cores HIS XVIII and HIS XIX. Istros might have had one protected occidental harbour basin – a cothon-type harbour (Carayon, 2005) – and two anchorage areas: southern and northern (Fig. 9). This urban configuration was possible until the beginning of the Late Roman Period (4th century CE), when the city's surface shrank, occupying only the Acropolis (7 hectares) with the abandonment of the investigated area.

From a paleoenvironmental point of view, at site scale, our data suggest the presence of a water body between the Acropolis (palaeo-island) and the Western Plateau. Hence, a question arises: how was communication between the two habitation nuclei possible? We observed in the field the presence of a ridge of uncertain origin (natural or anthropic), which forms the northern limit of the *Sărătură* depression (Fig. 10). Since it appeared a promising area for our research, two cores were drilled on the ridge (HIS X and HIS XX) and a completely different sedimentological composition from the other cores was found. The upper sequence of these cores is defined by silts and clays, overlying a fine grey sand unit, which led us to the supposition that the ridge was built as a dam or as a causeway, allowing communication between the two nuclei. In order to understand the function of the ridge, the information offered by cores was further investigated via geophysical survey and archaeological excavation.

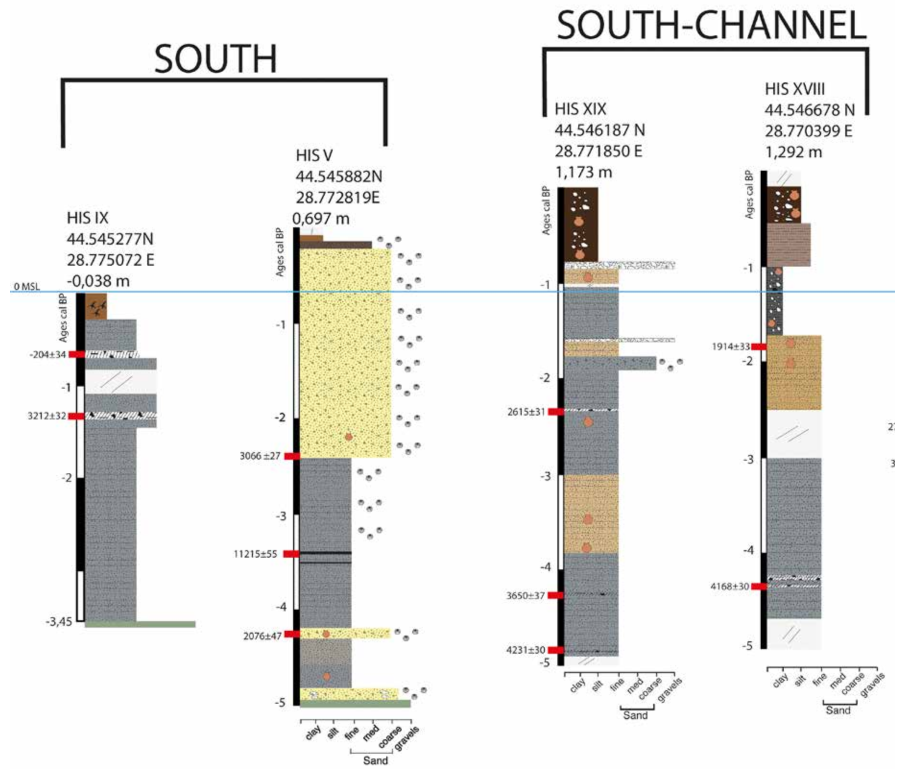
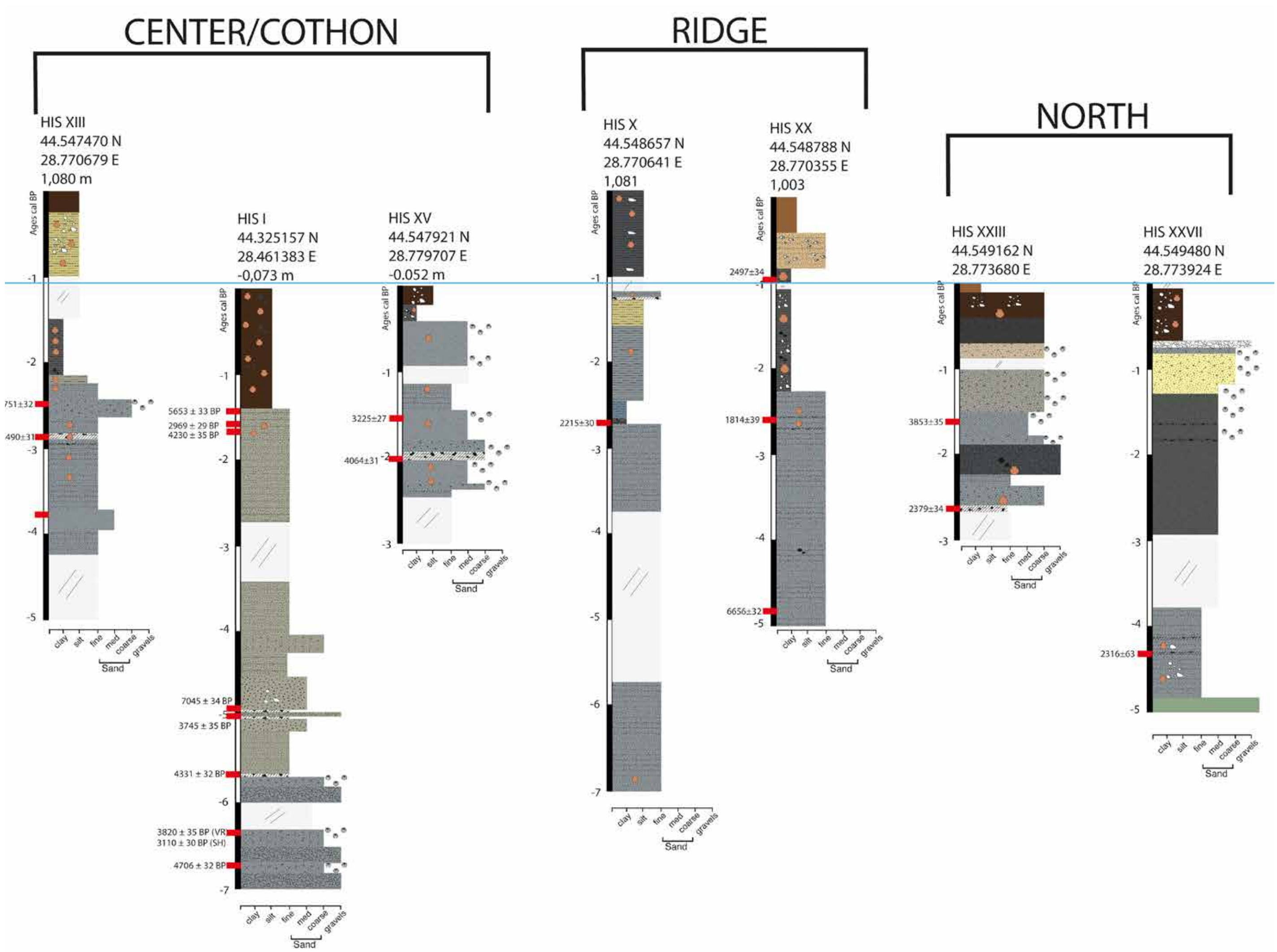


Figure 8 (above and opposite page). The cores used in this study, grouped by research area at site level. The cores are positioned with respect to mean sea-level (Credit: A. Bivolaru).

Geophysical investigations

The non-invasive investigation started in the summer of 2017, and therefore the results presented here are preliminary. Even though there were prior attempts to carry out a geophysical survey of the archaeological site, we do not yet have a complete plan of the city. This should be obtainable at least for the parts of the site that have not been affected by the hydro-geomorphological processes that are active in the area, and for the areas where systematic archaeological research has been undertaken for more than a century. A detailed city plan, together with the identification of archaeological structures that could provide clues to the possible location of the harbour(s), constitute the main objectives of our project.

The campaign that was undertaken in the summer of 2017 was based, on magnetometry: vertical gradient magnetometric survey regularly combined with GPR measurements (Fig. 9). For the magnetometry, we used Sensys equipment with five sensors installed at intervals of 0.5 m and 0.25 m above ground level; we covered a surface of approximately 4 hectares. The GPR profiles were measured with equipment produced by Malå Geoscience, with a 500 MHz antenna. The magnetometric



measurements covered a large part of the area around the Early Roman defensive wall, a surface between the latter and the classical defensive wall, and an area delimited by the northern half of the archaic defensive wall. We sounded the southeastern part of the area between the Early and the Late Roman defensive walls by creating several GPR profiles where, based on sedimentological data, we supposed there is a channel.

Even though modern interventions on the site have generated many perturbations that have sometimes obstructed the archaeological layers, we managed to identify several structures that have a high degree of magnetic susceptibility that could be attributed to cultural layers. Among these are the linear features in the area delimited by the archaic defensive wall: some are also identifiable on the ortho-rectified aerial photographs. These, together with other positive structures in the area, are probably part of a city grid that reminds us of a Milesian or Hippodamian plan (Fig. 9). In the northwestern sector of the Early Roman defensive wall there are also several positive characteristics of a circular or rectangular shape, some aligned or disposed in clusters (Fig. 9). Several of these present strong signs of burning, which are reflected in a powerful thermoremanent magnetism. The southern sector of the same Early Roman defensive wall is highly disturbed, especially by modern interventions, which makes it difficult to identify archaeological structures. There is, though, the possibility that the large anomaly in the southern extremity, which presents strong signs of burning, is also archaeological (Fig. 9). In the southeastern part of the area, between the two Roman defensive walls, there are no structures that manifest a contrast of magnetic susceptibility. In this area, the GPR profiles show continuous sloping structures, oriented southwards. These cannot be interpreted with certainty for the moment, but they can be related to manmade, sloping cobble-stone structures discovered in the proximity of our GPR-investigated area in 2006-2008

Core	Alt (STEREO 70)	Depth below MSL (cm)	Material	Lab code	Age BP & error	Age reservoir	cal 2σ	Remark
HIS_I	-0.073	148-149	wood	RoAMS 526.67	5653(33)	-	4549-4442 BCE	Rejected
HIS_I	-	151-161	charcoal	RoAMS 525.67	2969(29)	-	1278-1107 BCE	Accepted
HIS_I	-	161-162	organic matter	Poz-78016	4230(35)	-	2911-2851 BCE	Rejected
HIS_I	-	483-485	wood	RoAMS524.67	7045(34)	-	6003-5873 BCE	Rejected
HIS_I	-	489-493	organic matter	Poz-78019	3745(35)	-	2213-2035 BCE	Accepted
HIS_I	-	560-570	vegetal remains	RoAMS 523.67	4331(32)	-	3021-2892 BCE	Accepted
HIS_I	-	633-643	organic matter	Poz-78021	3820(35)	-	2351-2192 BCE	Rejected
HIS_I	-	633-643	marine shells	Poz-78333	3110(30)	498(41)	479-190 BCE	Rejected
HIS_I	-	643-653	wood	RoAMS 522.67	4706(32)	-	3470-3373 BCE	Accepted
HIS_V	0.697	171-181	Abra alba shells	RoAMS 834.90	3066(27)	498(41)	1411-1260 BCE	Accepted
HIS_V	-	276	wood	Roams 835.90	11215(55)	-	11258-11030 BCE	Rejected
HIS_V	-	350-360	Abra alba shells	RoAMS 836.90	2076(47)	498(41)	204 BCE-25 CE	Rejected
HIS_IX	-0.038	54-57	charcoal	RoAMS 838.90	-202(34)	-	1955-1957 CE	Accepted
HIS_IX		116-126	vegetal remains	RoAMS 837.90	3213(32)	-	1543-1417 BCE	Rejected
HIS_X	1,081	156-161	charcoal + VR	RoAMS 840.90	2215(30)	-	370-201 BCE	Accepted
HIS_XIII	1,080	142-157	Cerastoderma sp.	RoAMS 842.90	2751(32)	498(41)	976-882 BCE	Accepted
HIS_XIII	-	172-182	vegetal remains	RoAMS 843.90	3490(31)	-	1894-1740 BCE	Accepted
HIS_XV	-0.52	98-108	vegetal remians	RoAMS 845.90	3225(27)	-	1544-1430 BCE	Accepted
HIS_XV	-	148-151	vegetal remains	RoAMS 846.90	4064(31)	-	2680-2487 BCE	Accepted
HIS_XVIII	1,292	101-111	vegetal remains	RoAMS 848.90	1914(33)	-	9-172 CE	Accepted
HIS_XVIII	-	276-284	peat	RoAMS 849.90	4168(30)	-	2820-2660 BCE	Accepted
HIS_XIX	1,173	122-132	vegetal remains	RoAMS 850.90	2615(31)	-	860-791 BCE	Accepted
HIS_XIX	-	311	peat	RoAMS 851.90	3650(37)	-	2137-1927 BCE	Accepted
HIS_XIX	-	363-364	peat	RoAMS 852.90	4231(30)	-	2909-2858 BCE	Accepted
HIS_XX	1,003	12-0	charcoal	RoAMS 853.90	2497(34)	-	790-510 BCE	Rejected
HIS_XX	-	152	charcoal + VR	RoAMS 855.90	1814(39)	-	119-263 CE	Accepted
HIS_XX	-	380-390	peat	RoAMS 856.90	6656(32)	-	5636-5526 BCE	Accepted
HIS_XXIII	0	0	vegetal remains	RoAMS 860.90	3853(35)	-	2461-2267 BCE	Rejected
HIS_XXIII	-	0	peat	RoAMS 861.90	2379(34)	-	543-391 BCE	Accepted
HIS_XXVII	0	0	peat	RoAMS 863.90	2316(63)	-	545-201 BCE	Accepted

Table 1. Radiocarbon ages of cores used in this study.

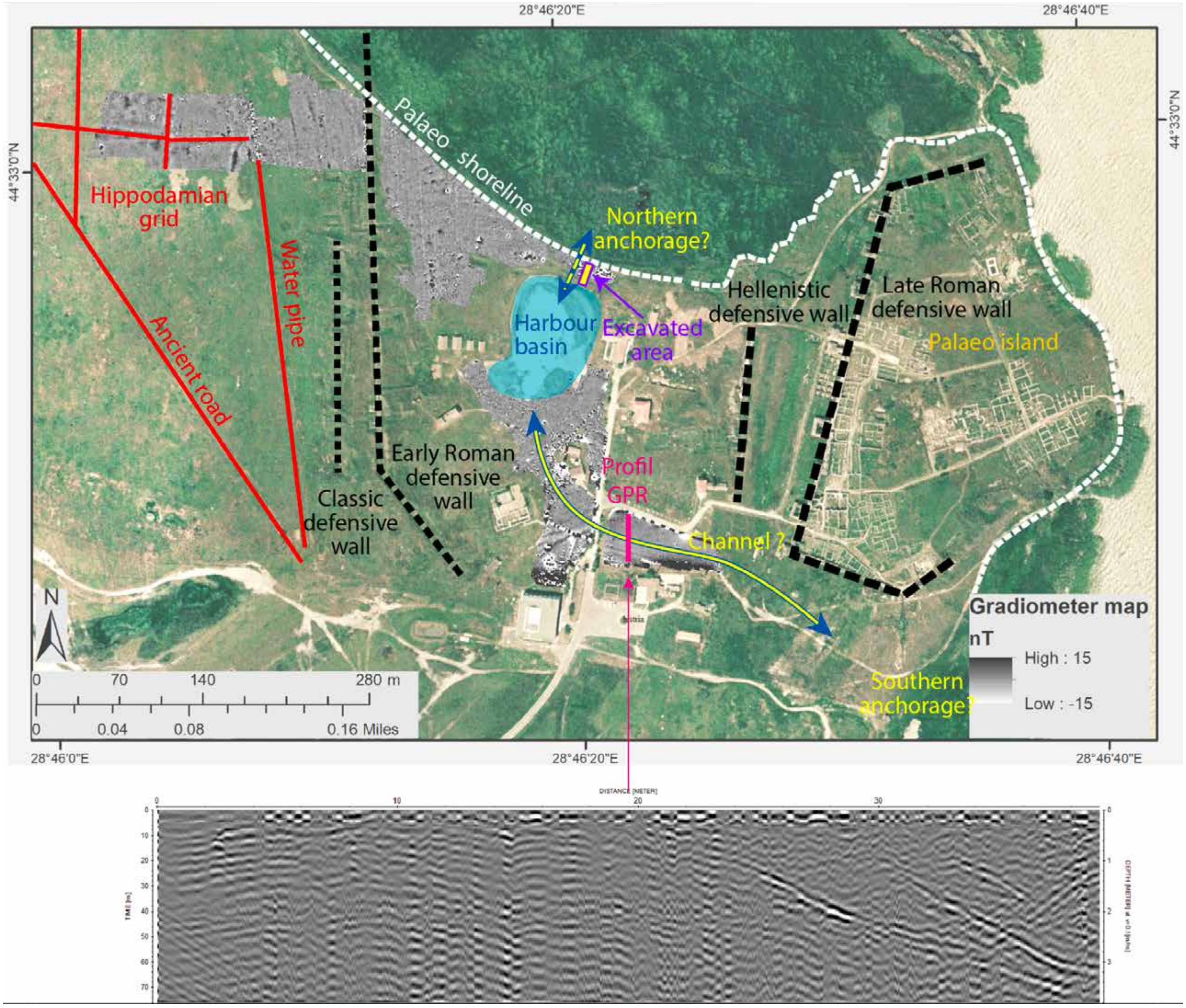


Figure 9. Possible harbour and anchorage locations based on the present geoarchaeological investigation (sedimentary cores, vertical gradient magnetometry, GPR and archaeological excavation). A protected harbour could have been located in the central-western part of the site, connecting a southern and/or northern anchorage via a channel (Credit: A. Asăndulesei, P. Pentsch).

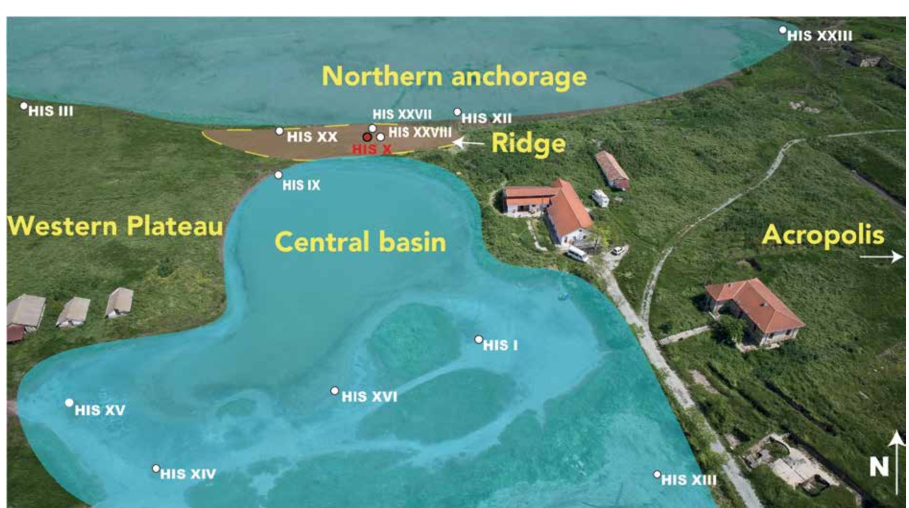


Figure 10. Position of the ridge and the two bodies of water. Core HIS X (in red) indicates a possible causeway/dam in this area (Credit: A. Bivolaru, A. Asăndulesei).

(Dabîca, 2011), interpreted as ramps related to harbour activity. Until further investigations, the observed features could also correspond to successive phases of accumulation of a beach-ridge.

Archaeological excavation

In 2017 and 2018, we conducted two archaeological surveys, S001 (with an additional trench named S002) and S003. The surveyed sector was named Sărătură because of its vicinity to the natural depression. The two trenches are located on the ridge between the northern margin of the Sărătură depression and the northwestern marshy shore of Sinoe lake (Fig. 11).

The 2017 trench is oriented N-S (perpendicular on the ridge) and measured 17 m long, 2 m wide, and 1.8 m deep (Figs 12-13). The excavation was stopped at this depth because of the groundwater table, which prevented us from going deeper in the absence of professional equipment.

Stratigraphically, we identified 22 units registering successive phases of occupation-abandonment-levelling. We discovered three archaeological structures at different depths, oriented NW-SE, and a semi-circular structure (Fig. 14). Also, we brought to light a rectangular structure, oriented N-NW-S-SE, that we preliminarily interpreted as a pilaster base, associated with the second Late Hellenistic structure (Fig. 14). All three superposed structures are rectangular and are built from local greenschist and limestone. They are made of medium stones (approx. 400 × 400 mm), faced only on the western side. The semi-circular structure is built of small stones – greenschist and limestone – and bricks. The so-called pilaster base is built of greenschist and limestone bonded with earth. During the excavation, no debris that could have been associated with a superstructure was discovered. For each structure an occupation layer has been identified, followed by an abandonment and afterwards by levelling with sand. An important remark relates to the spatial distribution of the structures: they are all located in the centre of the 17 m-long trench. No other structures have been identified south or north of them, and the artefacts recovered from these areas are very few in comparison to the quantity discovered in the area where the structures are concentrated.

The pottery from the excavation is in a relatively advanced stage of fragmentation, which makes its study difficult, but it can be mentioned that there are at least two, and possibly three phases. The material from the highest levels is dated from the middle of the 1st to the beginning of the 2nd centuries CE. There were fragments with a wider dating range within these contexts, up to the end of the 2nd-beginning of the 3rd centuries CE, but their association with a large number of sherds generally dated from the second half of the 1st century CE (50/75-100/125 CE) shows that some of these forms have an early dating in this case.

A second group corresponding to a second phase consists of material associated with the end of the 1st century BCE-beginning and the first half of the 1st century CE. The material is very heterogeneous and is defined by pottery, bones, worked antler (Beldiman *et al.*, 2019), metallic fragments, several coins, a large number of terracotta statuette fragments, and a Hellenistic stamped tile. 'Transitional' pottery types appear in these contexts marking the shift from the Late Hellenistic period to the Early Roman. From these contexts, we recovered Early Roman ceramics together with Late Hellenistic fragments and even forms and products that present the characteristics of both.

The function of these structures is unclear because the narrow width of the trench (2 m) prevents a definitive interpretation; still, we can draw some conclusions. First, the quasi-total absence of Late Roman material (only a few pottery sherds were discovered in the vegetal layer) indicates that the area was no longer in use during the Late Roman Period. The lack of structures and reduced number of artefacts in the northern and southern extremities of the trench and the thick layers of sand discovered in these areas might indicate works (that is the intentional deposition of sand), related to the micro-topography, such as stabilization or levelling of the land. The fact that the structures are faced on only one side suggests that only one side was visible. This indication, along with their orientation, which has remained the same for at least three centuries, led us to interpret them as possible terracing structures.

The 2018 excavation consists of a trench 15 m long and 2 m wide, with a depth of 0.50-0.70 m. The section (S003) is located east of the 2017 excavation, perpendicular to it and oriented E-W (Figs 12-13). On the northern side, the excavation possibly overlapped about 1 m of a test pit excavated in the 1980s and its resulting spoil. The substructure of a street was found over a length of 7 m, at a depth of -0.54 m in the eastern end of the section and -0.70 m in the western end (Fig. 15). It is built of stones, fragments of tiles and bricks, as well as ceramic and bone fragments, bound with yellow clay. In the rest of the trench, no other structure was clearly identified. In squares $B_{3\text{-}4}$ at a depth of -0.64 m, a limestone slab was identified, oriented NW-SE and heavily weathered. Another possible slab was observed when clearing the ground, located at the SE corner of the identified one and with the same orientation, but it was impossible to conserve it as the limestone was highly degraded; however, it was recorded in position. The archaeological material discovered in 2018 is heterogeneous and with a high degree of fragmentation. The ceramic material con-

Figure 11. Localization of archaeological surveys. Above: the position of the excavation on the general topographical plan (Credits: V. Bottez after Mehedințeanu, 2003). Right: the investigated area, aerial view from a drone (Credit: A. Bivolaru, A. Asăndulesei).

stitutes most of the assemblage. From the chronological point of view, it corresponds mostly to the Late Hellenistic-Early Roman periods (1st century BCE-1st century CE).

Discussion and perspectives

As shown by previous studies (Preoteasa *et al.*, 2012; 2013; Vespremeanu-Stroe *et al.*, 2017), Istros had access to the sea throughout its existence. The transformation from a maritime city to a landlocked site happened after the abandonment of the city in the 6th century CE, as proven by the new OSL ages from Sinoe lake (Vespremeanu-Stroe *et al.*, 2017). Although the city had access to the open sea, it suffered because of the impact of high sedimentation related to deltaic progradation, as the area is the end of a littoral cell. Under the impact of the sediment supply, together with climate, movements of the Earth's crust (tectonics and isostasy), soil erosion, and land use, the identification of the harbour or harbours is challenging. Along with these factors, the intense occupation of the city for 1300 years complicates the problem, as Istros underwent numerous urban changes, for both natural and cultural reasons.

Our paleoenvironmental reconstruction indicates the presence of seawater in the central-northern part of the site (Sărătură depression), as well as south of it, in what we called the 'channel' area. The dominance and monospecificity of brackish-marine taxa both for ostracods (Pontocythere elongata) and molluscs (Abra alba) suggest a shallow-water, coastal habitat. The low species diversity, typical of lagoonal environments (Carbonel, 1980; Guelorget and Perthuisot, 1983; Akoumi-

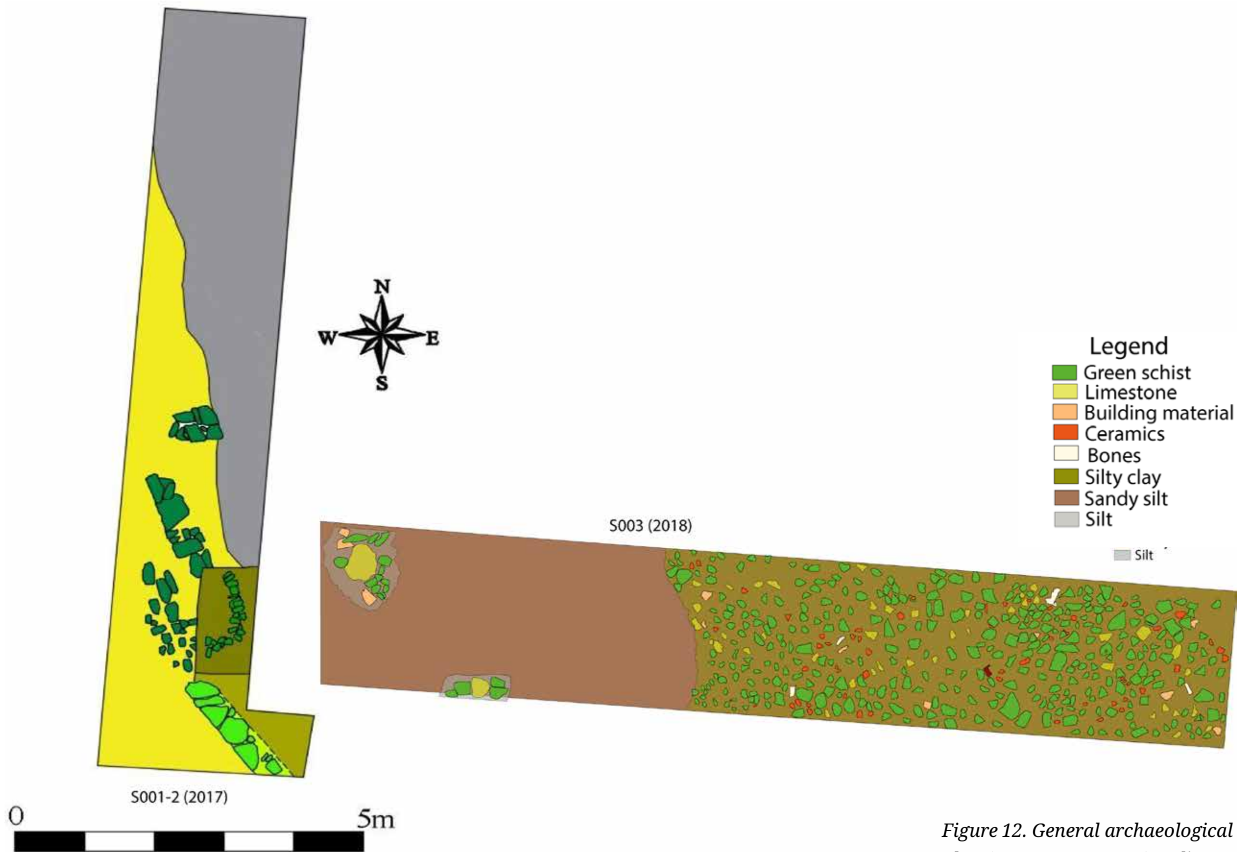


Figure 12. General archaeological plan (Sărătură sector) (Credits: V. Bottez).

Figure 13. Aerial photo of the excavation (Sărătură sector) (Credits: L. Cliante).

Figure 14. The structures discovered in 2017 (Credit: A. Bivolaru).

nanki and Nicolaidou, 2007; Bony *et al.*, 2015), suggest the existence of an open lagoon, with a strong seawater influence, in the aforementioned zone. However, the environment of this area is a low-energy setting, as shown by the presence of thick, fine-sand deposits, overlapped by fine-sediment layers (silts and clays) from which we recovered numerous artefacts, mostly ceramic sherds. The presence of the artefacts proves substantial anthropogenic activity in the area. In contrast, the cores from the northern and southern sides of the island, show a much coarser grain size distribution, fewer or no biological proxies, and fewer archaeological indicators. Even though suitable for landing boats or ships, none of these areas indicates a protected harbour-like environment.

The localization of a protected, most probably manmade harbour basin in the central-northern part of the site is revealed by bio-sedimentological signals. Two questions arise from its possible identification: firstly, when was the basin built and when did it of go out of use; and secondly, how was passage between the two nuclei achieved if the harbour basin separated them?

For the chronology, we know from epigraphic sources that a harbour installation existed at least since 300-200 BCE. Moreover, the existence of a fleet mentioned in the 3rd century BCE implies the existence of certain ship-maintenance structures. As such, from at least the end of the Classical period and beginning of the Hellenistic period, Istros had a manmade harbour structure. Based on our chronostratigraphic data, a radiocarbon age of 370-201 cal BCE was obtained from core HIS X, in a transitional phase from fine grey sand to fine grey silts, associated with a change in biological content. The shift between ostracod taxa from *Pontocythere elongata* to *Cyprideis torosa* and *Heterocypris salina* means a decrease in salinity, indicating a low input of seawater. A clear change is observed in the depositional mechanism, corresponding most probably with the harbour basin set-up. Moreover, in the cores from this zone, we noticed many chronological aberrations, corresponding perhaps to maintenance or dredging works, which we know were implemented sometime in the 2nd century CE from epigraphical sources (ISM I 178; ISM I 179). A more refined chronology would help our research, most probably obtained using other dating methods, such as OSL.

The construction of the harbour has very important implications in terms of topography and urban planning. The question of connecting the Acropolis and the Western Plateau led us to open an excavation in an area long-ignored by archaeologists. The discovery of the substructure of a street shows that at least during the beginning of the Late Hellenistic-Early Roman period, the ridge area was used as a passage. Also, the lack of Late Roman material originating from occupational or abandonment layers shows clearly that the area was no longer used by the end of the Early Roman period. The four structures discovered in 2017 could have been used as terracing constructions to facilitate the connection between the Acropolis and the Western Plateau. Their spatial distribution, located in a small part of the 17 × 2 m trench, and the thick layers of sand present north and south of them could indicate the presence of a natural border – a waterbody. The sand layers may correspond to stabilizing or levelling the land. The reduced amount of construction materials found may

Figure 15. The substructure of the street discovered in 2018 (Credit: A. Bivolaru).

be an indicator of the low height of these structures or of the use of adobe which, for taphonomic reasons, has not been preserved. Their orientation NW-SE could also be related to communication between the central basin and the northern anchorage spot, marking a possible channel. The substructure of the street exhibits a slope westward, towards the terracing/bordering structures. The relationship between the structures and the street is still unclear, but the structures might represent a step or limit to the former.

At the same time, the heterogeneity of the material found in the abandonment levels may indicate the use of the space as a waste depot. A similar situation, with highly varied ceramic material broken *ab antiquo* was described as a harbour depot by Cibecchini and Bargagliotti (2011) at Portus Sabris. Rubbish often accumulates at the base of quays and in unloading areas (Morhange *et al.*, 2015). Thus, we can advance the hypothesis that the ridge was linking an unloading area related to the harbour basin located in the central part of the site with the two habitation nuclei, the Acropolis and the Western Plateau.

All these results provide new, valuable information concerning how the city functioned, the location of its main economic hotspots – the harbour(s) – and how the two main urban units, the Acropolis, and the Western Plateau, were connected.

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Navigating Perceptions

Mariners and geographers of the Roman Levant

*Carmen Obied**

The diverse environmental and cultural dynamics of the Levantine coastscape were vital in advancing navigation during the Roman period. Traces of mariners' mental maps are inherent throughout Ancient Greek and Roman texts, reflecting a link between armchair geographers and mariners' practical experience which, when combined, present a complex 'jigsaw puzzle' of the world. Adopting a 'common sense geography' approach, this research re-evaluates maritime data, combining archaeological evidence, ancient sources, and GIS/QGIS. Patterns in the data reflect the important role of twin-settlements and fluvio-maritime secondary ports in this trade network. Evidence demonstrates the multivalent nature of perceptions of the Levant's maritime cultural landscape, which were affected by bird's-eye views, on-board perspectives, mariners' memories, and linguistic topographies.

Keywords: Archaeology, Roman, navigation, GIS, Levant, twin-settlements.

A recent resurgence of interest in the field of ancient geography and navigation has led to a need to re-evaluate the surviving corpus of ancient texts and archaeological evidence, to seek alternative modes of perceiving space in the past beyond the predominant linear, 'hodological'[1] approach (Geus and Thiering, 2014). The level of complexity inherent in ancient geographic texts and representations is often underestimated and is particularly evident in the Roman Levant. This research explores how the Levant's diverse environmental and cultural dynamics played an important role in advancing navigation and perceptions of space during the Roman period (Fig. 1). The Levant case study is set in the Roman period, from the Principate to the Diocletian (*c.*1st century BCE-3rd or 4th century CE), based on the temporal scope of the ancient authors writing about geography and navigation in this region.

The Levant is varied both physically and conceptually, and the nature of navigation is explored in relation to maritime conditions, harbours, and activities. The northern Levant (from the northern border of Syria and Turkey, extending to Tyre, Lebanon) has a predominantly rocky, indented coast, with mountains, promontories, bays, and river mouths offering shelter. In contrast, the southern Levant (from Tyre to Rafia, on the border of Israel and Palestine and Egypt) has an exposed, less-sheltered coast,

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1 See Janni (1984: 130) for the concept of 'hodological space' (from the Greek word *hodos*, meaning road or path), arguing that Romans preferred to envisage space not two-dimensionally with maps, but instead one-dimensionally through lines, as 'hodological space' (using the many surviving examples of land and sea itineraries as evidence).

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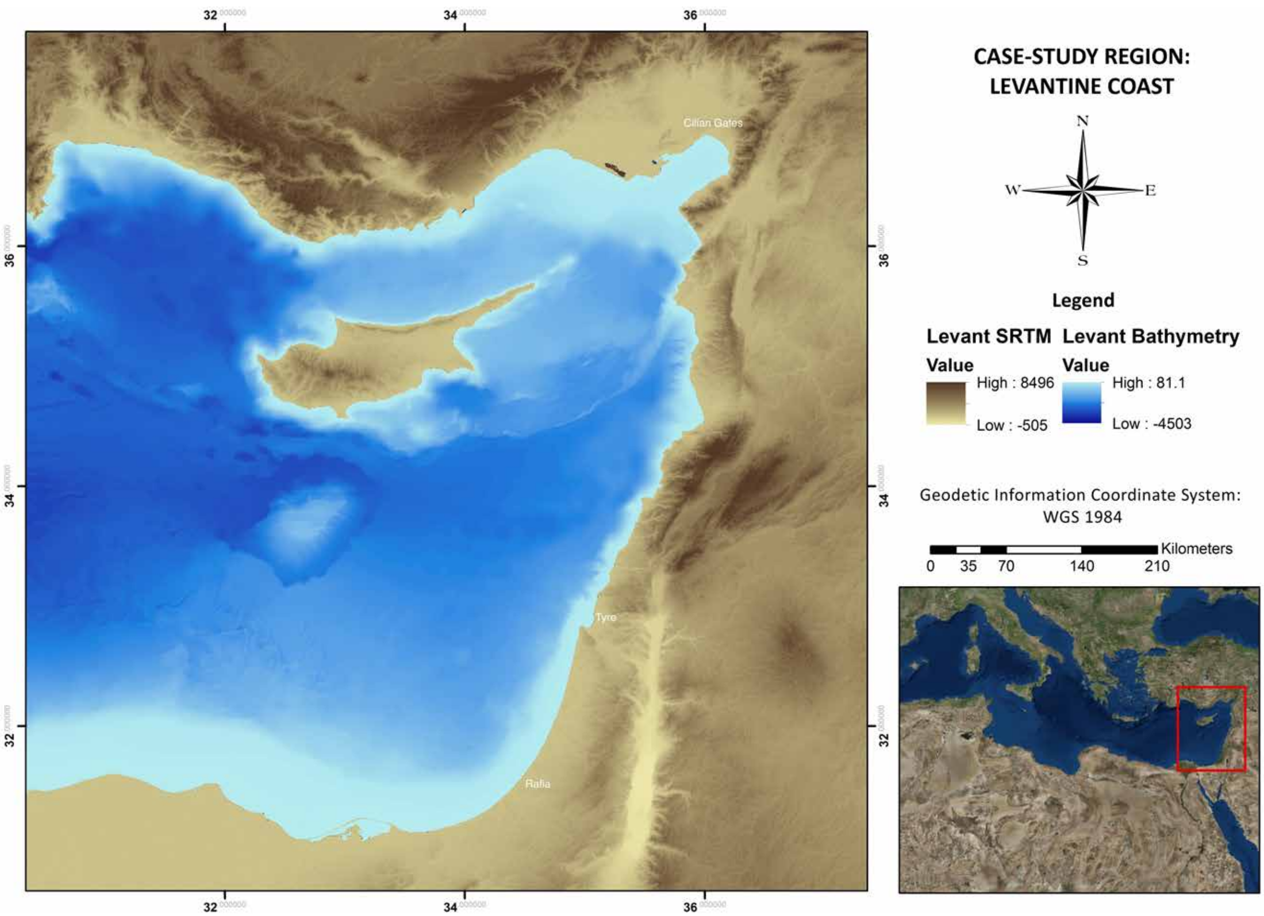

Figure 1. The Levantine coast, with its two main morphological subdivisions marked: northern Levant (Cilician Gates to Tyre); and southern Levant (Tyre to Rafia) (Map produced by the author on ArcGIS10.2.2. DEM: SRTM_1km, Bathymetry: Emodnet).

comprising mostly straight, flat, sandy beaches (and some bays, reefs and similar landmarks) (Smith, 1895; Horden and Purcell, 2000: 123-172; MVP, 2005: 227-229).

The natural arrangement of the coastline, with its sequence of prominent navigational markers, served as an active cognitive tool for navigating and describing journeys along the Levantine coastscape. Traces of mariners' mental maps are inherent throughout ancient Greek and Roman texts, reflecting a link between the armchair geographer and the practical movements of the mariner which, when combined, present a complex jigsaw puzzle of the *oikoumene* (known inhabited world). Geographic works should thus be approached as frameworks of knowledge in their own right, reflecting contemporary Roman cultural-political perceptions.

Navigating perceptions: common sense geography

The phenomenological experience of ancient mariners can be traced within the narrative descriptions of maritime travel assembled by ancient authors (Arnaud, 2011; 2014: 39; Kowalski, 2012). Seafaring communities relied on accumulated cognitive knowledge and mental maps of journeys to navigate the coastscape, and these were preserved through an oral culture (Thiering, 2012: 11-14; Arnaud, 2014: 40). The core of this article investigates key theories and practices of ancient mapping and navigation in the Levant. It presents an overview of research conclusions that highlight the significance of reconsidering the available corpus of maritime data, through an interdisciplinary methodology combining archaeological evidence, ancient literary sources, modern pilots,[2] and geospatial analysis using ArcGIS/QGIS.[3] The case studies are primarily based on geographic parameters and perceptions of space because the ancient treatises from the Roman period focused on geographic and navigational descriptions.

In antiquity, people envisioned journeys and the landscape not only in linear routes: they perceived space and navigated it in multi-faceted ways. Adopting a 'common sense geography'[4] approach (Geus and Thiering, 2014), this research builds on ongoing work by researchers who are challenging hodological models (*e.g.* Dan, 2014; Geller, 2014; Poiss, 2014) and seeks alternative ways of establishing spatial associations and orientation. This approach builds on implicit and explicit cues inherent in the maritime data, through the notion that 'the mariners' experience has been the origin of a common sense geography, which, in turn, has been the origin of the classical tradition of geography' (Arnaud, 2014: 66).

A prevalent matter of debate is how far maps, seafaring guides *(periploi),* and itineraries were used as a means of navigation in the Roman period (see Dilke, 1984 vs Janni, 1984; Lopez, 2015; Obied, 2016: 3-4, 41-44, 226-232, for discussion).[5] As surviving textual evidence on seafaring is limited, the higher number of itineraries found does not necessarily represent the only, or even typical, way of conceiving space in the Roman period, particularly if we account for the many variables on a journey. In re-evaluating the ancient sources and archaeological data, implicit practical elements and multi-dimensional perspectives begin to emerge in the form of bird's-eye panoramic views, on-board perspectives, mariners' memories, and linguistic topographies (using toponyms as a reference for orientation). Earlier notions of the sea and sea travel can be traced in ancient travelogues or *periploi,* such as Pseudo-Skylax's *Periplous*, *Stadiasmus Maris Magni*, and *Periplous Maris Erythraeai*, and geographic or cartographic treatises describing harbours and maritime journeys along a given coast, such as Strabo, Pliny the Elder, and Ptolemy (Dueck, 2012). Extant ancient maps include the Marble Plan of Rome (*Forma Urbis Romae*, made 203-211) and the Peutinger Table (*c.*4th century), as well as coastal maps – the Dura-Europos shield map (late 2nd-early 3rd century) and the Madaba Mosaic (*c.*6th century) (Harvey, 1980; 1999; Arnaud, 1989; Talbert, 2012; Salway, 2012). Moreover, sensory navigational markers such as landmarks, distances, celestial navigation, and sailing patterns can be traced in the practices of Micronesian and Polynesian cultures that orient themselves without navigational instruments, relying on practical mental models based on both implicit and explicit knowledge cues (Lewis, 1994; Thiering, 2012: 14).

Building on notions of seascapes and maritime cultural landscapes (Westerdahl, 1992: 6; Horden and Purcell, 2000: 11, 123-172), this article explores how the Levant's distinct coastline played a key role in the development of its maritime cultural landscape (Westerdahl, 1992), serving as a major interface for communication and trade throughout antiquity, linking the continents of Europe, Africa, and Asia (Frost, 1972; Blackman, 1982; Galili *et al.,* 2002; Cline, 2003: 364; Carayon *et al.,* 2011). Major trade routes linking Mesopotamia, Egypt, Asia Minor, and the Aegean ran directly through Canaan, Transjordan, and Syria-Lebanon (Cline, 2003: 364), and included the Via Maris, a major coastal highway from Egypt to Syria and Mesopotamia (Aharoni, 1966: 41-52; Stern, 2000; Hezser, 2011: 54).

Complexities and context in ancient sources

The Levant's diverse nature and strategic role offer a suitable theoretical framework for exploring spatial orientation, modes and scale of travel, and shifting perceptions of the seascape. The key study sources include: Strabo of Amasia's *Geographia* (*c.*64/3 BCE-23 CE); Pomponius Mela's *De Chorographia* (*c.*43 CE)*;* Pliny the Elder's *Naturalis Historia* (*c.* 23-79 CE)*;* Claudius Ptolemy's *Geographike Hyphegesis* (mid 2nd century CE); and two Anonymous *Stadiasmus Maris Magni* (*c.*200-300 CE) (Table 1). According to Nicolet (1991: 2-8), this temporal setting is considered 'the pivotal time for representations of space, as Rome attempts to grasp (cognitively and literally) the extent and limit of its power' (also Crawford, 1992; Adkins and Adkins, 1994; Morley, 2010; Scheidel, 2013: 2). However, these ancient texts contain both Greek and Roman roots, which likely influenced their varying perceptions. Thus, critical consideration of the complexities inherent in the texts of ancient authors is essential to understand the genesis of their work and representation of the

2 Main pilots and charts used included: Mediterranean Pilot V (MPV 2005); Sailing Directions (Enroute) for the Eastern Mediterranean (SDEEM 2005), British Admiralty charts.

3 Key resources for cataloguing coastal data for the case-study sites included: (De Graaw 2013, Barrington Atlas, Pleiades.stoa.org).

4 The concept of 'Common Sense Geography' forms the foundation of a recent collaborative research initiated by a group of scholars: K. Geus, M. Thiering, P. Arnaud, A. Dan, K. Guckelsberger, T. Poiss, G.F. Chiai, S. Bianchetti and T. Bekker-Nielsen (2014). It draws on the implicit knowledge and mental maps inherent in ancient sources, in which: 'Common' denotes a 'lower' geography, to be distinguished from 'professional' or 'higher' geography. 'Sense' refers to a 'naïve' perception and description of space and the use of 'intuitive' arguments in geographical contexts. 'Geography' refers to the aspect of historical geography concerned with implicit or tacit knowledge in ancient cultures (Geus and Thiering, 2014: 5; see also Thiering, 2012: 11-14, Arnaud, 2014: 39-68).

5 Dilke (1984) considered that Romans were familiar with or used maps, while Janni (1984) argued for a hodological linear view.

Author	Work	Date	Focus Region	Description	Route(s)
Strabo	*Geographia (Geog.)* (Jones, 2001)	*c* 64-63 BCE-23 CE	Oikoumene	17 'books' on geography	Whole world clockwise from Spain through Europe to the Black Sea, then southward through Asia to end in Africa.
Pomponius Mela	*De Chorographia (Chor)* (Silberman, 1988; Romer, 1998)	*c* 43 CE	Oikoumene	3-book geog. description	Anti-clockwise periplus of Mediterranean from the Pillars of Hercules (Straits of Gibraltar), followed by a clockwise periplus of the outer ocean back to the Pillars.
Pliny the Elder	*Naturalis Historiae (NH)* (Rackham, 1962)	23-79 CE	Oikoumene	37-book encyclopaedia	1. Anti-clockwise around Europe along its Mediterranean and Black Sea shores, before heading up the Danube and down the Rhine. 2. Anti-clockwise periplus of southern and eastern coasts of Mediterranean and Aegean around to the Black Sea and across to Persia. 3. Clockwise periplus of Oceanus back around to west Africa. NB: Other provinces (*e.g.* Hispania Baetica) are anti-clockwise, even in w. Mediterranean.
Claudius Ptolemy	*Geographike Hyphegesis (GH)* (Berggren and Jones, 2010)	Mid 2nd century CE	Oikoumene	Treatise on world cartography and geography	Geographic treatise and catalogue of the oikoumene, categorized into separate regions, grouped into three continents, roughly ordered north-west to south-east.
Anonymous	*Stadiasmus Maris Magni (SMM)*	3rd and 4th centuries CE (c.250-300) only preserved as 10th-century-CE manuscript	Asia Minor & Africa	Periplous with distances to harbours in eastern Mediterranean and North Africa	1. Alexandria to Pillars of Hercules (*i.e.* westward along the North African coastline to Libya, where there is a lacuna). 2. Alexandria anti-clockwise to Hellespont, then west to Pillars of Hercules (*i.e.* after lacuna [Utica]), picks up on Levant coast (at Tyre), then round Asia Minor to islands of Aegean, Cyprus, Crete before end.

Table 1. Key case study sources on Ancient Greek and Roman dealing with geographic and navigational accounts.

Levant.[6] A significant issue to recognize in the various manuscripts and editions of the ancient treatises relates to the common transmission of scribal errors throughout antiquity, due to miscopying, whether deliberate or accidental (Reynolds and Wilson, 1991: 25-34, 44-48, 207-239). A common feature of these ancient documents is that they were designed, developed, and preserved by armchair writers as 'living texts' that were continually added to, changed, and copied over time by scribes or copyists to update the information and correct it where necessary (Arnaud, 1998). This makes it hard to date and determine the sources used; for example, Ptolemy's *GH* is a complex text-compilation designed as a living document (Isaksen, 2011), to be added to, amended, and improved as knowledge advanced (Ptolemy, *GH* 2.1). Toponyms used and their origins need to be considered in context, to better understand the complexity inherent in these works in relation to the Levant coast. This is especially challenging for the *Stadiasmus*, for which this region is considerably complex and corrupted, largely related to manuscript corruptions in textual transmissions and gaps in the text, primarily caused by errors or emendations over time. Thus, context is crucial to understanding the underlying reasoning in ancient authors' representations.

6 For critical studies on the ancient sources, refer to key modern scholarly works by Aly (1957); Aujac (1966); Marcotte (2000); Prontera (1984; 1992; 2013); Van Paassen (1957). On ancient navigation, seafaring and *periploi* see Davis (2009: 158-197), Medas (2004a-b; 2008; 2011), Prontera (1992; 2013) and Casson (1989; 1991; 1994a-b; 1995). On maritime cultural landscapes see Westerdahl (1992).

Maritime conditions and navigational markers

Environmental conditions played a vital role in navigation and seafaring in the Levant and are often reflected in ancient geographical descriptions. Thus, it is important to consider the prevailing regional maritime conditions when exploring the capabilities and perceptions of early mariners or geographers. The Levantine coastscape comprises a series of micro-regions characterized by natural and artificial landmarks that served as key navigational aids for ancient seafarers (Fig. 2) (Phillips, 1993; Morton, 2001: 184-214; Parker, 2001: 35). The predominantly rocky northern Levantine coastline seems to have been minimally affected by Pleistocene sea-level changes (Shea, 2003: 316). In contrast, on the exposed southern Levantine coastline, *c.*220 km long, the Pleistocene sea-level changes are far more evident: with sea-levels falling, the Israeli Coastal Plain would have expanded tens of kilometres west of its present point, and the Nile Delta would have shifted northward (Walter *et al.*, 2000). The Levant's modern topography has been largely influenced by processes relating to the last glaciation, notably relative (eustatic) sea-level rise, regional or local tectonic activity, sediment deposition, and climatic change (Kraft *et al.*, 1977: 941; Raban, 1995: 143; Morhange *et al.*, 2006: 99; Stewart and Morhange, 2009). Since antiquity, these shifting

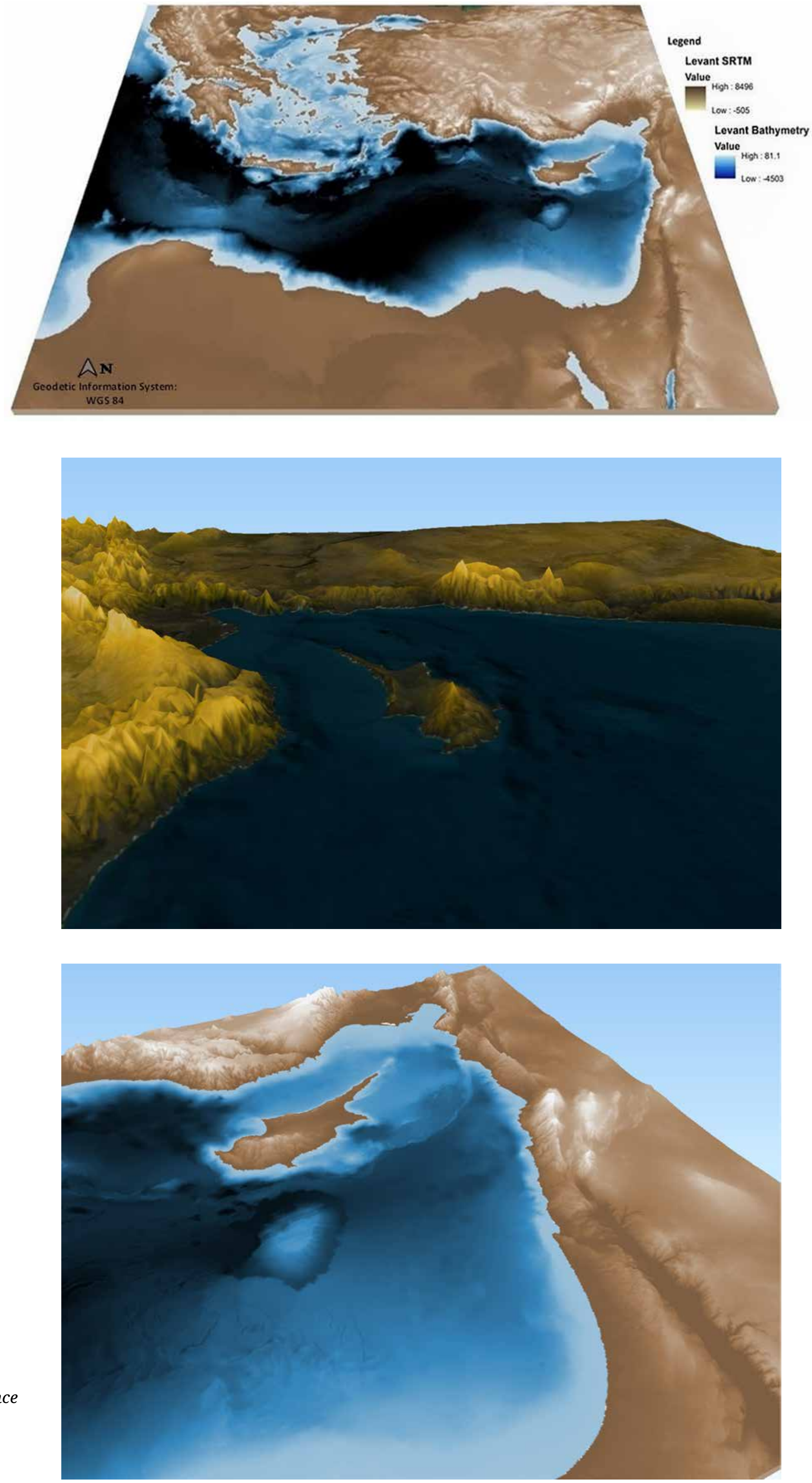

Figure 2. Three different perspectives of the Levant demonstrating the contrasting elevations along the coastline, which divide the landscape into a series of distinguishable reference points (Map produced by the author, using QGIS – Basemap: ©Bing Aerial Layer; DEM: SRTM_1km).

landscape configurations would have affected people's perceptions of the sea and coast.

The Levant's diverse meteorological conditions and geomorphological changes were vital in advancing ancient navigation techniques and perceptions. The most crucial factor influencing maritime conditions in the Levant was the wind. Wind conditions are particularly important in identifying patterns of early seafaring activity and wayfinding techniques. Favourable weather conditions seem to have prevailed in the Levant in the Roman period (1st century BCE-early 3rd century CE), coinciding with the peak of Roman Imperial expansion and political-economic stability (McCormick *et al.*, 2012; Beresford, 2013: 64). Navigation along coasts and open seas generally ran throughout spring, summer, and early autumn (Casson, 1995: 270-272); though it has recently been posited that winter sailing in the Mediterranean, though less frequent, also took place (Tammuz, 2005: 145; Whitewright, 2008: 48; Arnaud, 2012; Beresford, 2013: 6). The prevailing winds in the eastern Mediterranean are generally northerly and north-westerly (Safadi, 2016). But the different morphological characteristics of the northern and southern Levant meant the action of wind on the coastline and its effect on sailing also varied. In general, the northern Levant's coast is westward-facing and it is exposed to prevailing westerly winds (MPV, 2005: 25; MedAtlas). The best anchorages would, therefore, be in the lee of an off-lying island or promontory protected from the west (Blue, 1995: Ch. 4). In the southern Levant, the coast follows a generally N-S axis and is fully exposed to prevailing westerly winds, as well as winds that prevail from SW and turn to NW by the end of the day. A certain amount of shelter from prevailing winds is offered by the few promontories, offshore *kurkar* ridges, and river mouths. An awareness of diurnal cycles is vital for navigating the Levant, particularly when assisting ships to enter and leave a harbour, allowing flexibility to mariners when sailing in unfavourable conditions or against prevailing winds (Blue, 1997; Beresford, 2013: 222). References to favourable winds occur regularly in Graeco-Roman accounts and mariners were familiar with navigational aids in the form of local land or sea breezes (Morton, 2001: 51; Leidwanger, 2013: 3303-3035; Arnaud, 2014: 51-58). Currents, fetch, swell, and wave patterns also served as basic, reliable wayfinding tools, as they could indicate a vessel's orientation in relation to known winds or nearby landmasses. The prevailing current in the eastern Mediterranean is anti-clockwise (Hughes, 1998: 102-103; MPV, 2005: 17-19).

Overall, it can be hard to determine the exact wind impact along a coast, as the aspects of each harbour and regional maritime conditions can vary significantly (Blue, 1997). Harbour sites must thus be addressed in their specific context, with a consideration of the variables: physical determinants and morphological changes affecting the coast, alongside communities' perceptions and decision-making.

Sensory navigation

Ancient seafarers perceiving the coast from the sea relied on familiar elevated or chromatic landmarks, river mouths, and islands (as seen in Ptol., 4.5.7, 4.5.15; Ps. Skylax, 67.31; *Stadiasmus Maris Magni,* 139). Natural sensory markers alluded to in ancient sources included: physical features, sky observations (birds, clouds, stars, constellations), and sea behaviour, sounds, smells (surf break, changes in shape or direction of swells or waves, land odours). Artificial structures included shrines, towers, lighthouses, and seamarks (stakes, pillars) to warn of shallows or submerged reefs. The main navigation techniques were pilotage (coastal and inshore) and celestial navigation (Davis, 2009: 219-309; Lewis, 1994: 45, 79-83; Morton, 2001: 185-214; Davis, 2002: 219-309).[7] A wayfinder or mariner's sensory interaction with the landscape is varied and continually advances, adapted over time through accumulated experiences and memories (Ingold, 2000: 237-242). In this way, ancient geographers were able to draw a more practical account from such first-hand insights. Strabo claims his extensive travels put him in an ideal position to write his treatise and expresses the importance of the senses for perceiving the *oikoumene* (*Geog.* 2.5.11). Though extant Roman navigational instruments are rare, sounding-weights are extensively documented archaeologically and were used for navigation and determining the position and depth of the seabed (Oleson, 2008; Galili *et al.*, 2009: 344). They were also used in shallower waters to choose an anchorage. Seabed sediment samples could also provide valuable information of a sensory nature, such as the smell, taste, colour, and texture of the local topography (Waters, 1958: 18-20; Oleson, 2000; 2006; 2008; Morton, 2001: 207; Galili *et al.*, 2009: 344). Seabed samples could be taken as part of subsistence activities, *i.e.* helping to locate corals, sponges and fishing-grounds. This is attested in early accounts, such as Herodotus, *c.*440 BCE (2.5.28), and, most notably, Paul's shipwreck narrative (*Acts* 27: 13-20, 27-32), which intimately depicts mariners' on-board experience and the use of a sounding-weight to determine if the ship was approaching shallow water. Herodotus (*c.*440 BCE) also describes them being used for sounding and sampling (Hdt., 2.5.28).

Coastal temples, shrines, and towers or forts were often located on promontories, were clearly visible from

7 E.g. *Antikythera Mechanism*: complex mechanical navigational device (1st century BC) with possible astronomical connotations (Price, 1974), sheds light on the advance of cosmology and navigation during this transitional period.

the sea and acted as valuable artificial landmarks for mariners navigating between harbours in the Levant and were often linked to religious or defensive symbols (Semple, 1927; Morton, 2001: 189-201; Brody, 2008). Similarly, for people on the mainland, these sanctuaries and forts located on the hilltops would have been ideal for obtaining a panoramic, bird's-eye view of the surrounding seascape.[8]

Navigational links can be drawn ethnographically from Micronesian and Polynesian navigators who use a highly developed navigational framework without navigational instruments, as attested by experimental Pacific Ocean voyages in replicas of ancient local boats, such as the *Hokule'a* (Gladwin, 1970; Oatley, 1977; Hutchins, 1983). Their system relies on extensive knowledge of meteorological conditions and astronomy (celestial navigation) and allows them to sail longer distances using star compasses, based on a mental triangulation of memorized star-risings or settings known as 'star paths', while incorporating a phantom or emergency island (Hutchins, 1983; Lewis, 1994: 94-97; Davis, 2001: 177-185; Thiering, 2012: 14, 33). Micronesians used the *etak* system, based on distances measured by time segments or durations, comparable to ancient Greeks' early measurement units (Arnaud, 2014: 41-46). These sensory markers (landmarks, distances, celestial navigation, and sailing patterns) can thus be traced in the practical experience of the mariner, along with ancient accounts using distinctive landmarks and toponyms as a means of constructing a memory database of places and geographic features in the seascape.

Linking land and sea

There is a prevailing emphasis on the role of the sea as a driving factor for the development of ancient geographers' rationalization and representation of space in antiquity. Access to the sea was vital in the Levant and led to the establishment of numerous settlements along the coast, even directly on small offshore islands, such as Tyre, Arados, and their *peraiai*.[9] Archaeological and geoarchaeological projects at major coastal sites along the Levant (Ras Ibn Hani, Sidon, Tyre, Dor, and Caesarea) have revealed more than 5000 years of interactions between humans and the environment, as well as ground-breaking evidence towards the reconstruction of palaeo-landscapes and ancient harbour sites (Carayon, 2008; Marriner and Morhange, 2006a; 2006b; Marriner *et al.*, 2006; 2008a; 2008b; 2012; Carayon *et al.*, 2011a; 2011b). Such sites have a rich cultural heritage and contribute to understanding changes and advances in technology, harbour infrastructures, and the maritime landscape, from the Bronze Age to Islamic period (Frost, 1972; 1995; Flemming, 1980; Blackman, 1982; Raban, 1985; 1991; 1995; Blue, 1995; Galili *et al.*, 2009; 2010; Marriner *et al.*, 2012). On harbour infrastructures, recent projects reveal advances in technology and facilities, as seen at the sites of Ras Ibn Hani, Tyre, Akko, Tel Nami, Dor, Aphek, and Deir el-Balah (Marriner *et al.*, 2008a; 2008b). Evidence has also shown that harbour settlements in antiquity often took advantage of more than one harbour, combining a natural anchorage or port on the coast with an inland riverine harbour on an estuary (Raban, 1991: 134; Blue, 1997: 31-32), with examples at Tel Tweini, Syria (Al-Maqdissi *et al.*, 2008), and Sidon, Lebanon (Carayon *et al.*, 2012: 439-449). Harbours were also established on lagoons, as at Tel Dor, using its natural anchorage (Raban, 1995: 145).

Natural and artificial landmarks played a structural role in ancient mariners' understanding of the seascape, and subsequently, the geographers' cognitive arrangement of this space. These references aided mariners navigating this region and were considered noteworthy to the ancient authors, who often mention elevated and chromatic features (mountains and promontories, rivers, islands) along described journeys. In Greek and Latin periplographic traditions, as with the sea, rivers act as a reference to guide a reader along the landscape or a journey (Strabo, *Geog.* 3.2.1). Along the Levantine coast, river mouths aided in navigation, mooring, and moving goods upstream, linking the coast with societies in the region or hinterland (see Arnaud, 2016 for a recent approach to fluvio-maritime ports; Campbell, 2012).

Levantine twin-settlements and fluvio-maritime harbours

An interesting phenomenon observed in the Levant, particularly in the southern part of the shoreline of Israel and Palestine, is a tendency to have linked coastal and inland settlements, often referred to as 'twin-settlements' (Blackman, 1982: 193; Raban, 1985: 14; Patai, 1998: 134). These inland towns or centres and their 'daughter settlements' on the coast, tended to be fortified, even during the *Pax Romana* (Blackman, 1982: 194). Cases of such twin-settlements along this coastal stretch, based on ancient authors and archaeology, include: Iamneia-Iamneia Paralios, Azotos Mesogaios-Azotos Paralios, Ascalon-Maiouma Ascalontis, Gaza-Harbour of the

8 For example: When Strabo describes his visit to Corinth (*Geog.* 8.6.19-21), he does so almost as a modern visitor would, by climbing up to Acrocorinthus and describing the shape of the city, providing a full panorama view from above (cf. Poiss, 2014: 82-5-4).

9 Peraia/παραλία: mainland settlements (or parts of the mainland or neighbouring island clusters) politically controlled by an island-state (e.g. Strabo, Geog. 16.2.12-3). Gaining or maintaining such dependencies relied on continuous maritime contact (Constantakopoulou, 2007: 229).

Coastal Sites	Strabo	Mela	Pliny	Ptolemy
Iamneia/Iamneia Paralios	Iamneia, 16.2.28	-	Iamneae, 5.14 Jamnia (inland)	Iamnitarum Harbour, 16.2 Iamneia (inland, after Gaza), 16.3 Iamneia (inland, after Gaza), 16.3
			Iamneae (inland).5.14	Iamneia (inland), 16.3
Azotos Mesogeios/Azotos Paralios	Azotus, 16.2.29	Azotus, 1: 61	Azotus, 5.14	Azotos, 16.2
Ascalon/Maioma Ascalontis	Ascalon, 16.2.29	Ascalon, 1: 64	Ascalo, 5.14	Askalon (*noteworthy city*), 16.2
Gazaion Limen/Maiumas Gaza	Harbour of Gazaei, 16.2.30	Gaza, 1: 64	Gaza (inland), 5.14	Gazaeorum Harbour, 16.2
	Gaza (inland), 16.2.30			Gaza (inland), 16.3
Raphia/Raphia Yam	Raphia, 16.2.31	-	Raphaea (inland), 5.14	Rapheia, 16.3

Table 2. Twin-settlements in southern Levant (yellow: authors mention both coastal and inland town).

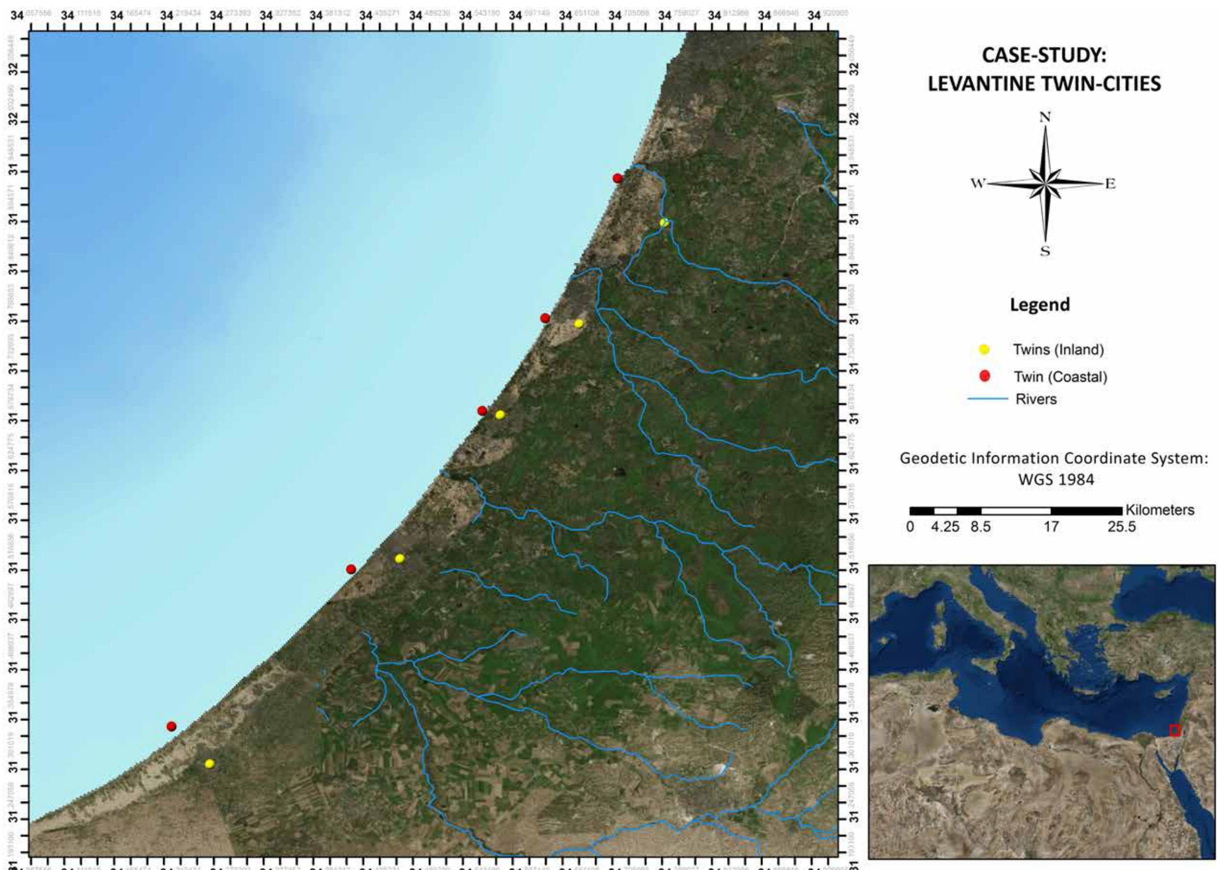

Figure 3. Pattern of twin-settlements on the southern Levantine coast (Map produced by the author).

Gazaeons and Raphia (Obied, 2017: 131-142)(Table 2; Fig. 3). In certain cases, twin-settlements are explicitly distinguished in ancient sources (such as Iamneia-Iamneia Paralios in Pliny, *NH* 5.14), while in others they are implied by the authors, who list both the coastal and inland towns. In the northern Levant, cases of twin-settlements, though fewer, include Seleucia Pieria, the main seaport of Antioch-on-the-Orontes (Strabo, *Geog.* 16.2; Brands and Meyer, 2006: 149-154).

Focusing on the southern Levant, we find a pattern of twin-settlements with a distance of *c.*3-6 km between the inland town and its linked daughter settlement on the coast (Blackman, 1982: 136). Due to this region's typically arid, low-lying coastline, there was limited availability of natural resources for cultivation. Thus, it is likely

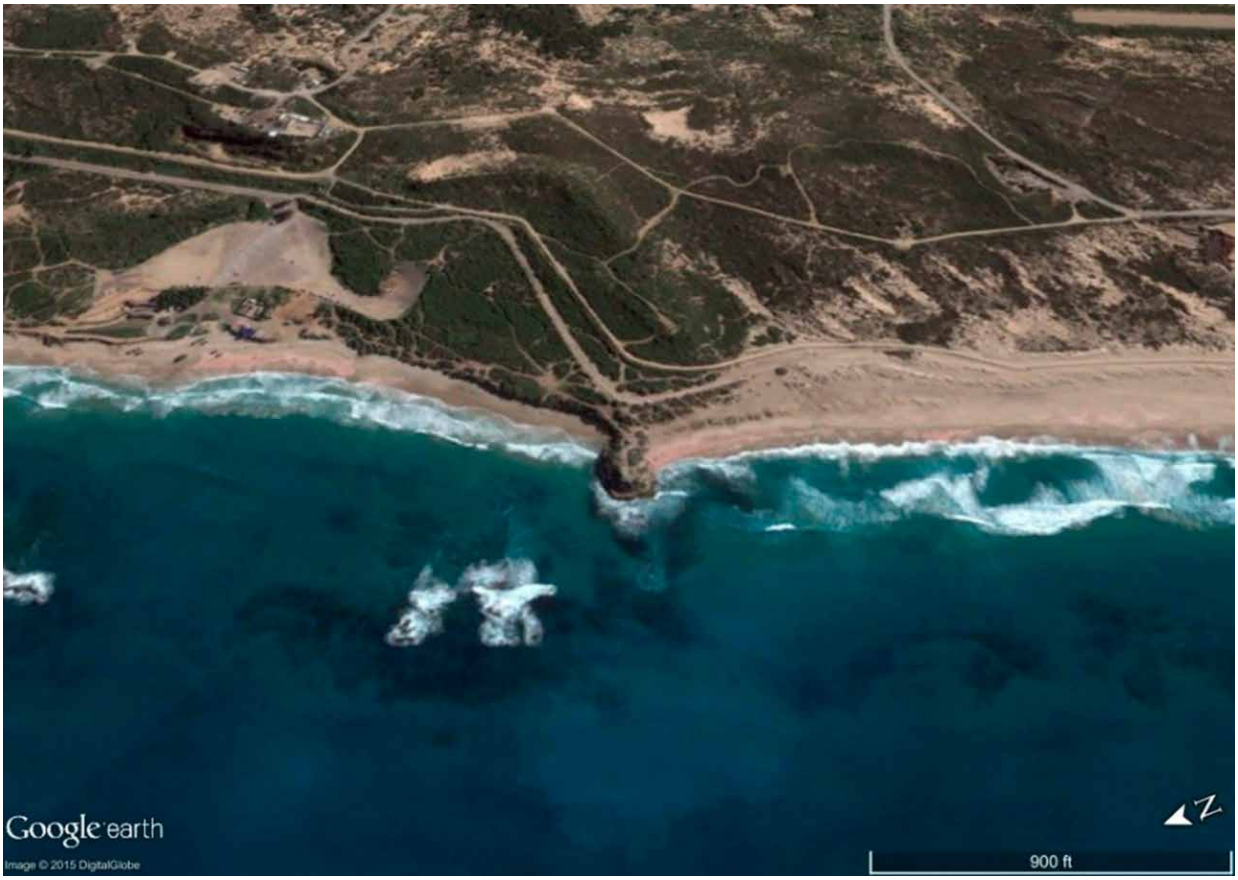

Figure 4. Bay of Iamneia Paralios (Image: Google Earth 2015. Yavneh-Yam, Israel, 31° 55' 22.062", 34° 41' 38.004").

earlier settlements were originally founded further inland where the land was fertile (Raban, 1985: 14; Blue, 1997: 31-32), then expanded towards the shore with growing maritime activity and trade, which led to developing linked port-towns on the coast. Regarding riverine settlements, this 'twin' arrangement was also connected to navigation upstream and the provision of a better-protected upriver harbour-town or village. As a result, these inland settlements tended to be situated on the coastal plain, or near it, close to navigable rivers and streams, allowing smaller vessels to navigate upstream from the estuary. This pattern is also attested along estuarine rivers in the Middle Bronze Age, with several settlements established on the coast at a river mouth, with a second settlement further upstream linked by the same river, usually 'where the river course intersected one of the shore parallel sandstone ridges' (Raban, 1985: 14). Similarly, they were a characteristic feature of the Greek world, referred to as *epineion*/ἐπίνειον, a coastal place at a distance from its political centre, *asty*/Ἄστυ (Lehmann-Hartleben, 1923: 24-26; Rougé, 1966; Blackman, 1982: 193; Bonnier, 2008: 54-57). Parallels of twin-settlements are found in other parts of the Mediterranean such as Rome and Ostia, Athens and Piraeus, Troezene and Pogon, and Gortyna and Leben (Semple, 1908: 78-79, 1916: 137).

Case study: Iamneia-Iamneia Paralios

The fortified maritime town Iamneia serves as a good case study of a 'twin-settlement' distinguished as such in certain ancient sources and attested archaeologically. Iamneia Paralios-Yavneh-Yam (and its inland city Iamneia-Yavneh) is *c.*20 km south of Jaffa-Tel Aviv and north of Azotus-Ashdod (Fig. 4). It had a good natural harbour due to its central location and natural sheltered anchorage, used for maritime activities and serving the hinterland (Fischer, 2007: 204-206). Both Pliny and Ptolemy distinguish between the seaport and inland town, while Mela (*c.* 43 CE) completely omits Iamneia. Pliny (1st century CE) clearly expresses its 'twin' nature, '*Iamneae duae, altera intus*' (two towns Iamnea, one of them inland, *NH* 5.14). Ptolemy (2nd century CE) lists coastal 'Iamneia Paralios' ('Iamneia-on-the-sea', *GH* 16.2-3), between Ashdod and Jaffa, and inland Iamneia, so the link is presumed. Though Strabo does not reference two distinct cities, he says Iamneia was 200 stadia from

Azotus and Ascalon (*Geog.* 16.2.28-29) and was Iope's 'neighbouring village'. Josephus describes Iamneia as a coastal town (*AJ* 13.10.395), yet also an inland town (*AJ* 14.4.75, *BJ* 1.7.156). It is also depicted on the Peutinger Table, and inland on the Madaba Map.

Prediction models and observed evidence for sea-level from the Carmel coast show, after 4000 BP, only a slowly rising sea-level in the Late Bronze to Iron Ages (late 13th-11th century BCE), while for the Hellenistic period, evidence from Tel Dor and Yavne Yam indicates that present sea-levels were reached by 2400-2000 BP (Sivan *et al.*, 2001: 114). In the Roman period, our knowledge of Iamneia-Yavneh and Iamneia Paralios-Yavneh-Yam is strengthened by historical and literary sources rather than archaeological evidence, which is scanty for the Hellenistic and Roman eras in particular (see Fischer and Taxel, 2006; 2014).

Pliny's account of Iamneia as a twin-settlement seems a notable mention, particularly as he emphasizes the inland town, which could reflect its regained administrative importance during that period. However, the extent of the link between the inland and coastal town of Yavneh is still not fully known, 'particularly during the periods when a settlement existed at both sites, Middle Bronze Age II and from Iron Age II until the end of the Early Islamic period' (Fischer and Taxel, 2006). This raises the question of how we can identify and corroborate this inferred connection between twin-settlements in the archaeological record.

At the inland site of Tel Yavneh at the foot of the tell, archaeological records show a range of artefacts from the Middle Bronze Age II to Ottoman and modern periods (Kaplan, 1957; Fischer, 2002; 2005; 2007; Fischer and Taxel, 2007: 230-245; 2008; Fischer *et al.,* 2008). Such finds, including architectural remains and pottery spread across from the tell, reflect the extent and continuity of this inland town and its significant role on this coastal plain, with its greatest peak in the Byzantine period (Fischer and Taxel, 2007: 230-241). Similarly, underwater surveys in the area of the ancient harbour of Yavneh-Yam have revealed remains of continuous maritime activity from the Middle Bronze Age to the Byzantine (such as anchors, fishing equipment, sounding-leads, amphorae), though most of the remains date to the Hellenistic period, when the port flourished (*c.*2nd century BCE). The site is also heavily affected by erosion. Evidence validates that Yavneh-Yam served as a port from the 1st century CE for the imperial city Yavneh (*c.*24 km east).[10] In relation to this link, inland Yavneh was positioned at a crossroad on a major artery leading towards the coast, particularly to Yavneh-Yam. However, the area is covered in sand dunes and the precise road from Yavneh has not yet been determined. According to Fischer, we can presume 'one of these roads ran along the banks of Naúal Soreq, perhaps even up to its estuary, and thence continued southwards to Yavneh-Yam along the seashore' (Fischer and Taxel, 2007: 206-207; Dorsey, 1991: 60-61, 64, 185-186, maps 1, 13). Evidence for a road on this route throughout these periods is further strengthened by the discovery of other ancient sites along the navigable river Naúal Soreq (Fischer and Taxel, 2007: 207), which was likely used by small vessels navigating upstream, linking the sea-ports with inland towns and villages and the hinterland.

Discussion of Levantine twin-settlements

This phenomenon of 'twin-settlements', particularly evidenced along the southern Levantine coast, has the potential to reveal significant insights related to settlement arrangements, environmental and socio-political shifts, and coastal vs inland links and perceptions. However, identifying explicit connections between 'twin-settlements' in the landscape and archaeological record is a complex issue. Interpretations rely on contextual considerations relating to: distances between an inland centre and its presumed harbour-town, the settlements' scale and political significance during the period in question, ancient authors' personal knowledge of the region and the context or dates of their sources and, most significantly, the available supporting archaeological material found at these sites (and hinterland areas) in which direct links can be identified or inferred. The types of evidence that can be discerned for the Levantine region include:

- Regular distances between the harbour-towns and their inland centres: ranging *c.*3-6 km. These cases were confined to the southern Levant due to its topography. Many of these settlements were originally established further inland and upriver, at the highest navigable point, where they could exploit the fertile land and agriculture for sustenance, while using harbours at the mouth of these rivers for commercial exchanges with other neighbouring coastal cities.

10 Yavneh-Yam Project: www.tau.ac.il/~yavneyam. In the Roman period, the site extended beyond the tell area. Roman artefacts include: pottery (including 'Herodian'); 'discus' lamps, 'Jewish' stone vessels; range of coins (including Herod Agrippa I; Roman city-coins); limestone ossuaries; tombs (1st-4th century CE). On a fragmented Greek inscription, see Isaac, 1991.

- Certain Levantine twin-settlements are explicitly distinguished as such by ancient authors: for example, Iamneia-Iamneia Paralios (Pliny, *NH*; Ptol., *GH*) and Gaza-Harbour of the Gazaeons (Strabo, *Geog*.; Ptol., *GH*). However, such distinctions referenced within ancient sources are scarce and do not appear to have been common practice.

- Presence of a road or navigable river that runs from the coast to the interior linking the two sites, as evidenced between Yavneh and its port Yavneh-Yam (Iamneia-Iamneia Paralios), and a possible link suggested with the nearby river, Naúal Soreq. Further evidence for such links includes bridges and walls or fortifications (as attested in Greece; Athens and its port, Piraeus, were enclosed or linked by 'long walls'). River-mouth harbours also served as coastal harbours connected to their sister harbours upstream. Links can be further supported by evidence of trade artefacts attesting to active exchange-communication between the people and towns in this region during the Roman era, particularly if the inland centre reveals a significant number of foreign trade items, which would likely have originated from the coastal harbour or trade port.

Analogous cases are attested in: a) different periods (for example, on estuarine rivers in the Middle Bronze Age), and b) different regions (for example, Greece, Crete, Italy, Carthage). These cases may help in recognizing similarities and variances in how and why twin-settlements developed and how they have been represented.

Islands and their *peraiai*

In considering the pattern of twin-settlements, islands and *peraiai* (as depicted in Graeco-Roman sources), can act as a 'bridge' unifying coastal and inland settlements. In the Levant, this pattern is observed with the island-state of Arados and its *peraia* ('the maritime tract of the Aradii' as described in Strabo, *Geog.* 16.2.12, in which he includes the mainland coastal towns Paltos, Balanea, Carnus, Enydra, and Marathos). Based on numismatic and archaeological evidence, settlements in the Aradian territory that minted coins of Aradian-type included: Gabala, Marathos, Carne, and Simyra (Seyrig, 1964: 12-15; Rey-Coquais, 1974).[11] Similarly, this control of mainland territories was exercised by Tyre, which Strabo compares to Arados (*Geog.* 16.2.23-4): both were rocky fortified island-states with limited natural resources, strategically profiting from their access to the mainland territories and resources. Perceptions of islands connected to the mainland due to geomorphological factors were also identified along the Levant. Recent geoarchaeological studies of coastal breakwaters and tombolos,[12] and palaeo-landscapes show that in the past (pre-imperial period) certain harbour sites were on islands, which became attached to the mainland over time through morphological coastal changes and artificial actions, such as Ras Ibn Hani, Sidon and Tyre (Frost, 2005: 45-52; Marriner, 2007; Marriner *et al.*, 2008a; 2012; Carayon *et al.*, 2011). In specific cases, this phenomenon of 'palaeo-islands' is noted by ancient authors: Strabo, Mela, and Pliny mention Tyre. Though it was a mainland settlement in the Roman period in which the ancient authors were writing, they unanimously refer to Tyre's 'palaeo-island' and tombolo, stating that its island became attached to the mainland due to the semi-artificial breakwater created by Alexander the Great in 332 BCE (Strabo, *Geog.* 16.2.22; Mela, 1: 65, Pliny, *NH* 5.17; Ptol., *GH* 15.5, 15.27; Romer, 1998: 53).[13] These descriptions of the landscape imply the ancient authors' knowledge of coastline configurations and corroborate with recent geoarchaeological research (such as Marriner *et al.*, 2007; 2008a; 2008b: 378), suggesting Alexander built the artificial breakwater on Tyre's shallow, submerged proto-tombolo, strategically exploiting the coast's natural morphodynamics.

Localized knowledge of the types of harbours and anchorages and their affordances along the Levantine coast would have influenced the mariner's chosen sailing route, as well as stop-off points for supplies, cabotage, or inland trade. Overall, control through the incorporation of territories, whether comprising areas of the mainland, settlements, or island clusters, denotes a certain sea power and is the political product of communication and exchange through regional imperial expansion.

Reflections on harbour terminology

Further links to perceptions of the maritime landscape can be traced from Ancient Greek and Latin harbour terminology (Table 3),[14] which can reflect a harbour's

11 Although ancient Gabala was part of Arados's *peraia* in earlier periods until the 3rd century BC, it is not mentioned in Strabo's Aradian *peraia*, implying his description (or source) is set in a later period, following Caesar's intervention in Syria.

12 Tombolo (spit): sand isthmus linking palaeo-islands to the adjacent mainland (Marriner *et al.*, 2008: 377).

13 Following this, Tyre served as Alexander's prototype for *Heptastadion* breakwater created in Alexandria's harbour to link the palaeo-island of Pharos to the mainland in 331 BC (Goiran *et al.*, 2005; Marriner *et aI.*, 2007), as depicted in Strabo (*Geog.* 17.1.6).

14 The focus here is on Greek terms as they have many words (and variants) to refer to ports, while Latin has one, *portus*, which has to cover the same semantic space (each language has distinct semantics) (see Liddel and Scott, 1996; Glare, 1976).

Simplified Key Harbour Terminology for the Levantine Coast

Ancient Greek	Transliteration	English Meaning	
Λιμήν:	*limen*	Harbour, port, or haven	
Derivatives/ Adj. of Λιμήν	εὐλίμενος	*eulimenos*	'with good harbours, of fine quality'
	εὐφυεῖ λιμένι	*euphuei limeni*	'of good natural disposition'
	ἀλιμένου	*alimenou*	Harbourless, shelterless
	λιμὴν κλειστός	*limen kleistos*	Closed or fortified port
	Λιμὴν ἔρημος	*limen eremos*	deserted port, with poor facilities, or shelter
ἐπίνειον / ἐπίτομον	*epineion*	port used by political (inland) centre compare with twin-settlements	
ορμος/ ὅρμος:	*hormos*	Anchorage, mooring, or roadstead	
Derivatives/ Adj. of ὅρμος	ὕφορμός / ὕφορμος	*hyphormos*	small anchorage
	θερινός	*therinos*	'for summer'
	τοῖς ἐτησίοις	*tois ethsiois*	'during the summer winds'
	παντοίαις ναυσίν	*pantoiais nausin*	'for all types of ships'
	πλοιαρίοις μικροῖς	*ploiariois mikrois*	'for small ships'
σαλος/ἐπίσαλός	*salos/episalos*	open roadstead	
ἐμπόριον	*emporion*	commercial centre	

Table 3. Simplified list of ancient harbour terminology for the Levantine coast. Definitions based on studies by: Lehmann-Hartleben, 1923; Rougé, 1966; Blackman, 1982; Liddell and Scott, 1996; Leonard, 1997; Counillon, 1998; Hansen and Nielsen, 2004; Bonnier, 2008; Arnaud, 2009; Buşilă, 2012; Kiesling and Isaksen, 2014. Note: The use and meaning of these terms are dependent on context (including source, period, region, and politics and bias).

functional, technical, or morphological features, and can be supported by archaeological evidence from these Levantine port sites. Thus, to understand the complex nature and role of these settlement patterns as described by ancient geographers, it is worth reflecting on the meaning of the various harbour terms used in the context of the Levantine coast (Lehmann-Hartleben, 1923: 24-26; Rougé, 1966; Blackman, 1982: 193; Leonard, 1997; Bonnier, 2008: 54-57; Medas, 2010). Along the Levantine coast, ancient authors generally use terms such as χωρίον/chōríon ('place') and Λιμὴν/*limen* (harbour, port, or haven), with *limen* being the most common, though *limenes* vary widely in type and characteristics (Arnaud, 2009: 174). More specifically, *limen* refers to a large, well-protected port (Rougé, 1966: 115-118). In the Levant, *limen* is used, for example, for Arados, Trieres, Berytus (Ps.-Skylax, 140), Gaza (Strabo, *Geog.* 16.2.30), and *Leukos Limen* (SMM 139-40) (see Buşilă, 2012: 235). *Limen* also appears in its derivative forms as qualifying adjectives (Rougé, 1966), such as εὐλίμενος/*eulimenos*, 'with good harbours, of fine quality', as attributed to Laodiceia (Strabo, *Geog*. 16.2.9), while Sidon is εὐφυεῖ λιμένι/*euphuei limeni*, 'of good natural disposition; naturally suited or adapted' (*Geog.* 16.2.22). Certain coasts, in contrast, were deemed ἀλιμένου/*alimenos,* 'harbourless, shelterless', as were the shores of Arados (Strabo, *Geog*. 16.2.13). *Limen* can also be accompanied by adjectives denoting the nature of a port, such as λιμὴν κλειστός/*limen kleistos*, 'closed or fortified port'; for example, Sidon and Berytus (Ps.-Skylax, 104; Lehmann-Hartleben, 1923: 68). Certain *limenes* were described as Λιμὴν ἔρημος/*limen eremos*, 'deserted harbour', which may reflect a harbour's abandoned state, or denote its poor facilities, or lack of shelter (cf. Counillon, 1998). A similar term to *limen*, that prevailed in Roman or Byzantine texts, is ἐπίνειον/*epineion*, a port used by a nearby political centre, city, or community (Ἄστυ / *asty*), often further inland, as seen at Levant twin-settlements such as Iamneia-Iamneia Paralios (Strabo, *Geog.* 6.2.4; Rougé, 1966: 109-110; Lehmann-Hartleben, 1923: 24-26). It can also mean 'arsenal' as with Carnus in Strabo (*Geog.* 16.2.12), though in SMM 128 it is described as σαλος/*salos*, an 'open roadstead'. The term ἐμπόριον/*emporion*, 'commercial centre', is only used in the Levant by the *Stadiasmus*, for Antiochia-on-the-Orontes (SMM 164). Additionally, ὅρμος/*hormos* (and its derivatives) is also used in ancient sources to mean 'roadstead or anchorage' (Rougé, 1966: 116), often accompanied by adjectives relating to a port's capacity, such as 'for summer', 'for all types of ships', 'for small ships', and 'during the summer winds' (*SMM*, verses 39, 14, 57, 63). Harbour toponyms could also be indicative of local resources such as freshwater sources or landmarks for mariners (as noted throughout the *Stadiasmus;* see also Strabo, *Geog.* 7.7.5). These various linguistic topographies and harbour indications may thus reflect ancient authors or mariners' knowledge of this coastal stretch.

Ship types and seaworthiness

As illustrated, Levantine coastal sites tended to be linked to a nearby river or stream, with river mouths serving as natural anchorages, navigational markers, freshwater sources, and inland communication. Vessels would often use the *chôma,* a breakwater on the outside of a port, for commercial exchange or unloading onto smaller vessels or barges moving upstream (Arnaud, 2016: 3). This complex network was facilitated by secondary harbours along the coastal route, as well as sea-ports functioning in tandem with fluvial harbours upstream, particularly with developing maritime trade in the Roman period. As rivers are shifting features of the landscape, changes in the coast and associated rivers often led to settlement adaptation, as at Akko-Ptolemais where natural processes such as sediment input likely contributed to the harbour degradation, causing a shift from the tell to the peninsula's bay, where an artificial harbour was built (Artzy, 2012: 6; 2015: 206; Giaime *et al.*, 2018). Conditions of such fluvio-maritime secondary ports or moorings would influence route choices and the efficiency of a journey (Raban, 1985; 1991; Blue, 1995; 1997; Arnaud, 2011: 417; 2016). The archaeological record attests a range of vessel types and sizes active during the Roman period, including large merchant-ships, medium-sized trading vessels, and smaller vessels for local work, as well as specialized vessels, such as dredgers, river barges, and lighters (Parker, 1992: 1-33; 1995; Casson, 1995: 159; Janni, 1996; Whitewright, 2008: 64; Wilson, 2011: 39, 54). Evidence for the relative size of ships and their style and function is further supported by the Althiburos mosaic (*c.*4th century CE), compared to Pliny's list of vessel types, *NH* 7.56). Different ship types were adapted to different types of harbours and journeys.

Papyrological evidence, though rare, also yields valuable insights into the nature of trade and trading vessels in the Levant. Sea journeys mentioned in the *Stadiasmus Maris Magni* follow the coast from Balanea to Laodiceia, thence to Posidium, then on to Seleucia Pieria, with small harbours and anchorages listed on the journey (for example, Paltos, Gabala, Heraclea, White Harbour, and Orontes River). Small coaster-merchant galleys, '*akatos*/*actuaria*' (Rougé, 1966: 60-61), were likely used on this route and were a predominant vessel type in the eastern Mediterranean, as attested by *Papyrus Bingen 77* (early 2nd century CE). *P. Bingen 77* attests coaster-ships, such as *akatos,* and active sailing routes from harbours of Paltos and Laodikeia:

> …From Paltos. 20. [The ship] of Zenon, son of Protos, 'Dragon'; 2500 artabae. Transport for Heliodoros 500 jars of wine.; From Laodike, 18. The ship of Kassianos, son of Kyros and of Dominios, son of Agathokles, "Elpis and…". Isi( ); 2000 artabae, transported for Dominios [x jars] of wine…" / ( ) 15Πά̣λτου κ Ζ̣ήν̣ω̣νοστοῦ̣ Π̣ρώτ̣ου̣ [-ca.?-]̣ ̣ ̣ κ( )( ) Δρά̣κ̣ων ( )̣ ̣ ω̣τ̣( ) (ἀρτάβαι(?)) Βφ ἄγει Ἡλιοδώρῳ οἴν(ου) Λε… [-ca.?-] φ̣ Λαδικ(ειας) ιη Κασ̣ιανοῦ τοῦ Κύρου καὶ Δόμν[ου τοῦ Ἀγ]α̣θοκλέους ἄκ̣(ατος) Ἐλπὶς [-ca.?-]̣ Ἰ̣σ̣ι̣ ( ) (ἀρτάβαι) Β ἄγει Δόμνῳ οἴν(ου) […]̣ (*P. Bingen 77*, Heilporn, 2000: 342-346)

The average speed of these coaster vessels ranged between 1.6-3.5 knots (Heilporn, 2000: 346): unfavourable meteorological conditions probably slowed them down (Heilporn, 2000: 342). Slower speeds may have also been due to stop-offs at harbours and anchorages along the Levant. Levantine harbours and anchorages between Balanea and Seleucia (Paltos, Laodicea, Heraclea, White Harbour, Posidium) were often used by such merchant coasters to take on water and supplies, as well as for overnight anchoring, and shelter while awaiting the favourable winds required by this vessel type (Casson, 1971: 159; Davis, 2009). The range of data available (literary, archaeological, replica vessels) suggests that at that time, the practice of close-hauled sailing was common (Casson 1951: 143; Rougé, 1981: 22; Palmer, 2009; Whitewright, 2011: 7-11, 2012: 11; Leidwanger, 2013: 3305, cf. Arnaud, 2011), although the most stable and efficient point of sail was usually a broad reach.

The majority of distances collated by ancient geographers derived from:

> a corpus of durations, either converted into distances according to rather simple tables, or extrapolated after a combination of distances driven from durations … durations consist of the core of the common sense geography of ancient mariners and formed their legacy. (Arnaud, 2005: 61-96; 2014: 46)

As highlighted, coasting was a favourable option for ancient mariners sailing the Levantine coast. For example, during the Roman Imperial Period, it appears Phoenician merchant-ships returning to Alexandria often opted for the longer coasting route from Brentesium, including the Levantine ports along the final stretch of the journey (Philo of Alexandria in *Flaccum* 26; Strabo, *Geog.* 6.3.7, *C.282*; Arnaud, 2011: 63). Supporting archaeological evidence for coasting in the eastern Mediterranean coast includes anchors, sounding-weights, wrecks, and ceramics (Raban, 1991; Parker, 1992; 1995; Oleson, 2000; 2008; Galili and Rosen, 2007; Galili *et al.,* 2010: 125-146). Roman sounding-weights in the Levant are mainly attested along the southern Levant's low-lying, unsheltered coast, with notable finds at Dor, Appolonia, and Caesarea (Oleson, 2008).

Anchor use can also provide a valuable indicator of sailing patterns (Arnaud, 2011: 63), particularly in conjunction with shipwreck evidence, such as the Tantura B shipwreck (Dor/Tantura Lagoon), a Byzantine shipwreck hull found lying over the remains of a large Roman ship (Wachsmann *et al.*, 1997: 6-7, 112). Anchors have been found in the Levant, particularly in the southern Levant: for example, in Ashkelon, Atlit, Appolonia, and Yavneh-Yam (Galili and Rosen, 2007; Galili *et al.*, 2010: 125-145). The increasing number of small iron anchors kept on small vessels from the 3rd century CE to the Byzantine period is an indication of coasting and a growing number of anchorages used *en route*. It also suggests that anchors were lost snagged on the rocky seabed or because a vessel had to escape quickly from an anchorage that had become dangerous. Often, a fouled anchor could not be hauled back. Keeping several anchors on board was thus a mariner's means to counteract such challenges (Arnaud, 2011: 63). Research indicates that:

> ...small coasters were the majority of units engaged in commercial transportation, even at medium range … and shows that on comparable exchange medium distance lines, although less numerous, medium-sized vessels are vectors carrying more than half of business volumes, and the large vessels were not exceptional. (Arnaud, 2011: 35)

These sailing patterns were influenced by increased knowledge of the maritime conditions and advanced technological skills, efficient networks of communication and exchange, periods of peace and stability, and organized, specialized trade. Considerations of the various vessel types and number of anchors on board, particularly in relation to the prevalent coaster-ships in the Levant, can shed some light on the role of smaller settlements or anchorages and secondary ports on these described journeys and, in turn, on how mariners adapted to the coastal landscape and regional maritime conditions.

Conclusions: mariners and geographers of the Roman Levant

People moved and interacted within a maritime cultural landscape, and thus perceived this space in multi-faceted ways, dependent on a multitude of environmental and political-cultural determinants. The evidence presented here demonstrates the multivalent nature of perceptions and representations of the Levantine coastline in antiquity. By building on ongoing work by researchers challenging hodological models and adopting a 'common sense geography' approach, this investigation has aimed to highlight the value of reconsidering the available corpus of maritime data (Geus and Thiering, 2014). The Levant's distinct topography played a key role in shaping local maritime navigation and perceptions of the landscape. In this context, at times less-conspicuous features could serve as useful intermediary navigational markers and anchorages, such as stopping-points for water and food supplies, shelter, and small-scale trade, which could add to our knowledge of localized navigation. References to islands and breakwater formations ('tombolos') in ancient accounts reflect a grasp of these types of morphological changes of the coastline, as well as human influence in shaping it. This was also the case with rivers and fluvio-maritime anchorages, often affected by dynamic changes of a coast and the morphologies of any associated river, in turn leading local maritime communities to adapt where they established their settlements or harbours. River mouths offered fluvio-maritime anchorages for vessels and extended links with inland and hinterland networks, revealing an important relationship between rivers and harbours along the Levantine coast in antiquity. The interaction between the prevailing maritime conditions, harbour affordances, and ships' capabilities affected the mariners' choice of harbours or anchorages on the Levantine coast.

As highlighted, the patterns explored reflect the important role of twin-settlements and fluvio-maritime secondary ports and anchorages within this network, showing a capability to adapt to shifting conditions, routes, accessibilities, and needs. Characteristic factors in the cases discussed were influenced by the distance between coastal and inland centres (that is, twin-settlements and *peraiai*), located in strategic positions with close access to both sea and the hinterland, as a means of linking coastal and inland activities. Varied perceptions among the ancient authors suggest the division was not clear-cut, though they do show a common tendency to focus more on the coastal landscape in their described journeys. Based on ancient references to twin-settlements and *peraiai*, such political annexations can provide insights into temporal and political-economic settings of the described settlements, as well as shifts in the landscape and/or town status. Such insights can thus potentially reveal the date and setting of the sources the ancient authors relied on and reflect the authors' diverse views on shifts in settlement arrangements, geomorphological changes, and ways of conceptualizing space. The natural maritime conditions of the landscape, as well as commercial and political events in the region, eventually led to the development of the aforementioned 'twin-settlements', as reflected in ancient sources and archaeological evidence.

Common patterns of twin-settlements and *peraiai* reflect ancient authors' tendency to perceive the *oikoumene* ('known world') in terms of divisions and links between the coast and inland, or islands and mainland (as highlighted by Aristotle, *De Mundo* 394: 3-4, cf. Davis, 2009: 41). The patterns emphasize the diverse nature of Graeco-Roman perceptions of the coastal landscape and generally reflect a perspective of this region largely influenced by multiple sets of sources (of varying nature), likely including earlier and out-of-date information. Nevertheless, their representations highlight the importance of maritime places, along with the activities in this area and interconnectivity between coastal harbours and centres with those in the hinterland. Furthermore, archaeological data in the region such as harbours, anchors, sounding-weights, wrecks, ceramics, and papyrology shed light on critical factors that affected sailing and trading practices in the Levant, characterized by different ship types adapted to different harbour-types and a journey's purpose.

The regional differences in the accounts and perceptions are noteworthy, as they can reflect the specific geopolitical contexts the authors were writing in, and what led to their descriptions. Overall, the ancient authors generally show an awareness of the landscape and serve as a valuable source, as long as we take into account the nature and purpose of their works, as well as the geopolitical factors influencing the region and their ideologies.

Navigating the maritime cultural landscape is dependent on the perceptions of the mariner undertaking the journey, and in turn, this could provide geographers with first-hand insights from which to draw more practical accounts. Physical features of the landscape played a fundamental role as natural landmarks, as distance or boundary-markers, as anchorages, and as a means of communication within a dynamic exchange network connecting sea and land. The various natural signs and landmarks depicted in these ancient treatises are thus interconnected with memory and mental maps, familiarity, and experience of the seascape, and an ability to adapt to change. These navigational markers reflect dynamic representations of cultural practices consisting of embodied skills that involve specific ways of perceiving the landscape. These perspectives are intertwined with mariners' and travellers' practical knowledge rooted within geographers' notions of spatial constructs.

The nature and structure of the sea journeys described by ancient authors were driven by mariners' cognitive experience of sea travel within the maritime cultural landscape. The key significance of approaching this research data through the range of ancient sources lies in the different contexts they offer in terms of their genesis, genre and style, spatial-temporal setting, purpose, and intended audience. Yet they also share similar influences on forming their perceptions and descriptions, thus providing us with a more holistic image of the heterogeneous nature of writing during the Roman period and the importance of the sea and mariners in shaping these ideologies. As mentioned, recurring traits can be noted in the works of ancient authors, such as referencing the coastline and rivers to locate the descriptions within the *oikoumene* (Talbert, 2010: 4; Scheidel, 2014). These traits are a means of conceiving and representing knowledge, power, and understanding of the maritime cultural landscape and its connection with cosmological phenomena. Through re-evaluating the ancient sources, implicit practical elements and multi-dimensional perspectives emerge in the form of bird's-eye panoramic views, on-board perspectives, the mental maps of mariners and travellers, and linguistic topographies using toponyms as a reference. In this way, the wide range of sensory navigational markers created a 'memory database' of places and features along a journey (Thiering, 2012: 33).

Overall, the ancient geographic treatises and *periploi* echo an ability to distinguish, memorize, and categorize features and places for navigating and mapping the landscape in the Roman period, as well as adding cultural meaning to these reference markers and spatial representations. These references are not static: context and accumulated experience are central to the type of data transmitted by these ancient texts. These ancient geographic accounts thus act as verbal representations of sea journeys, demonstrating a more intimate insight into 'experiencing' the Roman maritime cultural landscape based on multisensory navigation. From the 'scientific scholars' and 'common sense geographers' to the mariners, merchants, and travellers, Roman perceptions would have entailed multi-faceted worldviews that co-existed and advanced based on the dynamics between coastal and inland communities, the nature of these interactions, and their geopolitical sphere.

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The Rock-Cut Shoreline Features of Dana Island and the Maritime Landscape of the Taşucu Gulf, Rough Cilicia

Michael R. Jones

Dana Island in Mersin province, Turkey, was the focus of the Boğsak Archaeological Survey's fieldwork in 2016 and 2017. Cilicia's ancient inhabitants used Dana Island as a site for a port, quarries, and a fortress; activity peaked in the Late Antique period (4th-6th century CE). Rock-cut features along the island's northwestern shore include building foundations, cisterns, quarries, and sloped features initially suspected to be slipways for ships – however, these last features more closely resemble well-preserved quarries further inland. This paper examines shoreline features on Dana Island and neighbouring coastal sites, and their relationship to ancient maritime activity.

Keywords: Boğsak Archaeological Survey (BOGA), quarries, slipways, Byzantine trade, Isaurians, Late Antiquity, Cilicia.

The Boğsak Archaeological Survey (BOGA), directed by Günder Varinlioğlu of Mimar Sinan Fine Arts University, focuses on a 20 km section of the coast of eastern Rough Cilicia (Mersin Province, Turkey). The survey area consists of the shoreline and hinterland of the Taşucu Gulf from ancient Aphrodisias in Cilicia to the west (modern Ovacık) to ancient Holmoi (modern Taşucu) to the east. Although a mountainous ridge blocks access to the interior from the sea along 16 km of this coastline (Figs 1-2), ancient settlement remains are concentrated at several mainland harbours, including the double harbour on the Ovacık peninsula (ancient Aphrodisias), Tahtalimanı (possibly ancient Palaia), and the bays at Boğsak (ancient Asteria) and Ağa Limanı (Varinlioğlu *et al.*, 2017: 50).

During the 1st millennium CE, Holmoi, at the mouth of the Göksu (ancient Calycydnus) River, was likely the most significant port in the region: it was the sea access route for Seleucia *ad Calycadnum*, some 8 km upriver, which was the province's main military and administrative centre (Vann, 1998: 309; Varinlioğlu, 2007; 291-294). Seleucia may have served as a regional supply base (perhaps including naval installations for warships) in the Byzantine-Persian war, when a mint was briefly located in the city in 616-617 CE (Foss, 1975: 743-744). Unfortunately, the remains of ancient Holmoi are likely located under layers of silt and possibly under the modern town of Taşucu. Although several smaller sites have also been identified on the coast, it has not been fully explored (Varinlioğlu, 2017: 245).

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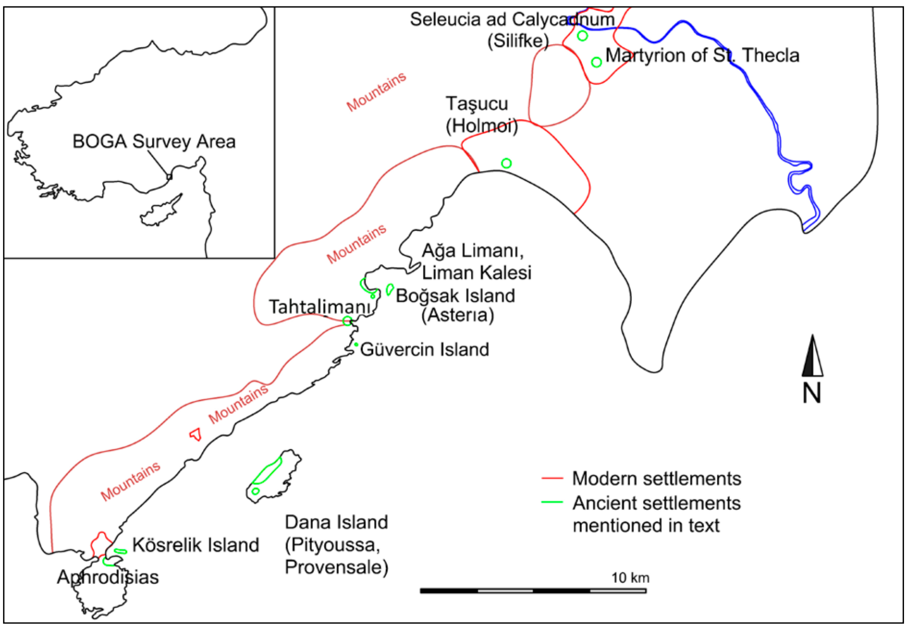

Figure 1. Dana Island viewed from the mainland (Photo M. Jones).

Figure 2. Map of the BOGA survey area with sites mentioned in the text (After Varinlioglu et al., 2017: 51, fig. 1).

The BOGA survey area includes four islands close to the mainland: Boğsak, Dana, Güvercinlik, and Kösrelik, all of which feature archaeological remains dating primarily to the Late Antique period (*c.*4th-6th century CE). While Güvercinlik and Kösrelik are small islands that were perhaps used as Byzantine ecclesiastical sites, the larger islands of Dana and Boğsak sustained larger populations (Varinlioğlu, 2017: 245-248, 250-251). Such dense settlement, particularly on islands, fits the pattern seen across the Cilician coast and indeed much of the coast of southern Asia Minor during Late Antiquity (Foss, 1994: 45-48; Hohlfelder and Vann, 2000: 133-134; Varinlioğlu, 2007: 304-308; Rauh *et al.*, 2009: 285).

Ships carrying cargoes from Egypt and the Levant to points further west frequently sailed along this route, taking advantage of the prevailing westward-flowing currents, the diurnal cycles of land and sea breezes near shore, and the many islands and visible landmarks of the coast (Pryor, 2000: 12, 14, fig. 2, 15, 20-21, 24). This route was likely followed by the Bronze Age Uluburun ship from a Levantine port, and finds of anchors, amphorae, and other artefacts located during underwater surveys attest to seafaring along the Cilician coast from pre-Classical through post-Byzantine times (Evrin *et al.*, 2004; 2005; Toskay Evrin and Evrin, 2005; Ward, 2005: 124-125; Pulak, 2008: 297, 298, fig. 97, 299). The coast of eastern Rough Cilicia was a contested region at various points during the 1st millennium BCE: the Babylonian king Neriglissar defeated the Cilician king Appuašu in the area during a raid in 556 BCE, and the region later became a centre of Persian military activity (Rauh *et al.*, 2009: 270-271; Autret *et al.*, 2014: 597-599). During the Hellenistic era, Cilicia was a frontier region dividing the Ptolemaic and Seleucid empires, and its rugged coastline was later famous as a haven for the Cilician pirates defeated by Pompey the Great in 67-66 BCE (Mitford, 1980: 1235-1238). There are at least nine major fortified sites, ranging in date from the 1st millennium BCE to the Medieval period, along the coast in the BOGA survey area (Varinlioğlu *et al.*, 2017: 51). They were likely used both by the indigenous population – which had a reputation for banditry in antiquity – and garrisons from larger states and empires seeking to control the region (Lenski, 1999: 452-453; Hohlfelder and Vann, 2000: 133-134; Rauh *et al.*, 2009: 262). Meanwhile, local forests were an important strategic resource for navies: several common timber species in Cilicia, including

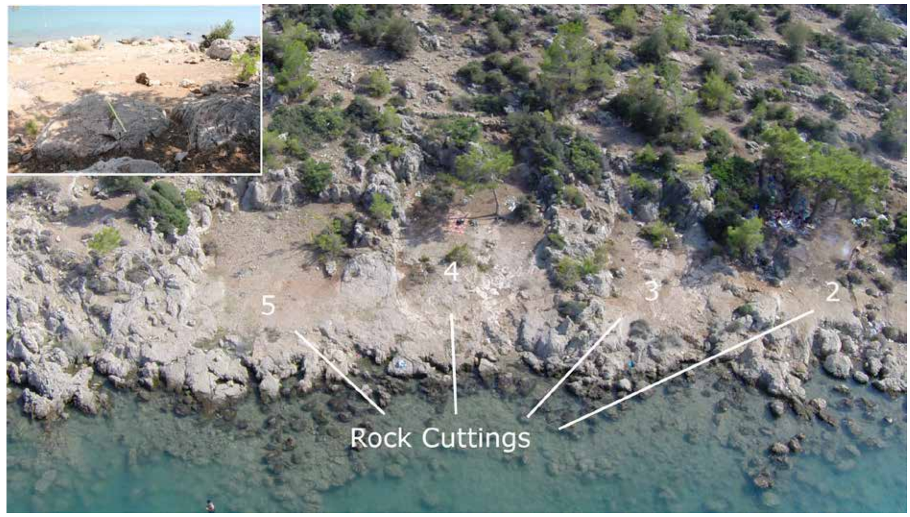

Figure 3. Overhead view of Boğsak rock-cut features photographed using a drone during the 2014 BOGA research season; inset, a suspected bollard in the back walls of the rock cuttings (Images BOGA Project).

cedar (*Cedrus libani*), fir (*Abies cilicica*), and (most likely) black or Calabrian pine (*Pinus nigra*), were felled for the construction of naval galleys, in addition to forest-related products such as pitch (Theophr. VII: 1-3, trans. Hort, 1999; Rauh *et al.*, 2009: 264-268; Akkemik *et al.*, 2012: 2; Akkemik, 2015: 53, 63, 95, 137-139; Pulak *et al.*, 2015: 45, fig. 5; Eger, 2017: 257).

After the Roman conquest, Rough Cilicia saw increased economic development and the establishment of new settlements. In the BOGA survey region, most ancient settlement remains date to the Roman and Early Byzantine periods, with activity reaching a peak in the 4th-6th century CE. Ships transporting *annona* cargoes of grain, wine, and oil from Alexandria and the Levantine coast to Constantinople sailed along the Cilician coast, in addition to sea-traffic with Cyprus and between local ports (Decker, 2001: 70-71; Iacomi, 2010: 27-28; Autret *et al.*, 2014: 610-611). Olive oil and wine production for export intensified, as shown by increased numbers of olive presses and threshing floors at Roman sites and the large-scale regional production and export of LR 1 amphorae from Cilicia and neighbouring regions (Decker, 2001: 76-78; Varinlioğlu, 2007: 304-308; Iacomi, 2010: 24-28; Demesticha, 2013: 170-173, 176-177; Autret *et al.*, 2014: 595, 604-612).

An important Christian pilgrimage route ran through eastern Rough Cilicia. The Martyrion of St Thecla in Seleucia *ad Calycadnum* and the complex at Alahan further inland were significant pilgrimage destinations: Varinlioğlu (2007: 293-294; 2017; 260-262; 2019) notes that churches in settlements along the sailing routes (including those in the BOGA survey area) would have attracted pilgrims in transit to more famous shrines. In addition to serving as demonstrations of piety, late antique church construction displayed the wealth and status of individuals in local communities, many of whom were connected directly or indirectly to maritime trade. A number of new churches were built in the BOGA survey area during the 5th and 6th centuries CE (Budde, 1987: 28; Varinlioğlu, 2007: 309; 2017: 246-250, 252-253).

Boğsak Island has been intensively surveyed since 2010, alongside terrestrial surveys of sections of the coast and its hinterland and limited underwater surveys in Boğsak Bay (Harpster and Varinlioğlu, 2015; Varinlioğlu, 2017). Although Boğsak is only 500 m long and 300 m wide, the late antique settlement, called Asteria in a documented 5th-6th-century inscription, covered virtually the entire island: its most intensive period of occupation was between the 4th and 7th century CE, when seven churches were built in the settlement, but pottery finds indicate continuing limited activity into the Middle Byzantine period (10th-12th centuries) (Varinlioğlu, 2017: 245, 258-259; Wohmann *et al.*, forthcoming). Remains on the mainland across from the settlement include a rubble wall enclosure, likely pre-Hellenistic in date, and late antique buildings, pottery and other small finds (Varinlioğlu, 2017: 252).

Dana Island's shoreline became a particular focus of interest after the documentation in 2013 of inclined rock-cut features on the southwestern shore of Boğsak Bay (Fig. 3a). These features range in length 12-16 m, 4.6-10.1 m in width and were initially identified as probable slipways for vessels (Harpster and Varinlioğlu, 2015: 23, 25). Their original lengths are likely preserved due to their location behind Boğsak Island, which offered some protection from wave erosion. Ridges in the bedrock were clearly cut down in the features, and rounded channels (100-200 mm wide, with similar depths) were cut behind at least four and perhaps all five (Fig. 3b); these cuttings might have been used as bollards although other explanations (such as millstone quarrying) are possible. Similar suspected bollards were documented in a rock cutting and possible slipway at Tersane Bay on the Lycian coast (Blackman, 2013b: 563-564, fig. B25.3-4).

At least 16 square holes (approximately 100-180 mm in cross-section and 110-200 mm deep) were cut into the bedrock further upslope. Although they do not appear to fit any clear pattern, they might have been related to quarrying activity or were perhaps used to hold wooden posts, bollards, or capstans. Alternatively, the site could perhaps be identified as a shoreline quarry area, based on worked faces in the features and several well-preserved quarry trenches delineating rectangular blocks documented upslope in 2018. Quarrying of the irregular limestone outcrops in this area would perhaps not have required the stone bollards at the site, unless they were added later. Nonetheless, some of the people of Boğsak village call the sloped shoreline features *çekek* or 'slipways', which could perhaps describe a later adapted use of the features (G. Varinlioğlu, pers. comm.).

The lack of rock cuttings for sleeper- and groundway timbers could indicate that loose timber sleepers or rollers were sufficient for hauling out smaller vessels. The location of the features near the shortest stretch of water between Boğsak Island and the mainland was likely suitable for hauling out or mooring small vessels used as ferries to and from the island or for other purposes: one of the main landing areas for the island, a flat natural formation with two sets of rock-cut stairways leading to it, is located on the south side of Boğsak Island, not far from the rock-cut features on the mainland (Varinlioğlu, 2017: 254, 255, fig. 7). Unfortunately, the Boğsak Bay features are difficult to date without further evidence.

Ancient Mediterranean slipways are generally identified as installations for naval vessels; no slipways for civilian vessels have been positively identified at other sites, although a few possible examples have been proposed (for example, Emporeio Bay at Alimnia) (Blackman, 2010: 16; Rankov, 2013a: 45; 2013b: 96). This association is due in part to the more frequent hauling out and maintenance required for naval vessels, although how often this was required in practice has been re-examined by some scholars in recent years (Harrison, 1999; 169-171; 2003: 78-79; Coates, 2012: 139-140; Lipke, 2012a; 2012b; Votruba, 2017). Documented Mediterranean slipways and shipsheds were built mainly in the Classical and Hellenistic periods, many for triremes and perhaps larger warships, although examples for smaller vessels are also known (Rankov, 2013a: 48; 2013b: 96-99). Classical-period triremes were at least 37-40 m in length and required slipways that were significantly longer; up to 140 men were required to safely haul out a trireme into its shipshed and 120 were required to launch one (that is most of the 200-man crew of such a vessel) according to a regulation from 5th-century BCE Piraeus (Blackman, 1987: 35-37; Casson, 1995: 302-306; Coates, 2012: 138; Rankov, 2013c: 117-118). Smaller rock-cut slipways may have been made for smaller Hellenistic-period *hemioliae*, reconstructed as 18-20 m long and about 3.5-4.5 m wide, which is longer and narrower than the Boğsak features (Baika, 2010: 75; 2013b: 342; Rankov, 2013b: 98). Shipsheds and slipways made of perishable materials were perhaps most common in antiquity, which may explain why few archaeological examples have been found. Textual references as well as excavated slipways built of materials such as earth and timber, sand, cobbles, and packed earth provide some idea of the variety of ways in which such installations were built (Blackman, 1988; 15; 2010: 13-15; 2013a: 124-129; Hurst, 2010: 32-33; Rankov, 2013c: 102-105; Baika, 2013a: 234; Gerding, 2013: 309-315; McKenzie, 2013: 382-384; Lentini and Blackman, 2014: 76-78). Ancient sources indicate that ships were sometimes hauled out on sandy beaches by digging a trench and lining its bottom with wooden groundway timbers carried on board for this purpose (Rankov, 2013c: 102).

Rock-cut features and other archaeological remains on Dana Island

Dana (ancient Pitusu or Pityoussa), is the largest island in the Taşucu Gulf, located 2.5 km from the Turkish mainland and approximately 20 km west of Silifke. It is a rocky island, 3 km long, 1.2 km wide, and 250 m in elevation. Although Dana's ruins have been reported on and visited for many years, the Boğsak Archaeological Survey is the first systematic archaeological study of the entire island: fieldwork began with reconnaissance visits in 2011 and 2014, followed by intensive surveys in 2016, 2017, 2018 and 2019; the results of the 2016 and 2017 surveys are presented here (Varinlioğlu, 2017: 248).

The island is occasionally mentioned in textual sources, including the Babylonian Chronicle, the *Stadiasmus Maris Magni*, and the *Acts of St Barnabus* (5th century CE), which mentions that the saint and his companions stayed at Pityoussa for three days due to foul weather. Dana Island is called Provensale in late medieval portulans, presumably after Provençal merchants or members of the Hospitaller crusading order: the latter was granted land in the region in the 13th century (Varinlioğlu *et al.*, 2017: 52). In the *Kitab-ı Bahriye* (*The Book of Navigation*, 1521), Piri Reis recommends anchoring at the north end of the island (advice repeated by at least one modern yachting guide) and obtaining water from cisterns there (Ökte, 1988: 1587; Heikell, 2006: 302). On the southern summit of the island there is a diamond-shaped, walled enclosure, 300 x 200 m, possibly Archaic period in date, and constructed of irregular, unmortared stones (Varinlioğlu *et al.*, 2017: 57; Rauh and Kaye, forthcoming).

Figure 4. Overview of Dana's shoreline, facing roughly north-east from the centre of the island's northwestern shore (left) and towards the southwestern end (right) (Photos M. Jones).

Small numbers of pre-Roman sherds were documented here, particularly in the rubble-fill of the walls, including Cypriot basket-handled amphora sherds (8th-3rd century BCE), the toe of a Hellenistic Rhodian amphora, and possible Late Classical (4th century BCE) Chian amphora fragments. Late antique construction is also represented in the southern citadel, contemporaneous with the vast majority of pottery finds at the site: structures from this period include fortress walls of mortared rubble masonry, a basilical church with an adjoining eastern chapel, two large, rectangular, vaulted cisterns (one 4-5 m x 2-2.5 m and several metres deep), and what appear to be mortared repairs to sections of the older walls (Varinlioğlu *et al.*, 2017: 57-58; Rauh and Kaye, 2017, forthcoming; G. Varinlioglu, pers. comm.). A stone stairway leading from the summit to the lower slopes may also date to this period (Varinlioğlu *et al.*, 2017: 58).

A settlement up to 1.5 km long and 150 m wide covers the lower slopes of the island's northwestern side, below quarries in which groups of rock-cut tombs were later made (Figs 4-5). Some of the most prominent archaeological remains are the rock-cut features along this shore, surveyed in 2016 and 2017 with the goal of identifying maritime installations. Such features could include shore-side buildings and quarries, break-

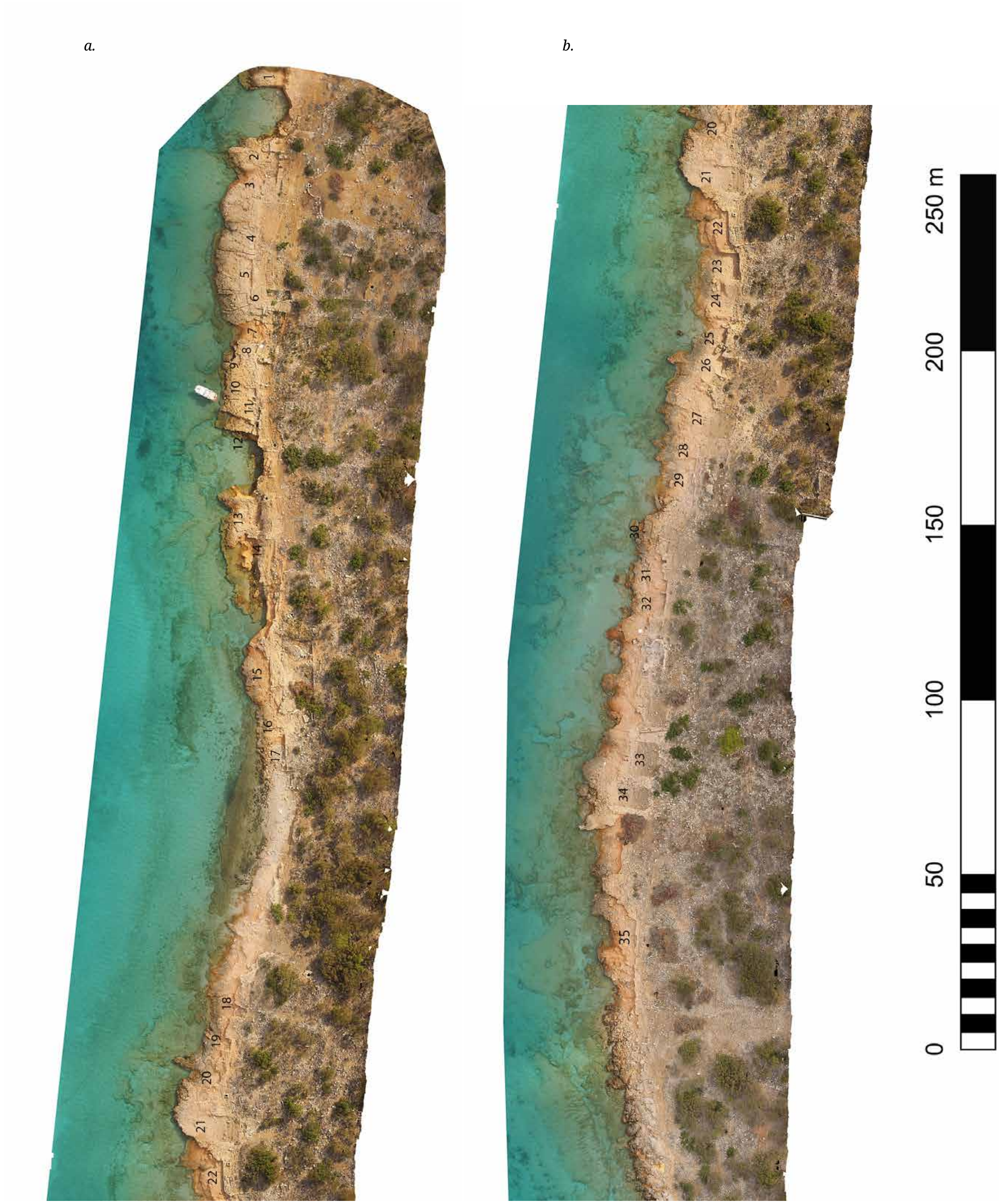

Figure 5. a-d) Photomosaic of rock-cut shoreline features along the northwestern shore of Dana Island. Major rock-cut features are numbered from north-east to south-west (Original image Tuğrul Oktaş/BOGA Project; adapted by M. Jones).

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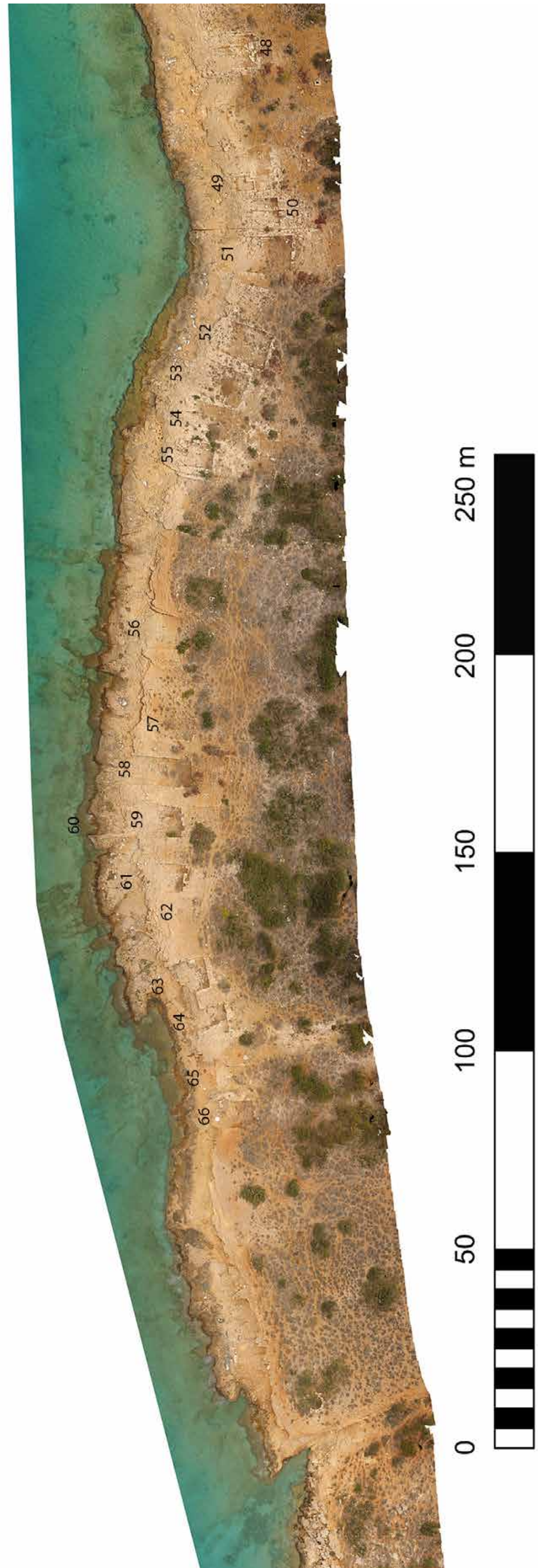
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250 m

waters, bollards, and landing stages, slipways and shipsheds, or evidence of local maritime-related industries such as *piscinae*, salt pans, or *garum*- or dye-processing installations.

Most buildings in Dana Island's lower settlement were constructed of limestone masonry with rock-cut foundations. Their masonry features suggest at least two phases of Roman or late antique construction, but architectural research on the settlement is still in an early phase (G. Varinlioğlu, pers. comm., October 2017). Remains of at least four churches dated stylistically to the second half of the 5th or early 6th century CE were identified here, contemporaneous with a number of churches in neighbouring settlements (Varinlioğlu *et al.*, 2017: 56-58; Varinlioğlu, 2017: 247, 249, 257). Two brick structures (unusual for Isauria, where stone architecture was most common) built along the shoreline appear to be baths fed by nearby cisterns; hypocaust *pilae* are visible inside one of the structures (Varinlıoğlu, 2017: 248, 249, fig. 3). Quarrying evidence was discovered above and to the south of the settlement as well as along the shoreline. Pottery ranging from the Classical to the Late Byzantine and Ottoman periods was collected during the survey of the lower settlement, but the vast majority of diagnostic sherds are Late Roman in date, with a peak in the 6th century (Figs 6-7) (Varinlioğlu *et al.*, 2017: 57, fig. 11, 58; Kaye and Rauh, 2017). An inventory of 148 copper or copper-alloy coins collected from Dana Island (without other provenience information) at the Silifke Museum consist almost entirely of copper *nummi* and other Roman and Byzantine issues; no earlier coins were identified (Kaye and Rauh, 2017). No prehistoric or Bronze Age artefacts were found during two seasons of surveys, and Classical and Hellenistic as well as post-Roman sherds were recorded in the lower settlement only towards the far northwestern end of the island (Varinlioğlu *et al.*, 2017: 58). These finds suggest that in most periods the island was used primarily as an anchorage and watering place for ships' crews. The citadel was also occupied in multiple periods, probably as part of a larger regional fortification system; it likely functioned as a lightly manned watch-post or beacon tower that could be reinforced with a larger garrison or used as a refuge by larger numbers if necessary.

Survey of the coastal rock-cut features began in 2014 with a shoreline photomosaic created using an aerial drone; individual features were then numbered on the photomosaic and documented on the ground in the summer of 2016 and 2017. Approximately 66 major rock-cut features were recorded along the shore;[1] this total does not include areas of natural erosion, cisterns, or smaller trenches, and channels, many of which seem

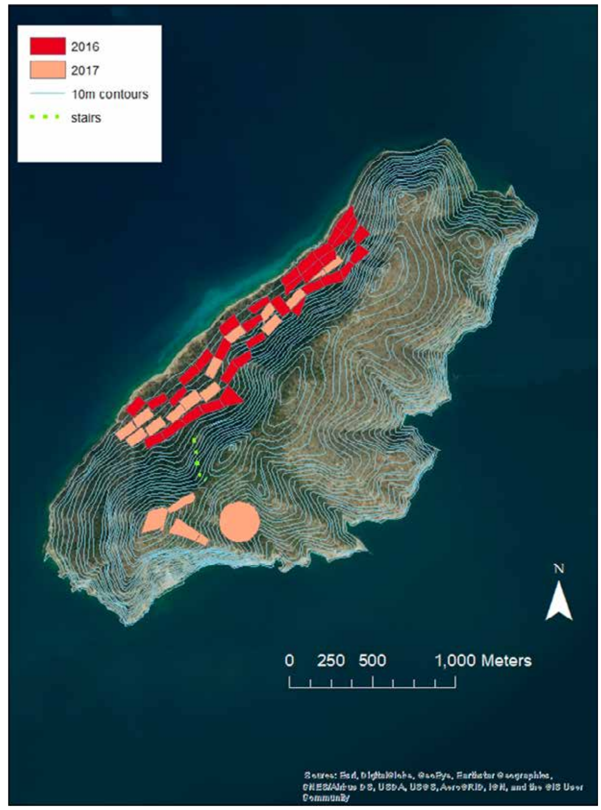

Figure 6. Survey transects traversed on Dana Island by the BOGA survey team during the 2016 and 2017 seasons (Image Noah Kaye, BOGA Survey Project).

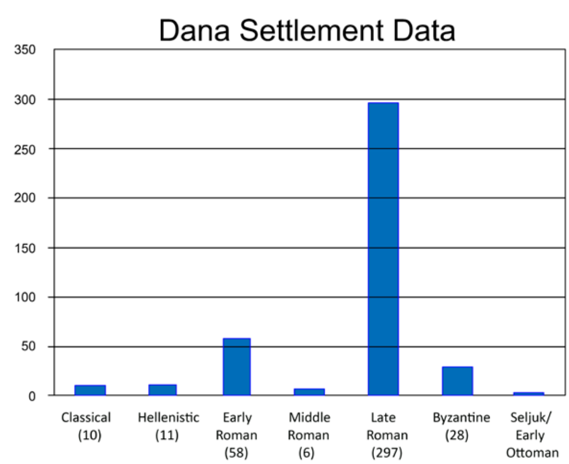

Figure 7. Diagnostic pottery finds from the 2016 and 2017 surveys of the coastal settlement, by period (Nicholas Rauh, BOGA Survey Project).

1 Numbers 36-40 were not used for numbering shoreline features.

Figure 8. Eroded areas along Dana's northwestern shoreline (Photo M. Jones).

to be the result of quarrying activity. The northwestern shoreline has been significantly eroded since antiquity, with up to several metres of the original rock cuttings damaged or completely destroyed by wave action (Fig. 8): wave-cut or marine notches and undermined rock formations are evident along much of the northwestern shore. Below the current shoreline, the seafloor drops a few metres (visible from the water's edge and in drone photographs) and no traces of rock cuttings extending further under water have been observed. Any sea-level changes due to seismic activity appear to have been minor (based on the surviving rock cuttings) although this needs to be corroborated by a geomorphologist. Some rock-cut shoreline features are also partly obscured by soil and rubble, particularly towards the island's southwestern end.

Up to 33 listed rock-cut features appear to be foundations for buildings, particularly along the shore's northern half. Similar to better-preserved foundations further inland, these features were cut into the bedrock with vertical walls and level floors (Table 1). The brick buildings near the shoreline illustrate how they were used. Some foundations were cut into a softer, friable conglomerate layer below the harder stratum of limestone in which most of the rock cuttings are preserved; this lower stratum was too soft for cutting ashlar blocks, and many of these features suffered substantial erosion (Fig. 9). Courses of ashlar blocks, remnants of mortared rubble walls, and (in one case) flagstones are still *in situ* in several of the rock cuttings (Fig. 10), but most foundations along the shore have been robbed completely: they clearly provided accessible *spolia* and ballast for passing ships. Possible landing-places along the northern section

Figure 9. The surviving brick structures, which were not robbed for building material, provide a clear illustration of how many of the rock cuttings along Dana's shore were used as building foundations. The foundation here is cut into the more friable stratum below the quarried layer (Photo M. Jones).

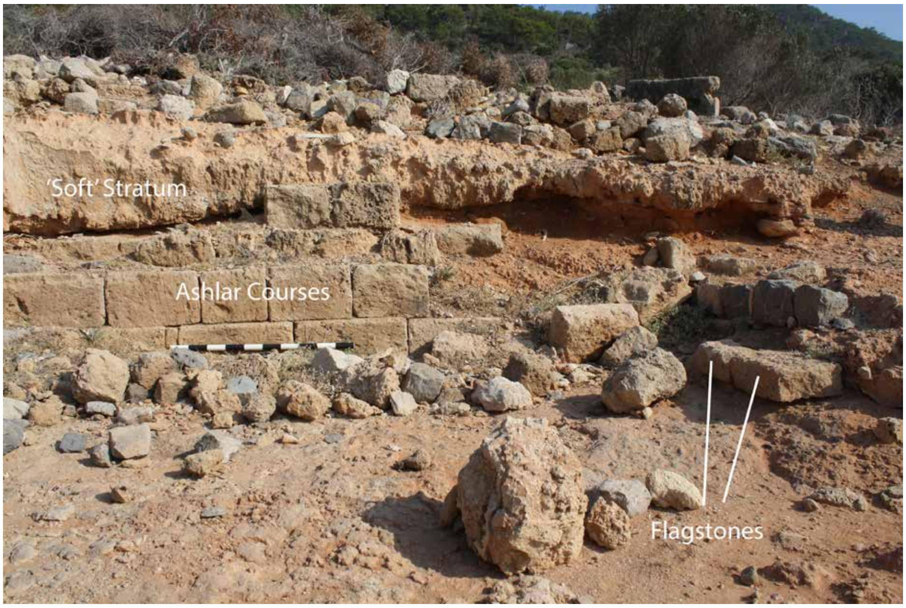

Figure 10. Feature 35, a rock-cut building foundation showing remains of walls and flagstones in situ (Photo M. Jones).

Identification of feature:	Feature numbers: certain or probable	Feature numbers: possible
Building foundation	3, 5, 8-11, 23, 28, 30-32, 35, 44, 46 (Total: 14)	4, 6, 7, 13-20, 21, 22, 24-26, 29, 46, 47 (Total: 19)
Quarry	1, 2, 21, 33, 41, 42, 43, 47A, 48, 49, 49A, 50-52, 54, 55, 58-61, 63, 64 (Total: 22)	27, 34, 56, 57, 62, 65, 66 (Total: 7)
Quarry repurposed as a building foundation		45, 53 (Total: 2)
Other (landing stage?)		12 (Total: 1)
Other (foundation for crane or hauling apparatus?)		47B (Total: 1)
Total number of labelled and identified 'major' features	36	30

Table 1. Provisional catalogue of significant shoreline features on Dana Island.

of the shore include a set of eroded rock-cut stairs near features F 8 and F 18, similar to examples on Boğsak Island (Varinlioğlu, 2017: 255, fig. 7), and F 12, an eroded ramp which may have served as a landing stage.

Like Boğsak, there are no natural springs on Dana Island, and water was stored in rainwater-fed cisterns. A partial survey in 2017 recorded 85 cisterns, but perhaps 200-300 were dug throughout the settlement. Documented examples are nearly all bell-shaped and were originally capped with separate limestone cistern heads, unlike the large, rectangular, vaulted cisterns built under dwellings on Boğsak (Varinlioğlu, 2017: 256-257). Forty-nine cisterns, including one rectangular example, were recorded along the northwestern shoreline. Several are exposed in eroded areas of bedrock, and at least four (at F 28, 30, 44 and 47) were apparently situated inside buildings, based on rock-cut foundations and setting-beds for walls (Fig. 11). Most surveyed cisterns are partially blocked by debris, so accurate capacity estimates are difficult, but many were at least 2-3 m in depth: two were measured with depths of 4.3-4.4 m. None was found near the shoreline south of F 49, where the largest shoreline features are located. Here the slope is steeper, and while structural remains continue further inland, surface potsherd finds are nearly absent near the shore south of F 64. An unidentified round structure 3.55 m in diameter south of F 66 marks the southern limit of archaeological remains near the shoreline.

In several locations curved or meandering rock-cut channels, typically about 200 mm wide and of varying depth, were found descending to the shore (Fig. 12). These may have been used as drains for excess rainwater, possibly to prevent flooding during winter rains, as were trenches recorded on Boğsak Island (Varinlioğlu, 2007: 292). Other, shorter channels are likely quarrying or separation trenches (Ward-Perkins, 1972: 139-140, 140 fig. 1; Fant, 2008: 122, 123, fig. 5.1; Harrell and Storemyr, 2013: 24, fig. 7, 28, fig. 12). Long, straight trenches might have been used to efficiently delineate larger areas to be quarried around F 4-6, F 45-47, and F 50-51, similar to quarry features described in other regions (Ward-Perkins, 1972, 140-144; Harrell and Storemyr, 2013: 33-34).

Quarrying activity at ancient coastal sites was not unusual: quarries near navigable bodies of water were generally preferred in antiquity because of the lower costs of sea or river transport (Ward-Perkins, 1972: 141-143; Dworakowska, 1975: 96-97; Fant, 2008: 125; Russell, 2013: 138-139).

Approximately 12-14 larger, inclined rock cuttings, 7-10 m wide and 9-18 m long, seem to comprise a distinct type of feature towards the southern end of the island (F 42, 43, 45, 48, 50, 51, 52, 53, 54, 55, 58, 59, and possibly F 55A and F 56). These were initially suspected to be possible rock-cut slipways for ships (Figs 13-15) (Varinlioğlu, 2017: 249). They are separated from the shore by an eroded shelf 5-15 m wide. If they had extended to the current shoreline, their original lengths would have been 25-30 m: too short for triremes but adequate for some smaller ancient warships and rowed vessel

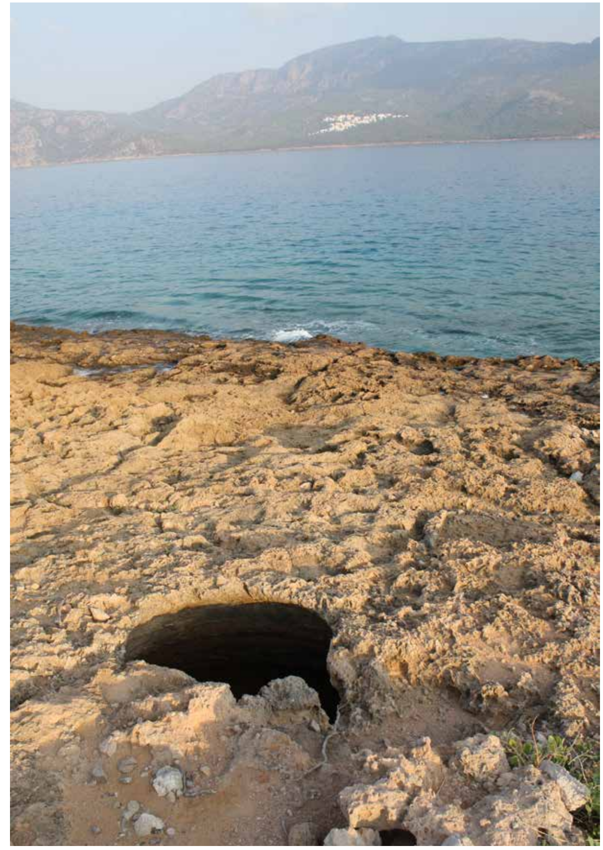

Figure 11 (right). Cistern opening in an eroded area of the shoreline near Feature 47 (Photo M. Jones).

Figures 12 a and b) Meandering rock-cut trenches leading to the shoreline, possibly drains (Photos M. Jones).

Figure 13. Feature 52, an inclined rock-cut feature (Photo M. Jones).

Figure 14. Feature 58 (Photo M. Jones).

types reconstructed as 12-25 m long (Table 2).[2] Remains of surviving slipways and shipsheds or their estimated lengths (in most cases original lengths have not survived) are typically 30 m or longer, with only a few documented examples under 20 m (Blackman and Lentini, 2003: 387, 392; Coates, 2012: 134; Blackman, 2013a: 131-132; Rankov, 2013b: 91-92). Several of the sloped features on Dana are either severely eroded or partially buried and therefore difficult to examine and measure without excavation. Most are cut to depths of approximately 300-600 mm, although several features towards the shore's southwestern end (F 58, for example) have one or more walls that are substantially deeper (1-1.3 m).

The early fortifications and pottery on the island combined with rock cuttings are reminiscent of rock-cut naval bases of the Classical and Hellenistic periods, that typically consisted of one or a few rock-cut slipways, often cut into rocky promontories and

2 Rankov estimates the lengths of several types of ancient warships based on *interscalmium* distances, from the 20-oared *eikosoros* (13-16 m) to the 30-oared triakonter, 50-oared bireme pentekontor, liburnian, (all 19-21 m), and the *hemiolia* (22-25 m) (Rankov, 2013a: 76, 85-92). Two smaller Roman vessels excavated in Pisa (Pisa Wreck C, a rowed vessel, and Pisa Wreck F) were approximately 11.7 m and 10 m long, respectively (Bruni, 2000: 45-47, figs 34-37).

Feature number	Width (upper or inland end/lower end)	Length (preserved)	Distance from upper/inland edge to shore (approx.)
50	6.9 m	9.2 m	25.3 m
51	10.8 m/ 9.0 m	(eroded)	-
52	8.8 m/ 9.0 m	16 m	29.6 m
53	6.5 m/ 8.8 m	14.5 m	27.0 m
55	6.7 m (near upper end)	15 m	15.5 m
57	5.6 m/ 6.0 m	12.2 m	26.2 m
58	7.0 m/ 7.8 m	18 m	27 m
59	7.8 m/ 8.8 m	13.2 m	25 m
61	7.2 m/ 8.1 m	7.3 m	24 m
63	8.5 m (middle)	10 m	24 m
64	4.3 m/ 5.1 m	11.2 m	16.8 m

Table 2. Dimensions of selected inclined rock-cut features.

Figure 15. View of Feature 58 from below (Photo M. Jones).

associated with networks of watch- and beacon-towers or other fortifications (Baika, 2013a: 231-251). The double harbour complex at Alimnia (ancient Eulimna) off the western coast of Rhodes may have been a larger rock-cut naval base: this site consists of 10 and 11 sloped rock cuttings in two harbours separated by an isthmus and overlooked by a Hellenistic fort (Baika, 2013c; 340). However, rock-cut naval installations of this scale, if indeed these are correctly identified as slipways rather than quarries, were likely rare and reserved for locations with exceptional strategic importance or other superior qualities (such as Alimnia's double harbour), and small naval dockyards associated with ports appear to have been more common (Blackman, 2003: 83-85). The BOGA team considered the possibility that a number of earlier slipways were interspersed and perhaps obscured by later Roman and Byzantine quarries and architectural remains, but no such evidence was identified during the 2016-2017 survey seasons.

In 2016, three of the larger features (F 50, 52, and 58), as well as the gradient of a fourth (F 49), were measured with a total station; these features were chosen based on their size, slope, preservation, and a relative absence of soil and debris. Recorded gradients ranged between 4.7 and 6.5 degrees, which is within the range of slipways built for ancient warships (Rankov, 2013b: 95-96). However, additional features would have been necessary to haul out and berth such vessels. All slipway surfaces in contact with a vessel's keel must be constructed with a continuous gradient in order to facilitate a successful launch (Rankov, 2013c: 110, 119-120). This was not the case in at least one of the measured features (F 52), in which the slope actually decreased towards its upper (inland) end (although a similar change in gradient was documented in a shipshed at Sicilian Naxos: see Blackman

Figure 16. Feature 47A, a quarrying area (left), and 47B, an unidentified feature (right) (Photos M. Jones).

and Lentini, 2003: 404). No clear evidence was found for a superstructure or for roof supports at any of these features, but superstructures of perishable materials and unroofed slipways were also used in antiquity (Blackman, 2013a: 138). Square holes 70-100 mm in cross-section and typically 50 mm or so deep are found in the rock at various locations. Since they are not situated in regular patterns in the exposed features, their function is perhaps related to quarrying methods rather than architecture. Larger holes 220-250 mm in cross-section near F 17, 47, 47A, and 51, as well as a round example 350 mm in diameter near F 42, may be post holes for bollards or capstans used for moving heavy loads, particularly those around F 47A; separation trenches and the shallow, irregular shape of this feature identify it as a quarrying area.[3] The function of a unique rock cutting nearby (F 47B) and a group of three square or rectangular holes (250 x 250 mm and 300 x 200 mm) closer to the shore between Features 47A and 47B is unclear, but such a feature could have perhaps been used for hauling machinery or other equipment (Fig. 16). No conclusive evidence was found in the sloped rock-cut features for stone bollards or columns that could have been used for mooring or hauling vessels ashore, in contrast to Boğsak Bay. If any such features existed near the shore they were almost certainly damaged or destroyed by wave action, although natural rock formations could certainly have been used for mooring in antiquity, as they are today.

The floors of the features also lack evidence for trenches or attachment points for the longitudinal groundway timbers or transverse sleeper-beams that are necessary to decrease friction on the keel as a vessel is hauled out of the water. Evidence of such timbers is found in many documented slipways and shipsheds, and similar installations are common even today (Fig. 17) (Blackman and Lentini, 2003: 400, 404-405; Rankov, 2013c: 102-106, 110-111; Blackman, 2013a: 125-126, 134; Baika, 2013a: 241-243, 245). It is possible that small vessels were hauled into the features on loose(?) wooden planks, and in fact, impressions of wooden timbers have been reported in some documented rock-cut slipways, but no such evidence was found in the Dana Island features (Baika, 2013a: 241). Alternatively, wooden cradles are commonly used for hauling out boats in the modern Mediterranean, but there is no conclusive textual, archaeological, or iconographic evidence for their use in antiquity (Coates, 2012: 135; Rankov, 2013c: 113-115).

Although documented shipsheds and slipways may vary in length and width on the same site (Rankov, 2013a: 92-95), the wide variation in the dimensions of the features on Dana Island, as well as their generally rough workmanship, suggests that they are evidence of quarrying activity rather than purpose-built slipways for warships or civilian vessels. Shallow trenches, likely traces of quarrying trenches around stone blocks that were later removed, are visible in the floors of several sloped features. Longitudinal trenches in the floors and back walls of some features were initially suspected to be 'keel slots', in which longitudinal groundway timbers were installed; a ship's keel would slide over the groundway timber(s) as it was launched or hauled out. Blackman (2013a: 129) now believes that keel slots in identified slipways 'should probably be best explained as holding timbers as part of a more complex system of timber groundways' (see also Baika, 2013a: 241-242). However, unlike 'keel slots' documented at a few ancient shipshed and slipway sites (such as Appolonia, Rethymno, Sicilian Naxos), the Dana Island trenches are shallower (usually 30-100 mm or, in one case, 200 mm, rather than 300-350 mm), are curved in some cases, and do not extend the entire length of the features (Blackman and Lentini, 2003: 390, 400; Baika, 2013b: 300; 2013e: 504; Blackman, 2013a: 129). These characteristics

3 Blackman (2003: 88-89) proposes that shipsheds and slipways were sometimes equipped with hauling machinery, although such equipment could also have been used for other heavy loads, including sledges loaded with quarried stone.

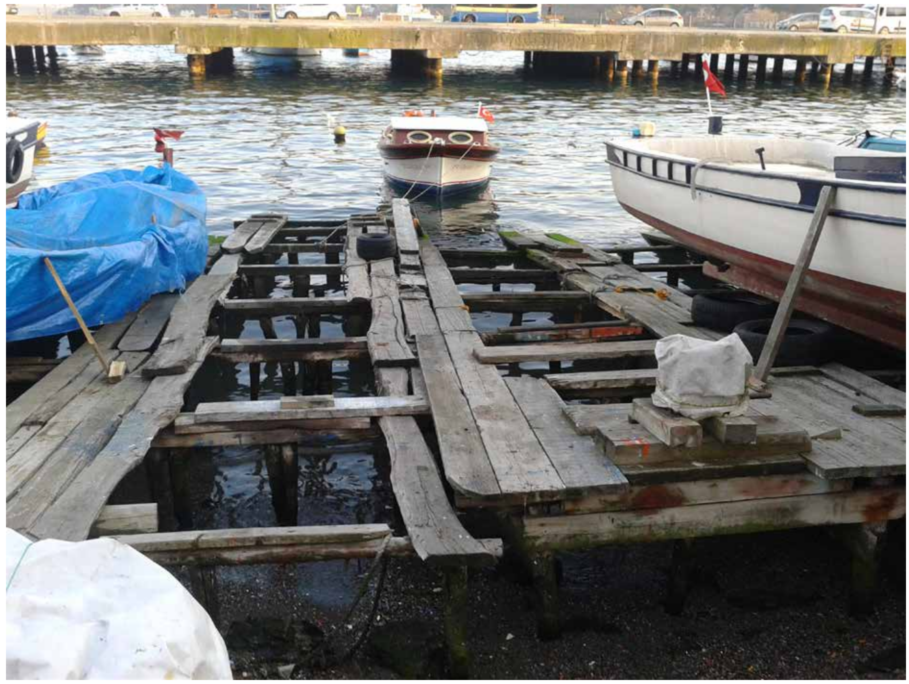

Figure 17. Modern wooden slipway in Sarıyer, Istanbul (Photo M. Jones).

Figure 18. Back wall of Feature 50 showing narrow and wide 'ramps', probably quarry trenches (Photo M. Jones).

suggest quarrying or separation trenches cut during the removal of stone blocks rather than features related to launching and hauling out vessels. The back or upslope walls of the features typically include short, sloped trenches or 'ramps' approximately 0.20-1 m wide, but significant variations in their shape, depth, and direction indicate that they are most likely the ends of quarrying trenches: narrower examples from the sloped features on Dana Island closely resemble a partially cut separation trench documented by Harrell and Storemyr at a Ptolemaic and Roman quarry near Edfu in Egypt (Fig. 18) (Harrell and Storemyr, 2013: 32, fig. 21). The wider 'ramps' in the back walls of some sloped features on Dana Island resemble cuttings at a shallow quarry-face near the island's summit.

Ramps and inclined surfaces are common in large-scale quarry sites, for moving heavy loads downhill. These inclines often follow a cleavage plane or particular stratum in the bedrock. The floors of both the inclined shoreline features at Dana Island and a number of the inland quarries are cut at a similar angle. Rock cuttings possibly used for bollards, cranes, or capstans are also

Figure 19. Sloped quarry faces further inland on Dana Island (Photo M. Jones).

features of some ancient quarry sites, and wooden bollards were used in some quarries into modern times to brake the descent of sledges loaded with stone (Ward-Perkins, 1972: 143, Pl. XII b; Dworakowska, 1975: 147; Adam, 2003: 23, 25-26, 31, 32, fig, 31; Fant, 2008: 124-125; Russell, 2013: 135-138). The shallow depths of some inclined rock-cut features near the shore also seem to support their identification as quarries. Dworakowska (1975: 148-149) cites several examples of shallow ancient quarries cut to the depth of one or two stone blocks, while Adam (2003: 27, 63-64) notes that the blocks extracted from many of the quarries around Rome were 600-650 mm in height (approximately 2 Roman ft), which is in fact fairly close to the heights of blocks removed from some quarry faces on Dana (Fig. 19).

The scale of quarrying across the island indicates that it was a major industry for its inhabitants. Some of the quarried stone was doubtless used for construction on the island, but much was likely exported as well, to neighbouring settlements – Boğsak/*Asteria*'s late antique structures most certainly used imported building materials – and perhaps to more distant destinations.[4] How long the quarries were in operation remains unclear. An area that the BOGA team designated 'The South Complex' was cleared of vegetation and mapped during the 2017 field season (Fig. 20). Here, building foundations had been excavated into bedrock while their upper sections were built with large ashlar blocks laid directly onto sloping walls; these are likely the original floor surfaces of an earlier quarry similar to the inclined shoreline features (Varinlioğlu *et al.*, 2017: 53, fig. 5). A small finds survey of the complex uncovered only Roman and Late Antique sherds. This construction style appears to be unique to Dana Island, but Roman and Byzantine ashlar buildings with rock-cut foundations are common throughout Rough Cilicia (Varinlioğlu, 2007: 311-312). The function and length of occupation of the complex is unclear, but it illustrates the adaptation of old quarries for new uses and is evidence of multiple occupation phases on the island.

Archaeological evidence on Dana Island is also consistent with other sources on the activities of the Isaurians of late antique Cilicia. The Isaurians are described in Byzantine sources as skilled masons: texts from the 5th and 6th centuries reference their employment in ecclesiastical construction projects in Syria, Anatolia, and Hagia Sophia in Constantinople, likely as seasonal workers, foremen, and occasionally master builders (Mango, 1966: 358, 361, 363; Gough, 1972: 199, 201). Such activity may have been particularly common during the reign of Emperor Zeno (474-491), a native of the region. Zeno funded the construction of new religious buildings at St Thecla's shrine in Seleucia *ad Calycadnum*, and his reign roughly coincides with construction projects at other Cilician sites (Mango, 1966: 358-359, 363-364; Gough, 1972: 199, 201; Elton, 2000: 295-299). While some Isaurian workers must have travelled overland to construction projects in inland Anatolia and Syria, others would have taken coastal sea routes, joining those working as sailors, merchants, and other tradesmen (Mango, 1966: 359, 361,

4 Murat Eroğlu of Gazi University in Ankara is currently completing an archaeometric analysis of building materials from Boğsak and Dana Island. This project will likely be expanded to local stone and clay sources in the Boğsak region in the future.

Figure 20. 'The South Complex': building foundations cut into old, sloped quarry faces (?) on Dana Island (Photo M. Jones).

363; 2019). Isaurians were prominent in the Byzantine army as well, another potential source of wealth and advancement for individuals from the region (Mitford, 1980: 1250-1251). Documentary and archaeological evidence demonstrating significant Isaurian involvement in the Byzantine Empire outside their native region coincides with the most intensive building activity and evidence for wealth and prosperity at settlements in the BOGA survey area.

Conclusion

The age of the shoreline rock-cut features on Dana Island is difficult to determine conclusively. However, the BOGA survey's results suggest that most, if not all, of the features found along the island's northwestern shore likely date to the Roman and Late Antique periods, when a substantial permanent settlement existed on the island. The function of sloped rock-cut features on multi-period sites may be particularly difficult to determine. Such inclines are required for ancient slipways for ships but were also used for quarries, landing stages, streets and warehouses; in some cases, identifications of such features as slipways for warships have been debated or re-evaluated (Blackman, 2013a: 139; Baika, 2013d: 497-498, fig. B18.2a-b; Yorke and Davidson, 2017: 51, 52, fig. 5).

Although they have some similarities to the positively identified rock-cut slipways from other sites, the inclined features on Dana's southwestern shoreline most closely resemble better-preserved quarries and building foundations found further upslope on the island. Their shallow depths and slopes are probably attributable to the selective exploitation of a specific stratum of rock or the deliberate cutting of ramps for moving loads of quarried stone to the shore. Also, these features lack many of the distinctive features found in other identified slipways and shipsheds, such as evidence for groundway and sleeper installations, somewhat regular dimensions, evidence for superstructures, or bollards or columns used when hauling and launching ships. However, this does not preclude the later use of some sloped quarries or landing stages as improvised slipways, especially for smaller boats. For the late antique settlement, locations suitable for hauling out and careening and repairing vessels or housing them for the winter were probably necessary, but such facilities can be quite minimal for small coasters (Hohlfelder and Vann, 2000: 131, fig. 7, 133, fig. 9). Ships and boats could also moor along the island's northwestern shore during much of the year.

Survey-finds suggest that Dana Island was only lightly settled before and after Late Antiquity, but at the least, it was used over a long period as a useful anchorage and watering place. Dana undoubtedly had a certain strategic value as well, and the early fortifications and pottery finds at the island's southern summit attest to its use as a fort or watch-post along a major maritime route and political frontier. The quarrying evidence on the island seems to correspond with the increased settlement and trade in southern Asia Minor during Late Antiquity, as does the evidence in Byzantine textual references to Isaurian activity as masons and builders outside Cilicia. More research is needed to understand the degree of involvement of Dana Island's Byzantine inhabitants in local, regional, and long-distance trade, but the *annona* trade with Constantinople certainly played a role in this region's prosperity. Dana was on an important maritime route for millennia, but apparently only the social and political conditions of the early Byzantine Empire seem to have stimulated intensive exploitation and settlement. The population of Dana and nearby sites appears to have dropped significantly by the 7th century, possibly due to Arab incursions. Small amounts of Byzantine pottery on Dana and Boğsak attest to a continued Byzantine presence, perhaps military in nature, but late antique levels of activity were not matched in this area until recent times (Varinlioğlu, 2007: 314-316).

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Appendix

List of presentations and posters exhibited at the Under the Mediterranean Nicosia Conference

*papers published in this volume, in the HFF Short Report (SR) series (https://honorfrost-foundation.org/publications/short-reports/under-the-mediterranean), or elsewhere. The references to independent publications concern mainly journal articles and may not be exhaustive.

Contributions	Publication*
Oral Presentations	
In the Footsteps of Honor Frost	
Sophie Basch: Honor Frost, true to herself. From art and ballet design to underwater archaeology: a single and singular fate	All in Blue, 2019
Keynote: Patrice Pomey: Honor Frost Under the Mediterranean: From Maritime to Nautical Archaeology	
1. Nicolas Grimal, Martine Francis-Allouche: Honoring the Lady of Byblos	
2. Ibrahim Noureddine: Harbour Installations at Tyre North	
3. Nicolas Carayon: The Impact of Honor Frost on Phoenician Port Studies in the Levant	
4. Nadine Panayot Haroun, Lucy Semaan: Preserving the Landscape of Anfeh: From Nature to Culture	
5. Jean-Yves Empereur: Honor Frost and the Alexandria Lighthouse	
6. David J. Blackman: New Perspectives in Harbour Research	
7. Gregory F. Votruba, Osman Erkurt: Building Upon Honor Frost's Stone Anchor Foundations: Typology, Experimentation, Spatial Analysis and Prospects for Anchor Studies	
8. Harry E. Tzalas: 1985-2008: The TROPIS Symposia on Ship Construction in Antiquity	
9. Elpida Hadjidaki: Three Decades of Adventures with Honor Frost	
10. Pietro Romano Alagna: The Archaeological Mission of the Punic Ship	
11. Rossella Giglio: The History of Marsala's Shipwreck Exhibition from the Beginning to the Present	
12. Claire Calcagno, Elena Flavia Castagnino Berlinghieri: *The Second Life of a Phoenix*: Honor Frost's Unpublished Chronicles of a Punic Ship in Sicily	
13. Crystal el Safadi, Naseem Raad, Ziad Morsy, Lucy Semaan, Dorothy Chakra: From One to Many: How Honor Frost's Legacy Shapes Scholars	-
Maritime Cultural Landscape	-
14. Julien Beck, Dimitris Sakellariou, Flavio S. Anselmetti, Despina Koutsoumba, Alexandra Zavitsanou, Morgan Surdez, Ioannis Panagiotopoulos, Ioannis Morfis: Late Pleistocene to Holocene Submerged Shorelines and Landscapes off Franchthi Cave, Greece	Beck *et al.*, 2017
15. Matthieu Giaime, Christophe Morhange, Nick Marriner, Matteo Vacchi, Miguel Angel Cau, Joan J. Fornós: Geoarchaeological Investigations on the Roman Harbour of Pollentia (Bay of Alcúdia, Mallorca, Spain)	Giaime *et al.*, 2017
16. Nena Galanidou, Dimitris Sakellariou, Alexandra Zavitsanou, Grigoris Rousakis: Exploring the Submerged Prehistoric Landscapes of the Inner Ionian Sea Archipelago, Greece	Galanidou, 2018
17. Theotokis Theodoulou, Nikos Papadopoulos, Kleanthis Simyrdanis, Gialuca Cantoro: Geo-Archaeological Investigations at the Submerged Remains of Ancient Olous (Crete): Preliminary Results from 2015	Simyrdanis *et al.,* 2016
18. Gilad Shtienberg, Justin Dix, Ruth Shahack-Gross, Assaf Yasur-Landau, Joel Roskin, Revital Bookman, Nicolas Waldmann, Sariel Shalev, Dorit Sivan: Anthropogenic Overprints on Natural Coastal Aeolian Sediments: A Case Study from the Periphery of Ancient Caesarea, Israel	Shtienberg *et al.,*2017

Contributions	Publication*
19. George Papatheodorou, Maria Geraga, Nikolaos Georgiou, Dimitrios Christodoulou, Xenophon Demas, Martine Francis-Allouche, Nicolas Grimal: Marine Geophysical Implications in the Ancient Harbour of Byblos, Lebanon	-
20. Christophe Morhange, Nick Marriner, David Kaniewski, Matteo Vacchi, Alexandra Bivolaru, Matthieu Giaime, Soumaya Trabelsi: The Geoarchaeology of Natural Hazards in Ancient Harbours	-
21. Mari Yamasaki: Cognitive Coastscapes in the Archaeological Context	-
22. Emad Khalil: The Marsa Bagoush Research Project – MBRP	SR 4, Khalil, 2020
23. Michal Artzy, Christophe Morhange, Amani Abu-Hamid, Matthieu Giaime, Harry Jol, Paul Bauman, Ann Killebrew, Jamie Quartermaine, Gloria López: Coastline, River Changes and their Effects on Anchorages / Harbours and Habitation Patterns: Akko (Israel) as an Example	This volume
24. Ehud Galili, Jonathan Benjamin, Deborah Cvikel, Danni Rosenberg: Inundated Neolithic Villages on the Carmel Coast, Israel	-
25. Elias Spondylis, Vasiliki Ivrou: Metohi: An Underwater Middle Helladic Site in the Pagasitikos Gulf, Central Greece – Interaction Examined Under the Notion of Maritime Cultural Landscape	-
26. Konstantinos Vouvalidis, Georgios Syrides, Olga Koukousioura, Katerina Kouli, Georgia Karadimou, Panagiotis Tsourlos Eleni Aidona, Domna Terzopoulou, T. Nathan Arrington, Marina Tasaklaki, F. Thomas Tartaron, Christos Domakinis: Locating Ancient Stryme in the Changing Palaeogeography of the Thracian Coast (North Aegean Sea, Greece)	-
27. Mantha Zarmakoupi, Magdalini Athanasoula: The Delos Underwater Survey Project (2014-2016)	Zarmakoupi, 2018
28. Michele Stefanile: Fishponds and Maritime Structures in the Roman *villae maritimae*: New Data from the Southern Latium Underwater Survey	-
29. Athena Trakadas: The Maritime Cultural Riverscape of Ports Along North Africa's Atlantic Façade	-
Maritimity: Between Land and Sea	-
30. Aurora Higueras-Milena Castellano, Antonio Manuel Sáez Romero: An Embracing Seaport beyond the Pillars of Heracles: The Area of La Caleta (Cadiz, Spain) in Phoenician and Punic Times	Saez Romero and Castellano, 2018
31. Linda Hulin, Senta German: Up from the Sea: Mariner Cultural Worlds in the Late Bronze Age Eastern Mediterranean	-
32. Christina Marangou: The Kastro Coastal Rock-cut Site (Myrina, Island of Lemnos): Metaphorical, Representational and Tangible Maritime Aspects	-
33. Shelley Wachsmann: The *ploiaphasia/navigium isidis*: A Possible Modern Continuation?	-
Maritime Archaeological Management	
34. Ofra Barkai, Oded Katz, Amit Mushkin, Beverly N. Goodman Tchernov: Long-term Retreat Rates of Israel's Mediterranean Sea Cliffs Inferred from Reconstruction of Eroded Archaeological Sites	Barkai *et al.,* 2017
35. Anna Demetriou: Ancient Shipwreck Sites in the Eastern Mediterranean: Revealing the Fragments of their Biographies in the Present	-
36. Massimiliano Secci: Maritime Archaeological Management in Italy: Skeleton-first or Shell-first Construction?	-
37. Barbara Euser: A Strategic Protection Scheme for the Submerged Bronze Age Town at Pavlopetri	SR 10; Euser, 2020
38. Katerina P. Dellaporta: From J*us Naufragii* and L*ex Rhodia* to UNESCO 2001 Convention	-
Conservation and Archaeological Science	
39. Carlos Jimenez, Katerina Achilleos, Louis Hadjioanou, Antonis Petrou: Understanding Life on the Pot: Marine Biofouling and Wreck-Site Formation Processes of the Kyrenia Shipwreck (Cyprus)	-
40. Marios Konstantinos Vaziourakis, Angeliki Nikitidou, Maria Elissavet Thomadaki, Stella Demesticha, Chrysanthi Papadopoulou, Ioannis Iliopoulos, Spiros Sergiou, Pavlos Megalovasilis, George Papatheodorou, Maria Geraga: Studies on the Sedimentological Regime of the Mazotos Ancient Shipwreck, Offshore Cyprus	-
41. Ruth Shahack-Gross, Isaac Ogloblin, Assaf Yasur-Landau: Post-Depositional Underwater Processes in Ceramics Found in an Oxygenated Environment at the Byzantine Anchorage of Dor, Israel	-
42. Marina Šimičić: The Early Croatian Boats at Nin – Repair and Reconservation Begins	-
43. Asaf Oron, Nili Liphschitz, Ehud Galili, Gideon Hadas, Benjamin Held, Raphael Linker, Robert Blanchette: Dead vs. Med.: Characterization of Waterlogged Wood Finds from the Dead Sea and the Mediterranean	Oron *et al.,* 2016
Shipwrecks	
44. Peter B. Campbell, George Koutsouflakis: Evidence of Ancient Trade from the Fourni Archipelago, Greece	This volume
45. Christos Agouridis, Myrto Michalis: The Arduous Voyage of Underwater Research during the Recovery of the LBA Shipwreck off the Islet of Modi	This volume
46. Xanthie Argiris: Two Shipwrecks from the Islands of Leipsoi and Arkioi	-
47. Damian Robinson, Franck Goddio: Ship 11 from Thonis-Heracleion, Egypt: Boat Sacrifice in an Osirian Sacred Lake	Robinson, 2018
48. Carlo Beltrame: The Routes of the Marble: Transportation of White Marbles in the Mediterranean	-
49. Cristina Bazzano, Timmy Gambin, Roberto La Rocca: Mixed Cargoes in the Western Mediterranean during Late Antiquity: The 'Messina 1' Shipwreck	SR 5; Bazzano *et al.*, 2020
50. Stella Demesticha: The Mazotos Shipwreck, Cyprus: A Preliminary Analysis of the Cargo	This volume
51. Marie-Pierre Jézégou, Patrick Andersch Goodfellow, Jonathan Letuppe, Corinne Sanchez: A Wreck of Late Antiquity Discovered in a Bank of the Port Channel of Narbonne (France)	This volume
52. Mark E. Polzer: A Moveable Feast... Beyond the Maritime: The Phoenician Shipwreck at Bajo de la Campana and Implications for the Orientalising Process on the Iberian Peninsula	-

Contributions	Publication*
53. Maayan Cohen: The Ma'agan Mikhael B Shipwreck: Preliminary Report	SR 2; Cohen and Cvikel, 2019; 2020
Connected by the Sea	
54. Crystal el Safadi: The Maritime World of the Early Bronze Age Levant through Space and Time	Safadi and Fraser, 2019
55. Duncan Howitt-Marshall: Mariners, Maritime Connectivity and the 'Ritual' of Sea Travel in Early Neolithic Cyprus	This volume
56. Ezra Marcus, Paula Waiman-Barak: Reconnecting the Maritime Levant at the Dawn of the Middle Bronze Age	-
57. Michele Massa: Pre-Middle Bronze Age Maritime Exchange Networks between the Aegean and the Levant: An Anatolian Perspective	-
58. A. Bernard Knapp: Piracy in the Late Bronze Age Eastern Mediterranean?	Knapp, 2018
59. Gil Gambash, Paula Rut Zadok: Levantine Connectivities	-
60. Anja Krieger: Making Connectivity Visible: A Study in Maritime Interactions in the Eastern Mediterranean from the Late Bronze Age to the Archaic Period	-
61. Aylin Güngör: Points of Intersection – 'Emporia' and Their Archaeological Remains	-
62. Enrique Aragón: Maritime Connectivity Network Analysis via a Case Study of the Metallic Assemblage from Rochelongue Shipwreck Site (eight-sixth century BC) West Languedoc, France	Aragón, 2018
New Technologies and Maritime Archaeology	-
63. Elisa Costa, Stefania Manfio, Sebastiano Tusa: Virtual Reality and Virtual Dives among Sicilian Marble Cargos	SR 3; Costa *et al.*, 2020
64. Fabio Bruno, Loris Barbieri, Antonio Lagudi, Maurizio Muzzupappa, Sebastiano Tusa, Alessandro Cozza, Raffaele Peluso, Gerardo Ritacco: Enhancing Learning and Access to Underwater Cultural Heritage through Digital Technologies: The Case Study of Cala Minnola, Sicily	-
65. Isabelle Hairy: The Evolution of Survey Techniques on the Qaitbay Underwater Site at Alexandria, Egypt	SR 11; Hairy, 2020
66. Gunnar Liestøl, Elpida Hadjidaki: Experiences with Mobile Augmented Reality at Phalasarna. Combining the Present with the Past *in situ*	Liestøl and Hadjidaki,2019
67. Smiljko Rudan, Irena Radić Rossi: Numerical Simulation of the Sinking Ship Scenario, Based on the Archaeological Records	-
68. Nikos Papadopoulos, Gianluca Cantoro, Theotokis Theodoulou, Nasos Argyriou, Julien Beck: 'Dive' in the Past of Ultra Shallow Marine Archaeological Sites in Eastern Mediterranean through Geoinformatics	-
69. Michel L'Hour, Daniela Peloso, Franca Cibecchini, Denis Degez, Vincent Creuze, Frédéric Osada, Christophe Leclerc: The 3D Technologies for the Archaeology in the Deep Sea: the Danton French Battleship (Cagliari, Italy)	-
70. William M. Murray: The RAM3D Database Project: A Web Portal for the Study of Ancient Mediterranean Warships and Ramming	-
71. Jeremy Green, Patrick Baker: The University of Oxford, Research Laboratory for Archaeology Cape Andreas Expeditions 1969-1970, Working with Legacy Data	Green, 2019
72. Madeline McAllister: Seeing is Believing: The Rhetoric of Photogrammetric 3D Digital Models of Underwater Archaeological Sites	-
Ship Construction in the Ancient Mediterranean: Methods, Driving Factors, and Cross-Cultural Exchange	-
73. Emmanuel Nantet: The Tonnage of the *Syracusia*. A Metrological Reconsideration	SR 7; Nantet, 2020
74. Mohamed Abd el-Maguid: Where to Situate the Abu Rawash Boat in the Corpus of Ancient Egyptian Boats	-
75. Kevin Melia-Teevan: A Study in Framing Development in the Mediterranean from the Ninth century BC through the Ninth Century AD	-
76. Christopher John Davey: The Development of the Roman Merchant Ship Sail-plan	Davey, 2018
77. Deborah Cvikel: The Akko Tower Wreck, Israel: hull-construction report	Cvikel, 2016
78. Giulia Boetto, Chiara Zazzaro, Pierre Poveda: A Preliminary Study of the Remains of Four Vessels Found in the Ancient Harbour of Naples, Italy	This volume
79. Avner Hillman, Deborah Cvikel: The Construction of Ma'agan Mikhael II.	This volume
80. George Koutsouflakis, Eric Rieth: A Twelfth-Century Byzantine Shipwreck in the Port of Rhodes –	This volume
81. José L. Casabán, Irena Radić Rossi: The San Girolamo Shipwreck (1576): Preliminary Report on the Hull Design of a Sixteenth-Century Ragusan Nava	-
Maritime Cyprus	
82. Jean-Yves Empereur: The Hellenistic Port of Amathus, Cyprus: Archaeology, History and Publication	Empereur and Kozelj, 2017
83. Simon James, Lucy Blue, Ferréol Salomon: Investigations into the Ancient Port at Dreamer's Bay and the Maritime Environment of the Akrotiri Peninsula, Cyprus	-
84. John Leonard: Coves, Carobs and Ancient Commerce: Evidence for the Enduring Maritime Landscape of Cyprus' Northern Coasts	-
85. James Muhly: Cyprus and Mediterranean Trade in Copper Oxhide Ingots	-
86. Michael Antonakis, Nikola Babucic, Sławomir Chwałek, Marcin Frączek, Tomasz Kalicki, Piotr Kusztal, Łukasz Miszk, Wojciech Ostrowski, Ewdoksia Papuci-Władyka, Martina Seifert, Weronika Winiarska: Paphos' Harbours revisited: Results of Interdisciplinary Research of the Paphos Agora Project	-
Ports, Harbours and Anchorages in the Ancient Mediterranean: New Discoveries and New Approaches	
87. Yannos G. Lolos, Angeliki Simossi: Salamis Harbour Project, 2016-2017	SR 12; Lolos and Simossi, 2020
88. Tom Hillard, Lea Beness: Looking for the Harbour of Classical Torone: Underwater Exploration and Geophysical Prospection	This volume
89. Mustafa Koçak, Erkan Dündar: New Surveys at the Patara Harbor: An Overview on the Harbor Defense Systems	This volume

Contributions	Publication*
90. Kalliopi Baika, Dionysis Evangelistis, Jari Pakkanen: Underwater Excavations and Interdisciplinary Research in the Ancient and Medieval Harbour of Kyllene/Glarentza (NW Peloponnese, Greece): 2013-2015 Field Campaigns	-
91. Ross Thomas, Alexandra Villing: The Harbour of Naukratis, The British Museum Fieldwork 2012-2017	-
92. Assaf Yasur-Landau, Ehud Arkin, Ayelet Gilboa, Ruth Shahack-Gross, Ilan Sharon: Underwater Excavations in the South Bay of Dor and the Development of Harbors in the Eastern Mediterranean	-
93. Thomas Schmidts: Ainos: A Harbour City and Hub in the Northern Aegean	-
94. Ida Koncani Uhač: Roman ports of Istria (Croatia)	-
95. Souen Fontaine, Mourad El-Amouri, Frédéric Marty, Corinne Rousse: The Submerged Monumental Complex of the Roman Harbour System of *Fossae Marianae* (Gulf of Fos, South of France)	This volume
96. Carlos Cabrera-Tejedor, Fernando Amores Carredano: The Two Ports Ishbiliyya (Islamic Seville) and their Islamic Shipsheds	This volume
97. Robert L. Hohlfelder: Enhancing the Roman Imperial Maritime Infrastructure: Nero's Deeds and Dreams	-
98. Pascal Arnaud: *Limen kleïstos*: Fortified Ports and Their Evolution from the Peloponnesian War Down to the Age of Augustus	-
99. Simon Keay, Pascal Arnaud: Port, Place or Complex System? Rethinking Roman Mediterranean Ports in the Light of the Portuslimen (RoMP) Project	-
100. Michael R. Jones: The Rock-Cut Shoreline Features of Dana Island and the Maritime Landscape of the Taşucu Gulf, Rough Cilicia	This volume
101. Patricia Antaki-Masson: Fortified Crusader Harbours of the Syro-Lebanese-Palestinian Coast	This volume
102. Dan Mirkin, Deborah Cvikel, Oren Tal: Crusader Mooring: A View from Arsur (Israel)	Mirkin *et al.*, 2016
Posters	
P1. Kalliopi Baika, Diamanto Rigakou, Garoufalia Metallinou, Andreas Vött, Peter Fischer, Claudia Finkler: Geoarchaeological Research in the Harbours of Ancient Korkyra (Corfu, Greece)	Finkler *et al.,* 2019
P2. Alyssa Pietraszek, Beverly Goodman-Tchernov, Dani Nadel, Oded Katz: Erosional Notches, Pits, and Potholes Offshore: Signs of Past Coastlines	-
P3. Chelsea Wiseman: Defining the Levantine Maritime Neolithic: GIS Analysis of a Maritime Cultural Landscape	-
P4. Areti Chalkioti: Maritime Landscapes of the Northeast Aegean: Coastal Evolution and Changing Boundaries	-
P5. Maria Geraga, George Papatheodorou, Christos Agouridis, Myrto Michalis, Heleni Kaberi, Margarita Iatrou, Dimitrios Christodoulou, Elias Fakiris, Michael Prevenios, Kordella Stavroula, George Ferentinos: Marine Geophysical Explorations in the Saronic Gulf, Greece: The Test Case of a LBA Wreck Site off Modi Islet	Geraga *et al.,*2017
P6. Alexandra Zavitsanou, Dimitrios Sakellariou: Submerged Prehistoric Landscapes in the Aegean Sea	-
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P14. Mai Tarek Ghanem: Maritime Museums and Their Role in Preserving Cultural Heritage	-
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P16. Mohamed Ahmed Khedr: Treasure-Hunting and the Underwater Cultural Heritage	-
P17. Colin Breen, Lucy Blue, Kieran Westley, Nicolas Carayon, Wes Forsythe, Marianne O'Connor, Ruth Plets: Benchmarking Maritime Cultural Resources in Syria	-
P18. Veronica Ford, Cassy Cutulle: The 2015-2017 Kyrenia Ship Conservation Project: Approaches to the Preservation of Objects Associated with the Kyrenia Shipwreck	-
P19. Ivan Gorlov, Sergey Fazlullin: Attribution of Fragmented Archaeological Ceramics: A Geochemical Approach	-
P20. Elizabeth (Lisa) Briggs: DNA From the Wine-Dark Sea: Examining the Efficacy of Extracting Ancient DNA From the Ceramic Matrix of Pottery Vessels From Mediterranean Underwater Contexts	-
P21. Isaac Ogloblin, Amanda Holdeman, Ruth Shahack-Gross, Assaf Yasur-Landau: Combining the Use of Fourier Transform Infrared Spectroscopy (FTIR) and Thin-section Analysis to Study Underwater Materials From the North Bay of Dor, Israel	-
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Contributions	Publication*
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P39. Pere Ridao, Nuno Gracias, Irena Radić Rossi: The Methodology and Results of the AUV (Girona 500) Survey of the Present State of the Gnalić Shipwreck Site	-
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UNDER THE MEDITERRANEAN I

This volume is a collection of 19 articles in three sections reporting on recent research on the archaeology of shipwrecks, harbours, and maritime landscapes in the Mediterranean region. The shipwrecks section looks at excavated vessels from Mazotos, Modi Island, the port of Rhodes, Naples, and Narbonne, as well as a sailing reconstruction of the Ma‘agan Mikhael ship.

The harbours section includes articles on areas from the Levant to Seville looking at a variety of harbour defence systems and dockyards dating from the Hellenistic period to the 12th century AD.

Articles in the third section on maritime cultural landscapes combine data sets to examine human interactions with the sea: navigation from the perspectives of the accounts of early geographers, the skills required by the earliest sailors, and the contextual reconstruction of sea routes; coastal survey and resource use; and geoarchaeological evidence used to analyse the choice of harbour location.

This book will be of interest to students and archaeologists researching the Mediterranean region, and all interested in a wide range of recent advances in maritime archaeology.

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