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Edited by

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Roberta Tomber composed and edited this issue,
which is dedicated to the memory of David P.S. Peacock

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HEROM: THE MATERIAL CULTURE FROM EGYPT'S ROMAN PORTS

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This volume of HEROM on the material culture of ports from Roman Egypt honours Professor David Peacock (1939-2015) by bringing together three papers that highlight select aspects of his career that had an impact on Roman archaeology and more specifically on many individual scholars. Here I touch on only a small number of achievements, approaches and techniques initiated by David that are now considered commonplace. More comprehensive obituaries are available in the *Journal of Roman Archaeology*[1] and the *Journal of Roman Pottery Studies*[2].

Between 1987 and 2003, Egypt was the centre of David's fieldwork and research interests and therefore it is appropriate that this volume takes Egypt as its starting point. In 1987 he joined a French team under the auspices of the Institut français d'archéologie orientale (IFAO) led by Prof Jean Bingen at Mons Claudianus, (1987-1993), where he surveyed 130 quarries for the extraction of the prized *granito del foro*[3]. Bringing with him an invaluable background in geology and decades of knowledge and experience of Mediterranean archaeology, the timing of this project was fundamental to the explosion of activity in the Eastern Desert and the burgeoning of Roman archaeology in Egypt. From here David's research led him to Mons Porphyrites (1994-1998) where he co-directed, with Valerie Maxfield of Exeter University, a major excavation and field survey revolving around the exploitation of Imperial Porphyry[4]. Both these projects not only explored their landscape within the Eastern Desert, but, by tracing the products from each centre, embraced the Mediterranean through economically intercon-

1. Keay 2015.
2. Tomber 2018.
3. Peacock and Maxfield 1997.
4. Maxfield and Peacock 2001; Peacock and Maxfield 2007.

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nected ports, and the relationship between and the distribution of these decorative stones and Empire[5].

Within David's scholarship, ports formed the ideal platform for investigating broad economic patterns alongside an interest in all aspects of materiality and technology. His interest in locating and investigating Myos Hormos – that most important port for facilitating Indo-Roman trade – was therefore the obvious next step in his Egyptian fieldwork. The on-the-ground location of Myos Hormos had been the subject of debate for some time, when David's 1993 article 'The site of Myos Hormos: a view from space' suggested that it lay at modern Quseir-al Qadim[6]. Controversial at the time, this identification is now universally accepted and confirmed by documents recovered from his Southampton University excavations there with Lucy Blue (1999-2003). A loan agreement of AD 93, on papyrus (Figure 1), unequivocally stated:

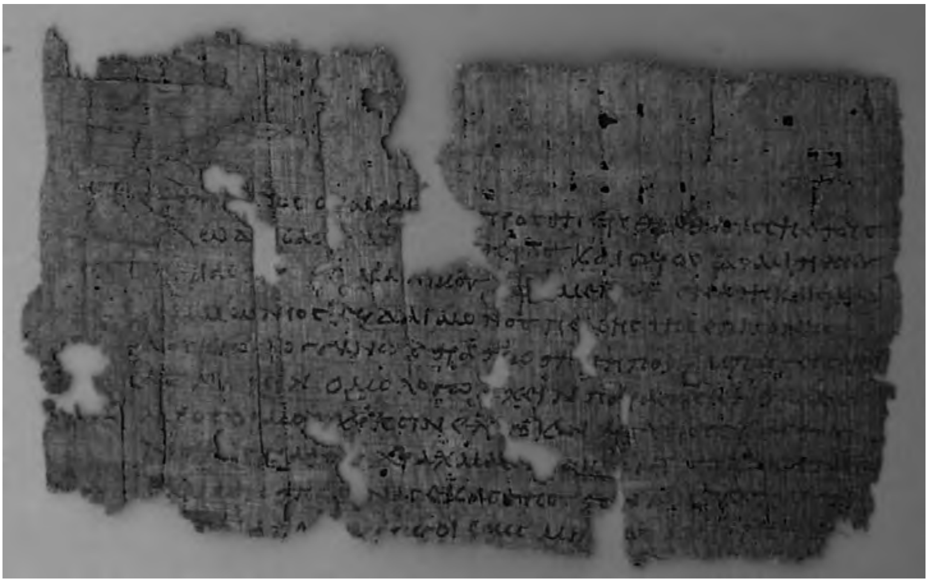

Fig. 1. A loan agreement of AD 93 on papyrus (190mm x 117mm; Trench 6E, context 4015) (© W. van Rengen, University of Southampton Quseir al-Qadim archive).

> *In Myos Hormos on the Red Sea, in the 12th year of Imperator Caesar Domitianus Augustus Germanicus, the 29th Phamenoth, Ammonios, son of Eudaimon, debtor, to Lucius Longinus soldier from the tesseraria*

5. Peacock *et al.* 1994.
6. Peacock 1993.

> *the* Seahorse, *greetings. I acknowledge to have received from you here in Myos Hormos a loan of 200 drachmas of silver coinage of the emperor bearing interest at the rate of one stater per mina monthly - - until the … of the month Mesore …*[7]

This excavation firmly established his contribution to Red Sea trade and Indian Ocean archaeology, solidified by two further projects, a co-directed field survey at Adulis, Eritrea (with Lucy Blue, 2004-2005)[8] and a masterful study of ballast, originating from David's recognition of vesicular basalt along the Egyptian Red Sea. The latter resulted in *Food for the Gods* (2007 with David Williams)[9], which used the characterisation of basalt to unravel the incense trade across the Indian Ocean.

These Egyptian and Red Sea projects provided opportunities for students, myself included, Fiona Handley and Julian Whitewright (this volume), and colleagues – particularly junior colleagues – to broaden their fieldwork and research opportunities. This approach was a hallmark of David's *modus operandi* with the consequence of a harmonious and loyal project team. In the field David managed to strike just the right balance between work and play. Infamous for his off-piste 'Peacock tours,' these afternoon forays might sometimes culminate in a flat tyre (resulting in a late entry to afternoon tea), but had the advantage of familiarising the team with the wider landscape to which David was so attuned. His skill at spotting a structure or pot sherd on a distant mound (or even a fragment of obsidian from a moving car!) was unrivalled, as was his ability to hone in on the important elements when faced with mountains of excavated finds.

Best known for his work on Roman pottery (especially amphorae) and stone, a perusal of the published volumes from Mons Porphyrites[10] and Myos Hormos[11] show that he also turned his hand to basketry/cordage, lamps, glass and coins. These diverse reports reflect not only his interest in all the objects and their role in Roman life and the Roman economy, but his insistence that all aspects of the excavation should be published in a timely fashion. In the absence of an on-site specialist, David was that specialist. In his final publica-

7. Van Rengen 2011.
8. Peacock and Blue 2007.
9. Peacock and Williams 2007.
10. Peacock and Maxfield 2007.
11. Peacock and Blue 2011.

tion, *The Stone of Life*[12], he used millstones to address themes of food production and trade that were long-standing research interests.

Many techniques that David pioneered, particularly those focused on pottery and stone, are now taken for granted. His multidisciplinary approach that included scientific analysis (petrology but also chemical techniques), quantification, technology and ethnoarchaeology together resulted in a middle range theory that (seemingly) effortlessly provided an understanding of the ancient world.

The three papers published here represent diverse aspects of Egypt's material culture. Those by Julian Whitewright and Fiona Handley demonstrate the remarkable evidence that can be obtained from Egypt due to exceptional conditions of preservation, particularly found in the Eastern Desert and at the Red Sea. The presence of these organic artefacts opens up many facets of Roman life that are normally closed and afford a remarkable immediacy to the past and its people.

Through textiles and ship fittings, Handley and Whitewright, respectively, point to the diverse nature of Egypt's population during the Roman period. Both categories of artefacts indicate the presence of foreign communities at Myos Hormos, and in the case of ship fittings, the importance technology transfer played between the Mediterranean and Indian Ocean.

In his paper, Grzegorz Majcherek provides an up-to-date understanding of African amphorae at the key entrepot of Alexandria and charts the major trends in food supply between the 1st and 7th centuries AD. Such an overview is reliant on characterisation and quantification – both of which, introduced by David, particularly through his work at Carthage[13], are now established methods in Mediterranean and Egyptian archaeology. Majcherek's work bring us firmly back to the Mediterranean, the focus of so much of David's research, but he clearly demonstrates its relationship to the Red Sea and trade beyond the Empire.

David's legacy continues to impact on the archaeology of Egypt and the entire Roman world, through his rich array of publications as well as the on-going research of the many students and colleagues whose lives he influenced.

12. Peacock 2013.
13. Fulford and Peacock 1984.

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THE SHIPS AND SHIPPING OF INDO-ROMAN TRADE

A VIEW FROM THE EGYPTIAN RED SEA PORTS

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Introduction

The trade networks between the Mediterranean World and the Indian Ocean represent some of the longest maritime routes of antiquity. Seaways stretched from the Red Sea ports of the Egyptian coast, along the East African coast as far as Zanzibar, around the Arabian peninsula to north-west India, and directly across the Indian Ocean from Socotra to modern day Kerala (FIG. 1). The mechanics of these routes are well attested through historical documents, for example the *Periplus Maris Erythraei* (PME)[1] provides an overview of the extent, general timings, goods and routes of trade. By contrast, the ships that were the main vehicles of this trade are harder to uncover, in part due to the absence of Indian Ocean and Red Sea shipwreck evidence of the type seen in the Mediterranean. Instead, archaeological work at the Egyptian ports of Myos Hormos and Berenike has provided a less direct means to uncover the ships of the Indo-Roman world through the discovery of recycled and discarded maritime components. This evidence forms the main focus of this paper, allowing a more detailed picture of construction methods, rigging practice, and potential performance to be formulated. These themes are explored across the course of this paper and in turn allow wider comment on the relationship between maritime technologies in the Indian Ocean and Mediterranean during the early first millennium AD.

1. Schoff 1912; Casson 1989.

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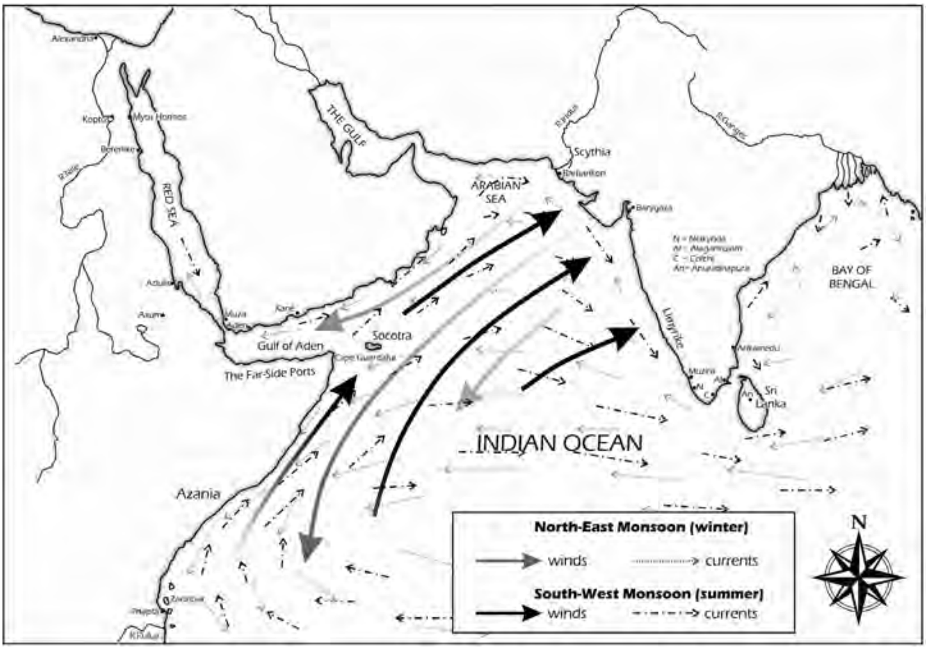

FIG. 1. The western Indian Ocean, Arabian Sea, Red Sea and Gulf, showing places mentioned in the text, destinations, ports of trade, and a schematic indication of the monsoon winds and currents (J. Whitewright).

The focus of the research presented here is directed firmly towards the material detail, and resulting analysis and interpretation, of the archaeological remains of Indo-Roman sailing ships found at the Egyptian Red Sea ports[2]. These objects are first described in terms of material derived from shipbuilding, ship repair and ship breaking activity, before focusing upon rigging components, including sails. The resulting analysis then aims to draw both of these themes together to present an understanding of the material detail of Indo-Roman shipping. As will become clear, wider analysis of Indo-Roman trade from the perspective of networks, institutions, exchange systems, etc is not part of this paper, being well served elsewhere[3]. Having stated that, much inspiration has however been drawn from the existing work of a number of

2. In general the archaeological material discussed in this paper is only found in the Egyptian port sites of Myos Hormos and Berenike, due to conditions of preservation, although as the text explains, the material has origins from across the Indian Ocean.
3. E.g. De Romanis and Tchernia 1997; Ray 2003; Boussac *et al.* 2012; Gurukkal 2016.

scholars, notably Roberta Tomber[4], Steve Sidebotham[5] and Eivind Seland[6] who have addressed the bigger picture of Indo-Roman trade and Indian Ocean networks.

The very phrase 'Indo-Roman trade' carries an increasing amount of academic baggage and inherently limits how we think about the systems, people and technology being studied[7]. Its use in this paper is simply intended to define a widely accepted period and place of study – the Red Sea and western Indian Ocean during the early centuries of the first millennium AD. Little interest is expressed in this paper regarding preconceptions of who is carrying on the trade, or the institutional structures behind that trade. Instead, the focus is firmly on the maritime technology that is visible through the archaeological record, with supporting historical and iconographic reference where appropriate. This record is sufficient to inform us of the complexities of understanding such ships, and the maritime technologies and cultures from which they stem. The view presented is therefore one that attempts to present a balanced interpretation of this material. This process illustrates beyond doubt the presence of ships on the Erythraean Sea that were built, rigged and used in a manner consistent with contemporary Mediterranean vessels. What is also evident is that the archaeological material of the Red Sea ports is potentially representative of Indian Ocean maritime cultures, as well as Mediterranean ones. This premise forms the basis of the research presented here, and ongoing since first working under the direction of David Peacock and Lucy Blue at Myos Hormos in 2001: primarily that there was a shared tradition of building, rigging and using ships that spanned the Mediterranean, Red Sea and western Indian Ocean in the early first millennium AD. The presentation and interpretation of the material that underpins this notion is the common thread that runs through this paper.

The archaeological sites that have provided the material described in the following sections are the twin ports of Myos Hormos[8] and Berenike[9], located on the Egyptian Red Sea coast (Fig. 1). The maritime artefacts from these ports provide a surprisingly detailed view of the nature of the shipping frequenting those sites. The word 'surprising' is appropriate because at first glance the arte-

4. E.g. Tomber 2008.
5. E.g. Sidebotham 2011.
6. E.g. Seland 2010, 2014.
7. Seland 2014, p. 388; also Gurukkal 2016 for a view of trade that plays down Indian involvement.
8. Peacock and Blue 2006, 2011.
9. Sidebotham 2011 provides a detailed view of the huge extent of work undertaken at Berenike.

facts seem uninspiring: fragments of broken wooden and horn rings, scraps of cotton cloth, and wooden elements that have been repurposed in buildings. As will be shown, these artefacts allow a detailed picture of the shipping that used the ports of Myos Hormos and Berenike to be developed. It is not so much the exact shape and size of individual vessels, but the overall traditions of construction, rigging and sailing that the mariners of the port employed. Such analysis follows below (Section 4), but, before that it is necessary to explore the artefacts themselves as a means to fully understand their material nature, disposition, advantages for study and inherent limitations. This is done by looking across the twin ports of Myos Hormos and Berenike from the perspective of the artefacts relating to hull, rigging and sails, although there is an emphasis on the former, especially during the first few centuries AD, because of the author's own work at that site. In each case, examples of comparative material is included where available as a means to fully contextualise and understand each class and type of artefact, although it should be noted that such examples are not intended to be an exhaustive catalogue.

Shipbuilding, ship-repair and ship-breaking

It is unsurprising that the Red Sea ports should produce archaeological evidence of ship building and related repair and breaking-up activity in relation to Indo-Roman trade. Much earlier Pharaonic period evidence from Wadi Gawasis gives an example of Nile-built vessels being transported across the eastern desert for use on the Red Sea[10]. The Egyptian Red Sea ports are the obvious location for the construction of the ships required by Mediterranean merchants for operation on the Red Sea and Indian Ocean. Likewise, once constructed, such vessels would have required annual and ongoing maintenance to allow them to complete the lengthy voyages to India and East Africa, and the Egyptian Red Sea ports are again the obvious location for such activity. Written sources (*O.Krok. 41)* attest to the transport of shipbuilding timber from the Nile to Myos Hormos, and that the timber itself was so valuable that the wagons carrying it were escorted by two cavalrymen (*O.Krok. 13*)[11]. Bülow-Jacobsen's analysis of this evidence concludes that timber was not transported to Berenike, perhaps because of the extra distance involved across the desert, and that Myos Hormos was therefore the main shipbuilding/ship repair location on the Egyptian Red Sea coast[12].

10. Ward and Zazzaro 2010.
11. Bülow-Jacobsen 2013, p. 567.
12. Bülow-Jacobsen 2013, p. 567; largely echoed by Sidebotham 2011, p. 201 with regard to Berenike being restricted to repair, rather than building.

Meanwhile, the trades of some of those working in the shipyard at Myos Hormos are described in the tariff from the Koptos toll-house, dating to AD 90, and including shipyard hands and caulkers[13].

Separating shipbuilding from ship-repair, and to a lesser extent ship-breaking, in the archaeological record is very difficult because of the similarity of the waste products produced and subsequently deposited. With this in mind, the archaeological material from Myos Hormos seemingly provides generic evidence for ship-repair and/or ship-breaking. Excavated material includes lead-sheathing fragments and associated iron tacks, lumps of pitch resin, and barnacles scraped from hulls and still bearing the impression of wood grain, all of which have been retrieved from the waterfront area of Myos Hormos[14]. Comparable material, identified as a ship-repair area, dating from the mid-3rd century BC through to the early Roman period has also been found at Berenike[15]. Taken together, the historical and archaeological material paint a picture of ships for the Indo-Roman trade network being built and repaired on the Red Sea. It can be reiterated that this is not a surprise, but simply sound evidence for an activity that must have taken place in order for the annual trading fleet to depart the Red Sea ports.

Turning to the ships themselves, it must first be noted that the underwater remains of wooden ships are extremely rare in the Red Sea and Indian Ocean region. Although Roman period shipwrecks have been documented in the Red Sea[16], they consist of amphorae rather than hull remains (Fig. 2). Any archaeological material that can fill this gap in the record is therefore highly significant for our understanding of the construction methods of the ships used in the Indo-Roman trade networks. At both Myos Hormos and Berenike, hull remains consisted of wooden elements that had been repurposed within buildings– beams and planks within walls, for roof beams at Berenike[17], and planking as a door threshold at Myos Hormos[18] – following ship-breaking activity. This statement raises the immediate and not unreasonable question of how it is possible to identify the wooden elements of a building as being recycled ship timbers. In the context of Mediterranean shipping from antiquity this is relatively straightforward, due to the construction

13. Blue *et al.* 2011, p. 188.
14. Blue *et al.* 2011, pp. 185-188
15. Sidebotham 2011, p. 205; Sidebotham and Zych 2012, pp.32-33; Sidebotham and Zych 2016, p. 4; Zych *et al.* 2016, pp. 328-331.
16. See Blue *et al.* 2012.
17. Vermeeren 1999, p. 316; Sidebotham 2011, pp. 198, 203, 239; Sidebotham and Zych 2016, pp. 4-14.
18. Blue *et al.* 2011, pp 179-181.

FIG. 2. Seabed scatter of Roman period amphorae (Amphore Égyptienne 4 and Dressel 2-4), comprising the Fury Shoals shipwreck, located between Berenike and Myos Hormos, and recorded through archaeological survey by a team from the University of Southampton (Image courtesy of Blue *et al.* 2012, fig. 11.1).

tradition of the planks being joined along their edges, with a series of closely set mortise-and-tenon joints, secured in turn with wooden locking-pegs driven through the plank into the tenon[19]. This process is one of the defining features of ancient Mediterranean shipbuilding, and leaves behind a characteristic row of carefully carved mortises in the edges of planks. Timbers carrying such markers, dating to antiquity and in a Mediterranean or related context, are highly likely to represent ship or boat remains[20].

At Myos Hormos, two pieces of wooden planking were excavated during the 2002 season (FIG. 3), both reused in secondary Roman contexts, from Trench 8A[21]. One piece (WO383) is relatively complete while the other (WO467) is

19. Whitewright 2016, p. 874.
20. E.g. Basch 2015.
21. Blue *et al.* 2011, pp. 179-181.

fragmentary. Both planks were fashioned by sawing. WO383 appears to have been reused at least once previously before ending up in a 2nd century AD context as a doorway threshold. The dimensions and shapes of both planks have been altered due to reuse and degradation, however both display mortise-and-tenon joints with a number of tenons, and wooden pegs that would have secured the tenons, still *in situ*.

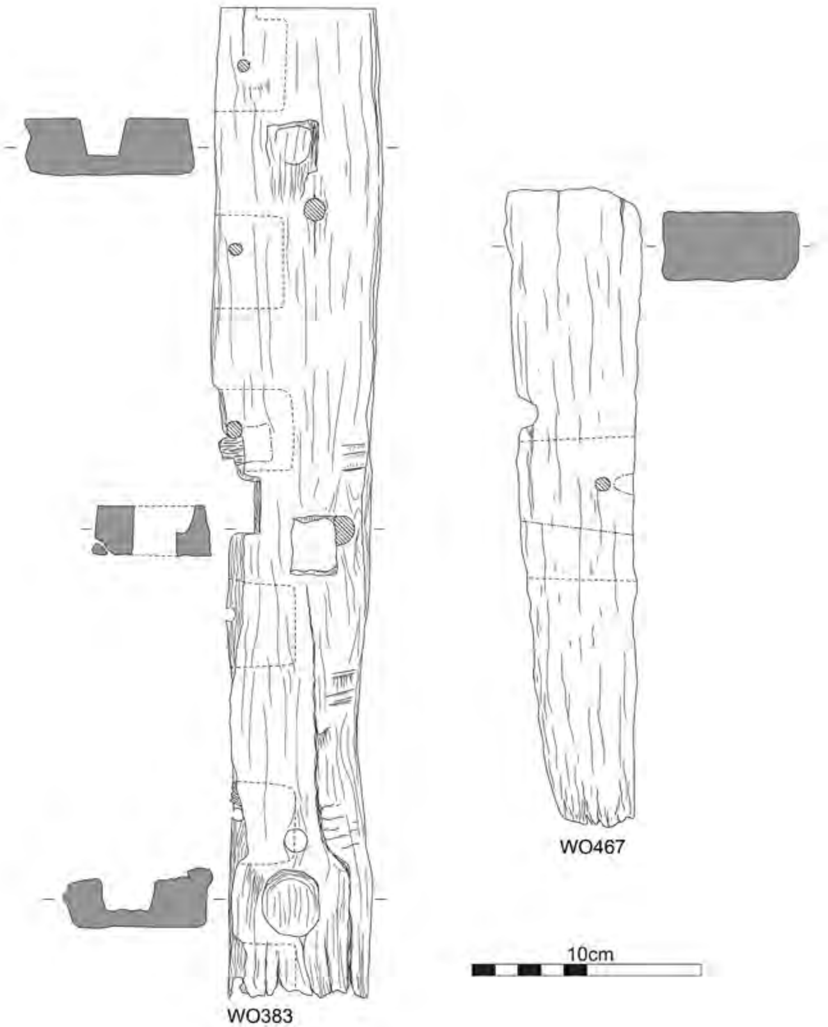

FIG. 3. Remains of ship-planking, reused in buildings at Myos Hormos, and demonstrating the characteristic Mediterranean mortise-and-tenon technique for edge-joining the planks (J. Whitewright).

The larger plank (WO383) is 862mm in length with an average width of 130mm and a consistent thickness of 50mm. The average dimensions of the mortises of the larger plank are 70-90mm deep by 60mm wide; the one surviving tenon is 6mm thick and the locking-pegs are 12mm in diameter. The mortice-and-tenon joints are spaced at an average of 80mm apart. Three additional features are present on the plank, probably resulting from reuse; a carved recess at either end of the plank, itself equidistant from a pair of square holes that are arranged in the centre of the plank. The second, smaller plank (WO467) is 275mm in length and of consistent width (60mm) and thickness (30mm). The smaller plank had one mortise 60mm wide; the tenon was still in place and measured 40mm wide with a 5mm diameter peg hole.

As noted above, planking of this type is characteristic of Mediterranean shipbuilding and examples date from the Late Bronze Age to Late-Antiquity[22]. Comparative classification of this material is challenging because of the temporal and spatial spread, combined with the difficulties in ascribing shipwrecks a precise origin in terms of their original construction. But, the material from Myos Hormos, and the comparative remains from Berenike can certainly be fitted very easily into the broader Mediterranean building tradition because of the characteristic mortise-and-tenons along the plank edges. Of further interest is the fact that from a materials perspective, analysis of timbers from Myos Hormos[23] demonstrates the use of timber species, such as teak or blackwood, that is Indian Ocean, rather than Mediterranean, in origin. Meanwhile, hull components from Berenike represent both Mediterranean[24] and Indian Ocean sources[25]. This can be taken alongside the written evidence cited above to indicate that timber resources from across the wider Indian Ocean networks, as well as Mediterranean ones, were brought to Myos Hormos and Berenike to facilitate the shipbuilding and ship-repair function of the two harbours.

The construction, maintenance, breaking-up and recycling of ships is therefore an important element of the activity of these ports, and indeed one that is critical to their actual operation as ports, through the provision of ships to service the trade routes themselves. Although often under-reported, this maritime element and the materials and people that it drew in from across

22. E.g. Pomey *et al.* 2012.
23. Gale and van der Veen 2011.
24. Sidebotham and Zych 2016, p. 4; Zych *et al.* 2016, pp. 328-329.
25. Hull fragments excavated at Berenike include cedar of Mediterranean origin, as well as Indian Ocean materials, see Sidebotham 2011, p. 198 for the former, pp. 203 and 239 for the latter.

the Mediterranean and Indian Ocean world offers a reflection of the Indo-Roman trade networks themselves, and the wider connections that were undoubtedly present across those routes. Such activity is of course inextricably associated with the long distance routes and networks to which the Red Sea ports were connected. Alongside this, and very much within the ports, were the day-to-day activities, for example fishing, that constituted an integral part of port activity and maritime life. Although not a direct focus of this paper, extensive artefactual remains of that aspect of Red Sea maritime cultures have been excavated from Myos Hormos, and are the subject of extended analysis and discussion elsewhere[26].

Rigging and sailcloth

The material described above that can be associated with the building, repair and breaking-up of ships is primarily concerned with ships' hulls and the large wooden timbers, planks, frames and the like, from which these were made. The other essential component of a functioning ship comprised the rigging and sails of the vessel, and artefacts representing these parts also survive in the archaeological remains at Myos Hormos and Berenike. In particular, notable classes of material (discussed below) include brail rings, sail fragments, rigging deadeyes and fragments of pulley blocks[27], representing many of the main components required for the wooden hardware of a sailing ship rig. As with the hull elements, their presence in the Red Sea ports should not come as a surprise, but as an expected part of the archaeological record of a port site frequented by a large number of ships that required servicing and maintenance.

While the numbers of these artefacts at each site does not seem large, e.g. 169 brail rings at Myos Hormos, when set against the total corpus of rigging components present from the entirety of the ancient Mediterranean the numbers are very significant[28]. Only one other site, the 4th century BC shipwreck at Kyrenia, has quantities of rigging material comparable to those from Myos Hormos. It may be noted that the Kyrenia shipwreck material is representative of a single vessel, at a single point in time, rather than the several centuries of rigging practice and multitude of vessels from the Red Sea ports. The importance of this for our understanding of Indo-Roman shipping is returned to below, but first it is worth reviewing some of the archaeological

26. See Thomas 2010, 2011, 2012.
27. See Wild and Wild 2001; Whitewright 2007a; Blue *et al.* 2011.
28. For a summary of this rigging material see Whitewright 2008, pp. 221-261.

material in more detail, specifically the material from Myos Hormos that provides a useful proxy for the overall range and classes of material present from the Egyptian Red Sea ports.

At Myos Hormos, rigging components of all types were recovered from an arc fringing the western side of the main occupation ridge at the site, overlooking the harbour and waterfront area[29]. In particular, a large amount of material was recovered from rubbish dumps, implying deposition through intentional discard after its useful life was over. This is confirmed by the broken or damaged nature of many of these items, primarily brail rings, and speaks strongly of the processes of maintenance and repair of the shipping that served the port.

Brail rings

Brail rings were by far the most numerous class of maritime artefact from Myos Hormos. They were excavated during every field season, principally from the Roman *sebakh* deposits, and encompass the full Roman chronology of the site, from the 1st century BC to the 3rd century AD. In the ancient Mediterranean brail rings were sewn to the face of the sail and acted to guide corresponding ropes, termed brailing lines or brails, from the foot of the sail, up its face, over the yardarm and back to the deck towards the stern of the vessel. Hauling on the brailing lines allowed the sail to be furled, reduced in size, or its shape adjusted without the need to send sailors aloft. The system of brails and the brail rings themselves are one of the most characteristic elements of the ancient Mediterranean sailing rig. They are visible in abundant iconographic examples and can be considered as its 'archaeological signature'. Within the Mediterranean shipwreck corpus brails are primarily made from wood or lead[30]. By contrast, of the 169 brail rings excavated from Myos Hormos only 51 (30%) were made from wood, and the remaining 118 (70%) were made from cattle horn. The wooden brail rings are manufactured with the grain running across the flat face of the ring, and this technique is mirrored in the horn rings, which

29. For further analysis of this distribution see Blue *et al.* 2011, pp 205-209.
30. Comparative selected examples, made from lead as well as wood, have been excavated from the Cavalière (Charlin *et al.* 1978, pp. 57-60), Grand Congloué (Benoit 1961, 178-179, pl. 30), Grand Ribaud D (Hesnard *et al.* 1988, pp. 105-126), Kyrenia (H. Swiny pers. comm.) and Straton's Tower (Fitzgerald 1994, p. 169) shipwrecks and from the anchorage of Dor (Kingsley and Raveh 1996, p. 55, pl. 49) in the Mediterranean and the river port of Naukratis in the Nile Delta (Thomas 2014, fig. 5). Additional material can be found in Carre 1983; Pomey 1997; Beltrame 2002; Whitewright 2008.

are cut from flattened pieces of animal horn[31]. The use of these two types of materials is consistent with finds of brail rings from Berenike, which were also made from wood and horn[32]. A sample of brail rings made from both wood (FIG. 4) and horn (FIG. 5) is included here in order to illustrate the characteristics of these artefacts.

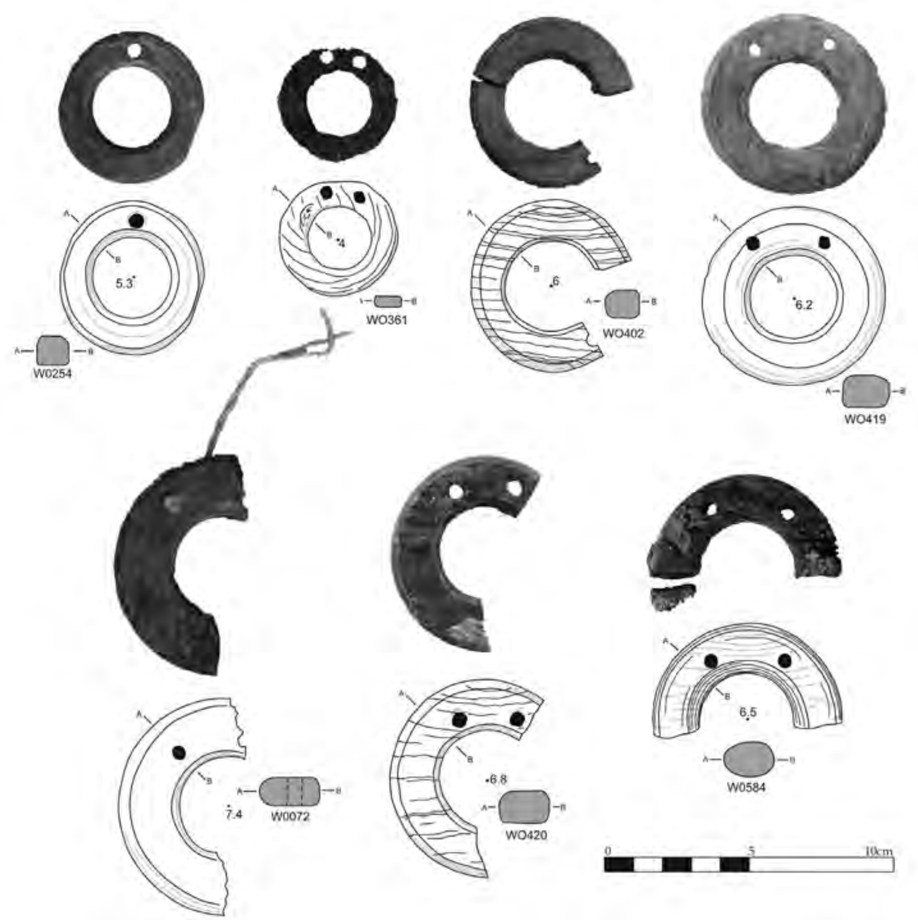

FIG. 4. Selection of wooden brail rings excavated from Myos Hormos. Each ring is shown in plan and cross-section; the centre number for each ring indicates the overall diameter of the ring (J. Whitewright).

31. S. Hamilton-Dyer pers. comm.
32. Wild and Wild 2001, p. 214; Sidebotham 2011, p.200.

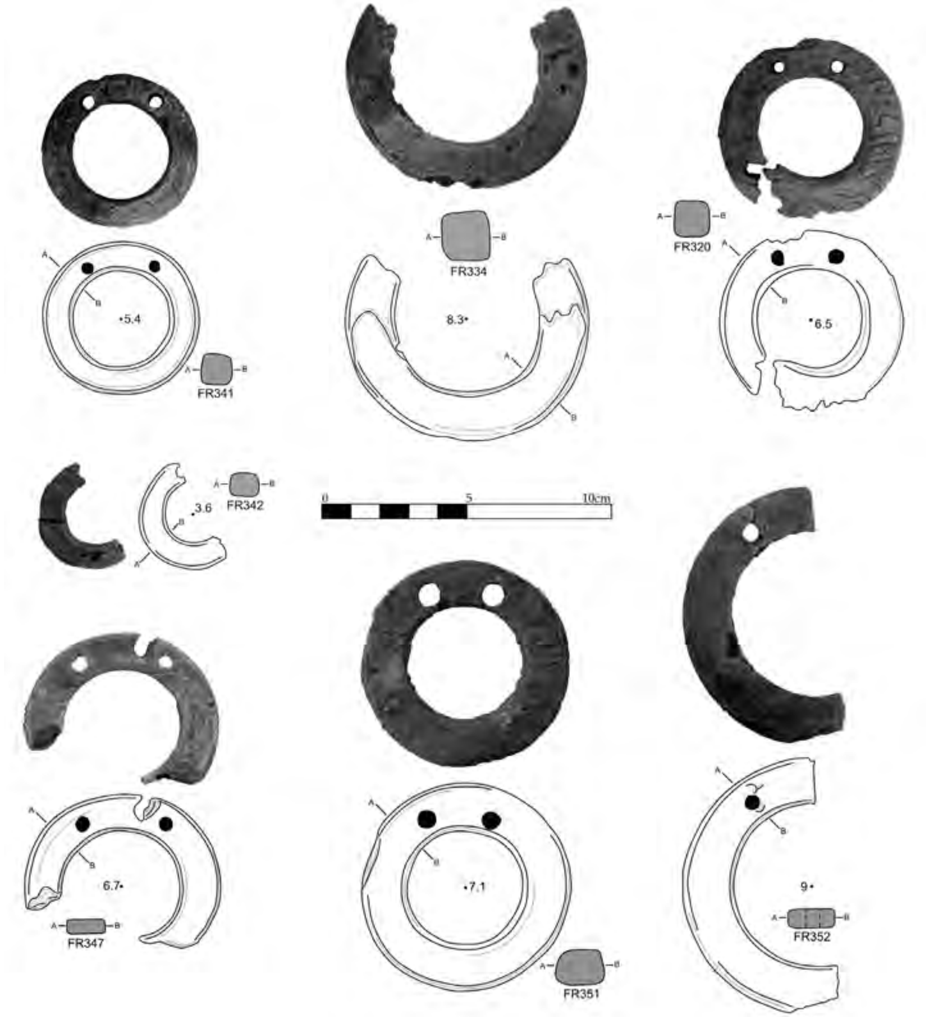

FIG. 5. Selection of horn brail rings excavated from Myos Hormos. Each ring is shown in plan and cross-section; the centre number for each ring indicates the overall diameter (J. Whitewright).

Although superficially similar, there are differences between individual rings from Myos Hormos with the illustrated examples representing diversity of detail in their manufacture. The most obvious of these is the large variation in size ranging from 27mm to 90mm in diameter in order to accommodate a correspondingly different range of brailing-line diameter (discussed further below). In the illustrated sample (FIG. 4-5) it is also possible to see differences in cross-sectional form; within wooden rings from almost circular or oval (WO584), to square (WO254) or rectangular (WO361) in shape, and in horn rings between square (FR334) and flattened rectangular (FR352).

The majority of the brail rings are pierced with two holes directly through the body of the ring, although some have a single hole. These holes were the point where the brail ring was attached to its sail, as demonstrated by a brail ring still attached to the fragment of sail cloth (Fig. 6). There is relatively little difference in the size of the attachment holes, ranging from 4-7mm, and with the largest brail ring (FR352) carrying an attachment hole only 1mm larger than that visible on the smallest ring (FR342). Attachment cordage itself was obviously a relatively consistent diameter. As well as the difference in form, the wooden rings also exhibit difference in their material origins. Some of the rings, as might be expected, are made from Egyptian and Mediterranean wood species, including olive and tamarisk[33]. But, many others are made of blackwood (African Ebony), which is a sub-Saharan species[34]. The importance of this, along with the use of horn, for informing our wider understanding of the shipping at the Indo-Roman ports is discussed below.

These apparently mundane rigging components allow a surprising amount of interpretation concerning the shipping that operated out of the Red Sea ports, their rigging and refitting. Critical to this is the sample size recovered from the archaeological record, which in conjunction with the long chronology of the remains, allows conclusions to be drawn that cannot be extracted from single shipwreck sites. Firstly, returning to the detail of the material from Myos Hormos, the difference in diameter between the largest (90mm) and the smallest (27mm) brail ring is striking, and possibly reflects some of the relative size differences between the largest and smallest vessels. Brail rings provide direct proportional evidence for the size of brailing lines because a larger brail ring will carry a larger rope. Larger diameter rope will logically be utilised to furl larger (heavier) sails, which would naturally occur on larger vessels. As such, the range of brail ring diameters present in the Red Sea ports is a direct reflection of the many different vessel sizes that operated out of them.

This model becomes more complex to apply when the wider variation in the Mediterranean square-sail rig is considered[35]. For instance, vessels carrying two smaller sails, rather than one large mainsail, would produce a sample of

33. Gale and van der Veen 2011, pp. 221-222.
34. *Ibid.*
35. See Whitewright 2016 pp. 879-884.

smaller brail rings than would otherwise be expected for a hull of the same size rigged with a single square-sail. Likewise a vessel rigged with an *artemon* foresail (small foremast) or a *mizzen* (small sail at the stern) would also have produced small rings in association with that sail, as well as larger rings from the mainsail. At least some of this variation is likely to be present in Indian Ocean shipping, where both single and two-masted ships are depicted. The exact nature of the sail-form on these vessels is ambiguous, but a single-masted ship is depicted on a pot-sherd from Berenike[36], from Alagankulam in south India[37] and from Anuradhapura in Sri Lanka[38]. Meanwhile, a number of depictions from Indian sources, including both pottery and coinage show two-masted vessels illustrating that such a rig was in concurrent use in the Mediterranean and Indian Ocean[39].

Returning to brail ring size as discussed above, it may be noted that the most important characteristic of the brail rings rigged on a single sail is that the diameter of the rings is uniform enough so that a small ring cannot fit inside a large ring when the sail is furled. Such an occurrence is likely to result in a tangle or jam when the sail is subsequently unfurled. With this in mind, the variation in the size of brail rings from Myos Hormos (27-90mm) can be usefully contrasted with the brail rings from the 4th century BC Kyrenia ship where a total of 171 lead brail rings were excavated[40]. Of these, 131 were similar to those from Myos Hormos (with two attachment holes punched through the body of the ring) and measured between 59mm and 67mm in diameter. The remainder, which measured between 65mm and 72mm in diameter, had a rectangular lug on one side where the attachment holes were located [41]. In both groups, the relatively tight clustering of the overall diameters is striking when compared to the wide range present at Myos Hormos.

Further comparative evidence comes from the Grand-Congloué site (210-70 BC), where lead brail rings also occur in two different forms. Around 80 rings (without lugs) exhibit a consistent diameter of c. 80mm, while another group (with lugs) ranged between 90-120mm[42]. Further analysis of the brail rings from the Grand-Congloué site is problematic because they are repre-

36. Sidebotham 1996.
37. Sridhar 2005, pp. 67-73, fig. 24.
38. Coningham *et al.* 1996, fig. 16; Rajan 2002, fig. 4c.; Allchin 2006.
39. Elliot 1885, pl. 1, fig. 38, pl. 2, fig. 45; Deloche 1996, pp. 243-244; McGrail 2001, pp. 253-255; Rajan 2002, fig. 4b; Sridhar 2005, pp. 67-73, fig. 7, pl. 23.
40. L. Swiny pers. comm.
41. *Ibid.*
42. Benoit 1961, p. 178.

sentative of at least two shipwrecks mixed together during excavation[43]. Each of the two groups of brail rings, with discreet forms and size, probably corresponds to a different ship.

Overall, the relatively close size of the brail rings found on the Kyrenia and Grand-Congloué sites backs up the observations made regarding the diversity in size of the Myos Hormos brail rings. The brail rings from Kyrenia and Grand Congloué are similar in size because they each come from a single vessel that would have required a single size of brail ring for a single sail. This provides a direct contrast with Myos Hormos, where the range of vessel size using the port is reflected in the diversity of brail ring size. At this point, an important caveat should be noted: that because of the variation in rig-type it is not possible to equate a specific brail ring diameter with a specific tonnage of vessel.

The overall form and material of the Myos Hormos brail rings is also significant. With regard to form, there is a lack of uniformity (visible mainly in cross-section) suggesting that individual makers had differing preferences for production techniques, resulting in different end products. Comparable diversity in cross-sectional form was also present in the lead brail rings from the Grand-Congloué shipwreck where three different forms of cross-section were observed[44]. There seems no reason at present to suggest that any of the different forms would have been superior to the others and it may have just been a matter of personal choice. Likewise, there is no obvious chronological patterning, or grouping, based on Mediterranean/non-Mediterranean materials. The materials used for the production of the brail rings from Myos Hormos are also significant. Most obviously, lead, which is a common brail ring material on Mediterranean shipwrecks, is absent and all the rings are made from wood or horn; the latter of these comprises 70% of the total. The wider faunal record from Myos Hormos, including a sawn-off cattle horn-core, suggests that cattle were driven to the site on the hoof[45], and so the horn brail rings probably indicate the reuse of horn from animals slaughtered at the site for food. The alternative is that the horn rings were manufactured on the Nile, as a bi-product of cattle slaughtered there, before being transported to the coast, either as finished rings or as horn in its raw material form.

43. Long 1987; Parker 1992, pp. 200-201.
44. Benoit 1961, p. 178.
45. Hamilton-Dyer 2011, pp. 246-247.

At Berenike, an ostracon (*O.Ber*. II 131) records the storage of rigging material at that site[46]. Given the number of ships visiting both ports it is likely that large stores of rigging material, or the raw material to manufacture it, would have been brought from the Nile. This view is further corroborated by the contemporary Koptos Tariff recording the transport of a ship's mast from the Nile to the Red Sea coast[47]. Of course, the archaeological remains indicate that the Nile, and the Mediterranean world beyond it, was not the only source for fitting and refitting rigging. As noted above, many wooden brail rings from Myos Hormos were of non-Mediterranean origin, specifically from sub-Saharan Africa. This corresponds closely with the trade routes attested in the *Periplus Maris Erythraei* that stretched down the coast of East Africa. Overall the evidence suggests that vessels were being refitted with locally produced horn brail rings prior to an outbound (from Egypt) voyage, while those lost or broken along the route would be replaced using local materials at the next port of call. The final stage of this cycle is the discard of these wooden rings and re-fit with local materials following a vessel's return to the Red Sea coast. It is such diversity of origin that probably explains the differences in the cross-section of the wooden brail rings. Different vessels visited many ports around the Indian Ocean in the course of trade and damaged or broken rigging may have been replaced at each. It is impossible to tell whether the rings were made in overseas ports and bought by the visiting vessels or made on board by the sailors from wood procured whenever they made landfall.

Sailcloth

The brail rings were the most numerous class of rigging component found at Myos Hormos, but they are surpassed in archaeological significance by the fragments of sail cloth that have been excavated at the site[48], with near-identical finds from Berenike[49]. In the context of maritime antiquity, the sailcloth found at these two Red Sea ports is virtually unparalleled in the material record. Sailcloth from any period is an archaeological rarity, and so the dozens of fragments from Myos Hormos and Berenike are exceptional. The key moment in the identification of sailcloth at Myos Hormos came in 2003 when a small fragment of textile (T331) was found from a late 1st or early 2nd century AD rubbish dump. It was possible to distinguish this as sailcloth, when compared to other textiles, because of the remains

46. Bagnall *et al*. 2005, p. 47.
47. Sidebotham 2011, p. 201.
48. See Handley 2011.
49. For the Berenike material see Wild and Wild 2001.

of a wooden brail ring still attached. Sewn to the sailcloth was a reinforcement strip of heavier, herringbone-style webbing material and it was to this that the ring was attached. The brail ring measured 50mm in diameter and its attachment orientation (with the holes uppermost) confirmed that the reinforcement strip ran horizontally across the face of the sail. Discovery of this fragment (Fig. 6) permitted the subsequent identification of a further 68 pieces of reinforcement webbing and fragments of sail and/or reinforcement webbing to add to the existing corpus of material from Berenike.

Fig. 6. Fragment of sail excavated from Myos Hormos, dating to the late 1st or early 2nd century AD with wooden brail ring attached to the reinforcement webbing (J. Whitewright).

While archaeological examples of ancient sails are extremely rare, there are numerous iconographic depictions from antiquity that are extremely useful for informing our general view of ancient sailing rigs[50]. These often show sails with a series of vertical and horizontal lines running across their face, interpreted as brailing lines (vertical) in conjunction with strips of textile or leather (horizontal) used to reinforce the seams between strips of sailcloth[51]. It is likely that as well as reinforcing the sailcloth, the webbing strips also served to reduce the amount of stretch to which the sailcloth would have been subject while under sail. The widely held interpretation of the iconography is confirmed by the examples of sailcloth from Berenike, Myos Hormos and also a contemporary find from the Nile at Edfu[52]. Sailcloth from Berenike was made with cotton reinforcement strips running both vertically

50. For discussion of such use see Whitewright 2017a.
51. Casson 1995, pp. 68-69, 234.
52. Rougé 1987; Black 1996, figs 5-6.

and horizontally[53]. Likewise, the sail from Edfu has a brail ring attached to the horizontal strip at the point of intersection with the vertical one[54]. One sail fragment from Myos Hormos (T392) comprises the sail's edge with the remains of a webbing strip in which the alignment of the surviving brail ring attachment indicates that the webbing strip ran vertically up the face of the sail. This arrangement is mirrored in another example (T27), which has two brail ring attachment points aligned in such a way as to indicate that the webbing ran in a vertical direction with no evidence for horizontal webbing present at either brail ring attachment point. In contrast to this, the original sail fragment T331 shows no sign of a vertical webbing strip at the point of attachment of the brail ring to a horizontal webbing strip.

The detail of the sailcloth finds from the Red Sea ports greatly expands our understanding of the physical construction of ancient sails. In particular, it seems to indicate that there were at least three possible approaches to sail-making in use amongst the shipping operating out of Berenike and Myos Hormos. One involved the use of vertical and horizontal reinforcement webbing strips intersecting across the face of the sail and to which the brail rings were attached. A second technique utilized only horizontal webbing strips to reinforce the sail, while a third technique seems to have utilised only vertical webbing strips. It may also be noted that in some cases the webbing spans across the seam between two lengths of sailcloth, and where brail attachments survive this can indicate the original alignment of the bolts of sailcloth. As this narrative indicates, some of these sails were made from cloth set horizontally, while others demonstrate vertically set lengths of sailcloth.

The material of the sailcloth also provides an insight into the wider sourcing of maritime materials within the Indo-Roman networks. The sailcloth excavated from Berenike and Myos Hormos was constructed from cotton; a contrast with the linen cloth and flax reinforcement used on the Edfu example[55], and the wider historical sources which also point to linen as the normal material for sailcloth in the ancient Mediterranean[56]. Moreover, in many examples from the Red Sea ports, both sailcloth and reinforcement strips were originally made in India[57], although several examples from Myos

53. Wild and Wild 2001, p. 214.
54. Black 1996, figs 5-6.
55. Wild and Wild 2001, p. 213; Wild 2002, p. 13.
56. Black and Samuel 1991, p. 220.
57. Indian and Egyptian produced cotton are distinguished from one another through the use of a 'z' spun (clockwise Z/Z) yarn for the former and an 's' (anticlockwise S/S) spun yarn for the latter. For Berenike see Wild and Wild 2001, pp. 211-220. For Myos Hormos see Handley 2011, pp. 325-330. See also Handley, this volume.

Hormos were also made from Egyptian cotton. This suggests that vessels engaged in the India trade may have been fitted out with Indian cotton imported into Egypt, or repaired upon arrival in India using local products[58]. If sails were constructed in Egypt from bolts of imported cloth, they could represent part of a return trade in relatively low value cotton. Indian cotton is mentioned in the *Periplus* (*PME* 41) as being one of the products of the land around the port of *Barygaza* and might therefore be a source of the cotton used in the sailcloth. It is interesting to consider how such imported material would have competed with the Egyptian cotton attested from Myos Hormos.

Sheaves and Deadeyes

In a ship's rigging the sail is raised and controlled by a system of ropes termed the 'running rigging', because it is free to move and be manipulated by the crew. Meanwhile, the mast is supported by 'standing rigging,' which is more permanently fixed in place and less readily adjusted during use. The final element of the ancient sailing rig represented in the archaeological record at Myos Hormos were seven wheels, termed sheaves, from pulley blocks (Fig. 7), and single large deadeye (Fig. 8). The latter is almost certainly from the standing rigging of a ship, while the sheaves could be from the pulley blocks that facilitated a vessel's running rigging, or from pulleys put to general use around the port.

Six of the sheaves date to the latter half of the 2nd century AD, while one (W0198) is early Roman in date. In all cases the accompanying outer shells, and axles upon which the sheaves would rotate within those shells, were absent. Six of the sheaves were flat, circular pieces of wood, termed disc sheaves, the design of which has changed little from antiquity to the present day. The sheaves range in size from 46mm to 81mm diameter with a consistent thickness of 14-16mm. The outer edges of the disc sheaves, where not decayed, were grooved to carry rope running through the block. It might be possible to account for the difference in sheave diameter by the use of bigger sheaves in blocks designed to resist higher loads, by contrast, the ropes that ran around these sheaves seem to have had a very consistent diameter. Comparative disc sheaves, or blocks utilising disc sheaves, have been excavated from a large number of shipwrecks or terrestrial sites dating to antiquity[59]. Disc sheaved blocks are also visible in the depiction of naval spoils on

58. Wild and Wild 2001, pp. 217-218.
59. Selective examples include Cavalière (Charlin, *et al.* 1978, pp. 57-60), County Hall (Marsden 1974, fig. 8.2), Grand Ribaud D (Hesnard *et al.* 1988, pp. 105-126), Laurons 2 (Ximénès and Moerman 1990, pp. 5-6, fig. 1), Madrague de Giens (Carre 1983, pp. 20-26,

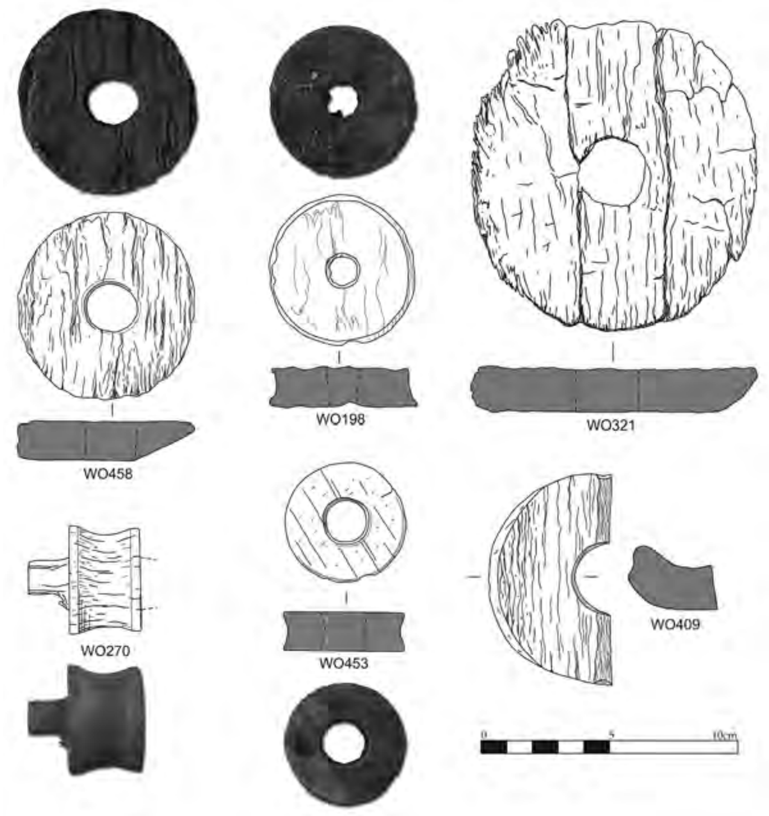

Fig. 7. Wooden sheaves excavated from Myos Hormos. All date to the second half of the 2nd century AD with the exception of WO198 which is 1st century AD in date (J. Whitewright).

the triumphal arch at Orange[60], further indicating their widespread use and likely ubiquitous nature.

By contrast, the seventh sheave excavated at Myos Hormos (W0270) was quite different. Although damaged it was clearly cylindrical in its original overall form with integrated axles. Such cylinder sheaves are distinctive to the ancient Mediterranean and a number of comparable examples have been excavated

49-50, 83, 94, 131, 154) shipwrecks and from a terrestrial context at the site of Kenchreai (Shaw 1967, fig. 1). Additional material can be found in Carre 1983; Pomey 1997; Beltrame 2002; Whitewright 2008.

60. Amy 1962, pl. 25.

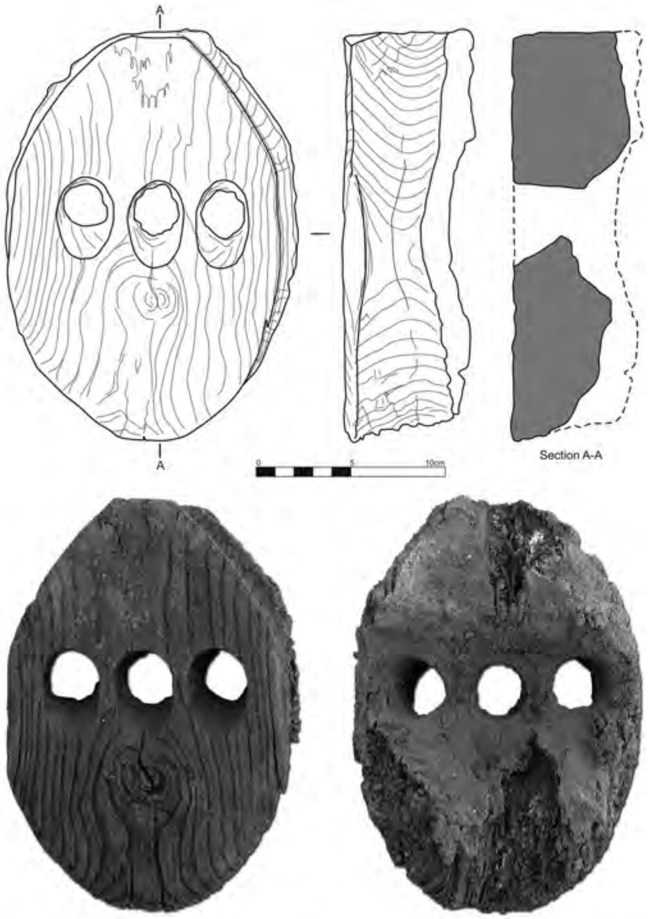

Fig. 8. Wooden deadeye excavated from Myos Hormos, dating to the mid/late 2nd century AD (J. Whitewright).

from shipwreck and harbour sites[61]. W0270 represents the only evidence of the use of this form of sheave block at Myos Hormos. The size of the sheave suggests a block of similar size to one found at Caesarea Maritima: 130mm long by 90mm wide. As with the brail rings described previously, the sheaves from Myos Hormos were made from wood with a variety of geographic ori-

61. Selective examples originate from the harbour of Caesarea Maritima (Oleson 1983, Oleson 1994, p. 104, fig. 33, pl. 22) and also from the Cap del Vol (Foerster 1980, fig. 5), Comacchio (Berti 1990), Grado (Beltrame and Gaddi 2005, fig. 2), Grand Ribaud D (Hesnard *et al.* 1988, pp. 105-126) and Kyrenia (Swiny and Katzev 1973, p. 351, fig. 12) wrecks.

gins including the Mediterranean (alder), but also the wider Indian Ocean region (teak from India, blackwood from sub-Saharan Africa)[62].

The rigging deadeye was excavated in the 2001 Myos Hormos season and dated by associated material to the mid-late 2nd century AD[63]. Deadeyes are usually rigged in pairs, allowing them to be tensioned at the base of shrouds or stays (ropes rigged to provide lateral and fore-and-aft support for the mast). Components of a broadly similar shape and function are still found on traditional square rigged sailing vessels today. The deadeye from Myos Hormos is an oval shaped piece of blackwood (*Dalbergia* sp.), pierced by three holes set alongside one another in the centre of the block. It measures 214mm long, 144mm wide and 55mm thick, although the reverse side had been heavily degraded. The outside edge had been grooved in order to take a rope strop which could have been up to 28mm in diameter. The three central holes could have carried ropes of up to 25mm in diameter. Comparable deadeyes, albeit much smaller in overall size, have been excavated from a number of Mediterranean shipwreck sites[64]. Apart from the overall size, other observable differences with the comparanda relate to the number of holes (two rather than three in some examples), or their arrangement. So although deadeyes from different contemporary sites in antiquity were serving the same general purpose, the detail of how they were deployed within a sailing rig differs from place to place[65].

Interpretation and discussion

The previous sections summarised the archaeological detail of the hull elements and rigging components found at Myos Hormos, which can also be taken as a representative of those found at Berenike. With this in mind, the following section sets out the broader interpretation of this material with regard to the implications it has for our understanding of the shipbuilding, rigging and sailing traditions used on the vessels of Indo-Roman trade that operated from, or visited, the Egyptian Red Sea ports. More specifically, this concerns construction sequences and overall traditions, the role of shipbuilding and maintenance within the port sites, the forms of sailing rig used

62. Gale and van der Veen 2011, pp. 221-223.
63. Thomas and Masser 2006, pp. 131-132.
64. Selective examples occur through five deadeyes from the Grado site (Beltrame and Gaddi 2005, p. 80), and fourteen from the Laurons 2 site (Ximénès and Moerman 1990, p. 7, fig. 2). Additional material can be found in Carre 1983; Pomey 1997; Beltrame 2002; Whitewright 2008.
65. For further discussion of this see Whitewright 2007a, pp. 287-288.

on merchant ships, and the likely resulting potential performance of such ships. Finally, it allows broader comment to be made on the technological relationship between Mediterranean maritime technology and Indian Ocean maritime technology during the peak period of Indo-Roman trade in the first centuries of the first millennium AD.

Shipbuilding and Rigging Traditions

Turning attention initially to shipbuilding and ship construction traditions, it is clear from the archaeological remains at Myos Hormos and Berenike that ships were being repaired and broken-up at both ports. The wider historical evidence indicates that shipbuilding was taking place at Myos Hormos during the Roman period, and probably at Berenike prior to the foundation of Myos Hormos. Indeed, it is possible to speculate that one of the reasons for the development of the latter port was because of its relative proximity to the Nile, several days closer when compared to Berenike, making Myos Hormos more easily accessible and therefore cheaper for the transport of supplies, materials, etc., including shipbuilding timber. It is beyond doubt that the vessels attested to in the archaeological record were built in the same construction tradition as contemporary Mediterranean ships: shell-based with edge-joined mortise-and-tenon planking. Furthermore, the material origins of the hull remains indicate that such shipbuilding timbers, utilised in a Mediterranean tradition, were sourced from the wider Indian Ocean region, as well as the Mediterranean. Of course, the exact origin of the ships themselves can never be known with certainty; they may have been variously under Mediterranean, Egyptian, Arabian or Indian ownership, and built, in theory at least, anywhere around the shores of the Indian Ocean. As noted by a referee of this paper, vessels could easily have been built under Mediterranean oversight in an Indian location. Similarly, the extent of vessels built in distinctly Indian Ocean construction traditions, within the Indo-Roman trade networks, is hard to fully quantify from the available evidence[66]. Such craft certainly played a role at individual ports and within local systems[67], but there can be no certainty regarding the use of long distance merchant ships built using an Indian Ocean, rather than Mediterranean, method. The overall picture is one of great potential complexity and the extent of the data available simply allows a reasonable interpretation that the main Red Sea ports of Myos Hormos and Berenike were engaged in the building (in the case of the former), refit and breaking up of Mediterranean style ships. Meanwhile, the geographical origin of the hull timbers highlights two possibilities. First, that

66. See Deloche 1996; Ray 2003, pp. 55-81; Kotarba-Morley 2017, pp. 197-202.
67. Kotarba-Morley 2017, p. 199.

timber as a raw material was transported to the ports along the Indian Ocean trade networks, and would have been a companion material to that attested to have arrived from Mediterranean sources. The second possibility is that the hull timbers represent ships from across the Indian Ocean, of Indian Ocean origin, but built in the same building tradition as contemporary vessels from the Mediterranean.

The same overall patterns are reflected in the rigging components recovered from the archaeological record at Myos Hormos and Berenike. Again, the basic comparative analysis of the material places it firmly within the square-sail rigging tradition of the contemporary Mediterranean; all of the maritime archaeological material described and discussed above is consistent with that found at contemporary sites in the Mediterranean. Within such a tradition, vessels may have been rigged with a single-mast, two equal sized masts, an *artemon* and mainsail, or a three-masted rig of *artemon*, mainmast and mizzen[68]. As seen with the hull timbers, rigging components of all types are derived from Indian Ocean sources, as well as Egyptian/ Mediterranean ones, raising the same set of possibilities for the origin of the ships they are rigged upon.

Moreover, material from the Red Sea ports represents several centuries of consistent rigging and shipbuilding traditions at the same site, especially with regard to rigging. This represents hundreds, even thousands, of vessels across the time period concerned within broadly the same geographical, economic and cultural context. In terms of technological practice and trajectories, it represents a view of how people were rigging and using their ships that is of much greater value than a small collection of single shipwreck sites. The ships represented in the archaeological record are thus of Mediterranean cultural origin (some of them almost certainly are), and also representative of Indian Ocean maritime cultures operating long distance sailing ships within a tradition of construction of rigging shared with their Mediterranean contemporaries. This possibility was raised by the present author in 2007 as a result of initial interpretation of only the rigging material from Myos Hormos[69]. Continued work on the archaeological material, extended here to the ship remains, has not diminished this argument; it remains entirely plausible to suggest that the material from the Red Sea ports represents a tradition of building and rigging vessels that was shared across the Mediterranean, Red Sea and western Indian Ocean in antiquity.

68. For a fuller outline of ancient Mediterranean rigging arrangements see Whitewright 2016, pp. 879-884.
69. Whitewright 2007a, pp. 290-291.

Ships and Sailing Performance

Of course, understanding the construction and rigging traditions of a sailing ship allows a reasonable estimation of overall performance to be made and the ships of the Indo-Roman trade networks, attested through the archaeological evidence of the Red Sea ports, are no exception to this. As outlined above, it is clear that a significant proportion of these vessels were built and rigged with traditions that are normally classed as 'Mediterranean'; shell-based mortise-and-tenon hulls, powered by a loose-footed brailed square-sail. What is unclear is the nuance of individual vessels within such traditions. For example, the absence of substantial hull remains means that an understanding of hull form can only be estimated, while the ambiguous nature of iconographic depictions of sailing rigs in the western Indian Ocean region means that overall sail-plan cannot be confirmed[70]. Consideration of performance, and the implications of such performance, therefore, requires some assumptions to be established through reference to the wider comparative evidence of the building and rigging traditions.

Firstly, in relation to hull form, the archaeological remains of ships and boats of all classes, shapes, sizes and purpose have been excavated from the ancient Mediterranean[71]. These range from harbour dredgers[72] and fishing boats[73] through to very large merchant ships of over 40m in length[74], and encompass vessels with flat bottoms as well as those with deeper keels[75]. Hull form in antiquity was therefore variable enough to indicate that vessel purpose, rather than sailing performance, was the key driver in the selection of shape. But, hulls did exist that were large, capacious, deep-keeled[76], and would have had the most effective hulls for long-distance open-water voyaging on a variety of different courses to the wind, including upwind. Secondly, research[77] has established the overall potential performance of the Mediterranean square-sail of antiquity in its various collated forms[78]. This can be summarised as upwind performance *in optimum conditions* of 60-65° for maximum heading angle to the wind, and with a VMG (velocity made good) of no more than 2 knots in a windward direction. Meanwhile,

70. For wider discussion of Indian Ocean sailing rigs in this period see Whitewright 2015.
71. Summarised by Whitewright 2017b.
72. Pomey and Rieth 2005, p. 50.
73. Boetto 2006, pp. 123-129.
74. Tchernia *et al.* 1978.
75. Whitewright 2017b, pp. 210-212.
76. For example, the 1st century BC Madrague de Giens shipwreck.
77. Whitewright 2011.
78. Whitewright 2011, table 6.

on courses across the wind (reaching) and downwind (running), average speeds of c.4-6 knots might be expected in favourable conditions with an estimated maximum speed of c. 12+knots.

Establishing the possible performance of at least some of the ships engaged in Indo-Roman trade permits some reconsideration of how mariners and merchants used such ships within the trade routes described by the ancient sources. Such activity must have paid significant attention to the weather patterns thought to have existed in the Indian Ocean in the early first millennium AD, namely the Indian Ocean monsoon system (Fig. 1). The seasonally predictable nature of that weather system has resulted, perhaps unsurprisingly, with sailing between Egypt and the wider Indian Ocean being conducted when the weather was most favourable: generally to the south and east in the late summer, and west and north in the winter and spring. Despite sailing vessels rigged in a Mediterranean tradition having some capacity to sail to windward in ideal conditions, it makes little sense to sail an upwind course unless totally necessary; courses to windward offer the slowest passage times while placing the greatest physical strain on a vessel and crew. By contrast, voyages made under favourable wind conditions offer the fastest passages with the least physical cost to ship or sailors. Acknowledging this, when attempting to reconstruct distance and time in maritime antiquity, is critical if a reasoned understanding of the spatial relationship between ports, along trade routes, and within networks is to be achieved.

Within the archaeological/historical literature associated with the Red Sea it is common for the perceived challenges associated with sailing against the Red Sea's northerly wind to be highlighted[79]. However, whatever the reality of these challenges in the Roman period, they did not prohibit the placement of important ports of trade at Myos Hormos, Clysma and Aila, at the northern end of the Red Sea. A simple exploration of this can be found in the north/south position of Myos Hormos and Berenike[80], with the latter often seen as facilitating easy trade because it did not require vessels to sail further north, against the prevailing northerly winds of the Red Sea. Analysis of vessel speed, terrestrial travel time and potential economic costs indicates that the situation is far more complex than this. In reality Myos Hormos was just as likely a destination as Berenike and one that could be regularly reached by sailing against the northerly wind.

79. Casson 1980; Facey 2004; Sidebotham 1989, pp. 198-201.
80. For an exploration of this particular case study see Whitewright 2007b.

With the concept of windward sailing in mind, it is interesting to note the observation by the authors of the *Red Sea Pilot* that 'Anyone used to sailing to windward will not find the Red Sea markedly worse than anywhere else'[81]. Sailors native to areas where upwind sailing was a part of life may have taken for granted the techniques required to sail to windward in the northern part of the Red Sea. By contrast, sailors from areas where favourable trade winds generally prevail during the sailing season, such as the Indian Ocean, may have had far more difficulty adapting to the unfamiliar conditions of the northern Red Sea. In the medieval period Indian Ocean merchant ships sailed only as far as Jeddah, and goods were then trans-shipped to Egypt by vessels from the northern Red Sea itself[82]. This strongly suggests a scenario where Indian Ocean sailors were unable to cope with the environmental conditions of the Red Sea, leaving sailors and vessels familiar with the requirements of upwind sailing to carry the cargoes. To Mediterranean sailors, the northern third of the Red Sea simply represented a region where favourable winds would not be encountered. Although an inconvenience after the favourable monsoon winds of the Indian Ocean, the rig, hull and sailing techniques of Mediterranean vessels and mariners would have been well able to cope with an extended period of upwind work. Such analysis is, of course, a counterpoint to the possibilities raised above regarding the presence of Indian ships in the Red Sea ports.

Finally, the corpus of brail rings from Myos Hormos indicates a range of rig sizes, assumed to represent a range of vessel size. Given what is known of the range of ship/boat-types and hull forms from the contemporary Mediterranean, it might be expected that a similar variety of craft was present in Myos Hormos. This would of course include very large merchant ships within the fleet of 120 ships attested by Strabo[83], but it must also have encompassed fishing vessels and ships of a size more suited to local coasting. Likewise, the nature of the harbour front at Myos Hormos[84] strongly suggests a system of lightering, whereby small boats unloaded merchant ships, moving the goods from ship to shore. Additionally, papyrological evidence indicates the presence of military vessels operating out of Myos Hormos[85]. Without significant hull remains, accurate reconstruction of these vessels is challenging – for instance in the case of military vessels or fishing vessels, where even the Mediterranean archaeological record is limited. But,

81. Davies and Morgan 1995, p. 26.
82. Facey 2004, pp. 9-11.
83. *Geography* 2.5.12.
84. Blue 2011.
85. Van Rengen 2011.

it is possible to arrive at a reasoned visualisation of what a large merchant ship, of Mediterranean cultural origin, operating out of Myos Hormos might have looked like. The vessel shown in FIG. 9 is a very large[86] merchant ship created for commercial consultancy work within the Centre for Maritime Archaeology at the University of Southampton. It is based on the shipwreck record present in the Mediterranean and is underpinned by a process of computational modelling and hydrostatic testing to prove stability, prior to visualisation and rendering. Its extreme size is deliberate, representing and exploring the maximum size and capacity such vessels might have reached, while remaining viable, seaworthy vessels. Its inclusion in this paper is not a statement that such vessels were the norm on Indian Ocean routes, rather an acknowledgement of the ultimate interpretation of the archaeological material presented here – that such vessels could have existed.

FIG. 9. Visualisation of a very large Roman merchantship, dating generally to the late 1st/early 2nd century AD. Top: waterline view from the port side. Bottom left: aerial view from the port quarter. Bottom right: aerial view from the port bow (Image courtesy of Science UK Ltd).

86. Critical vessel dimensions: length overall: 61m, beam: 13m, draught: 6.5m, displacement (overall): 2005 tons, displacement (cargo capacity): 1374 tons, total sail area: 937m².

Conclusions

The preceding sections demonstrate the extent of analysis and interpretation that is possible when reference is made to the detail of the maritime artefactual material from the Red Sea ports. In the case of the ships of the Indo-Roman trade networks it is only through reference to this archaeological material that it is possible to begin to understand the technological make-up of those ships in any depth. Moreover, this material must be considered with clear reference to the wider comparative, contemporary material. These comparisons, alongside the established historical, epigraphic and iconographic material, can potentially paint a vivid picture of the ships and shipping of Indo-Roman trade seen through the lens of the Red Sea ports.

That picture itself is one of technological continuity with the neighbouring Mediterranean; hardly surprising given its proximity, and the origin of much of the other cultural material from the Red Sea ports. It can be clearly stated that the shipping of the Egyptian Red Sea ports, at least that element represented in the archaeological record, were built with a shell-based mortise-and-tenon system of construction, and rigged with a loose-footed brailed square-sail. In this regard they would have been technologically indistinguishable from their Mediterranean contemporaries, and because of the present knowledge of the potential performance of Mediterranean shipping, such performance can be extended to the vessels operating on Indian Ocean routes. But, there are clear variations in the applied form of the rigging components discussed in this paper, when compared to their Mediterranean counterparts. This is hardly surprising when considered against the technological variation that is visible within the overall continuity of the Mediterranean square-sail rigging tradition in antiquity, and highlights the regional variation that is likely to be identifiable in maritime cultural artefacts, providing an adequate archaeological sample was available. Similarly, with regard to the materials of these components, the archaeological record tells a story of hull and rigging components manufactured from Indian Ocean materials, as well as Mediterranean ones. This in turn raises the question of whether or not the material related to shipping, excavated from the Red Sea ports, is as much a record of Indian Ocean maritime cultures as it is of those from the Mediterranean. The answer to this is unlikely to be proved decisively, but the possibility raised by careful analysis of the archaeological material must be acknowledged and considered further.

It can only be hoped that some future archaeological discovery, underwater or terrestrial, will unearth material within the wider Indian Ocean region that is comparable to that found in the Red Sea ports. Such a discovery would render our interpretation less reliant on an image of the shipping of Indo-Roman trade that is filtered through the narrow field of view available from the Egyptian Red Sea ports. For now, however, that narrow view is one that continues to offer the plausible reconstruction of a shared tradition of building, rigging, and by extension, use of ships and shipping that extended across both the Indian Ocean and Mediterranean world during the first centuries AD. With this in mind, it is striking to consider the possibility that an ancient mariner might have been equally at home, in the sense of a continuum of technical practice, working aboard a vessel in areas as geographically diverse and far apart as the province of Britannia or the ports of southern India.

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WHAT DID PEOPLE WEAR AT MYOS HORMOS?

EVIDENCE FOR CLOTHES FROM THE TEXTILE FINDS

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The Roman port of Myos Hormos, or Quseir al-Qadim as it is known currently, on Egypt's Red Sea coast has been the subject of two major archaeological excavations, by the University of Chicago from 1978-80[1], and from 1999-2003 through a project co-directed by David Peacock[2]. I participated in these later excavations as the textiles, basketry and cordage specialist for materials from both periods of the site, a Roman first through third century occupation, and a later Islamic settlement from the 11th – 13th centuries. An overview of the textile finds has been published in the excavation report[3], and a selection of the Islamic textiles published elsewhere[4]. This paper presents an opportunity to publish more finds from Myos Hormos[5]. It looks at the remains of the garments that people wore which were deposited in large rubbish dumps. The depth of the deposits combined with the arid climate of the desert means that organic finds, including textiles, have been well preserved. These fragments of clothes reveal information about the dress of residents and visitors to the port, with its widespread connections through Egypt, the coastlines of Arabia and Eastern Africa, and further afield to the Middle East and India.

1. Whitcomb and Johnson 1979, 1982.
2. Peacock and Blue 2006, 2011a.
3. Handley 2011a.
4. Handley 2007; Handley and Regourd 2009.
5. Many thanks are due to the reviewers of this paper who offered insightful and extremely helpful comments, and to the excellent work of the editor in supporting the development of the paper.

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Clothing: an overview

Around half of the Roman textiles (1,136 examples from 2,455) found during the excavations at Myos Hormos were identified as being of suitable quality to have been used in clothing[6]. The rest of the examples were fragments of textiles relating to the home (e.g. furnishings, towels), or, mostly, 'utilitarian', for example sacking, saddlery, sails, and scraps of coarse fabrics. These divisions are blurred by the reuse of textiles, for example, some of the utilitarian items such as saddle padding included repurposed garment fabrics.

There was a wide variety of people living at Myos Hormos from different cultural and geographic origins, all of whom would have brought textiles in the form of the clothes they were wearing and carrying, and possibly trading. There was probably a small resident population involved in more local and regional trade and ship repair work, as well as an indigenous desert population nearby. However, as a seasonal port Myos Hormos must have had many temporary residents. At its busiest times from November/December when the large ocean-going ships returned from India, and June/July when they set sail, the port must have been swarming with sailors and traders from India, East Africa and Arabia, mixing with Roman soldiers and merchants arriving from the Nile Valley[7]. Some of these people may have set up home in the port, as there may be evidence for an Indian quarter of the port based on pottery finds[8].

One of the key commodities, alongside exotic spices, that was brought into Myos Hormos were the luxurious textiles, such as silks, from the Far East (e.g. *PME*49)[9] that were highly prized by the Roman elite. These colourful and highly decorated textiles were destined to be used in clothing and furnishings, however, they passed through the port without leaving a trace in the archaeological record. No examples of this kind of very high-quality clothing have survived.

Roman clothing

Luckily, during the first through third centuries there is a relatively clear understanding of Roman dress, and plenty of evidence that it was fairly standardised. There are myriad representations of Roman dress through funerary monuments, mosaics and wall paintings, and specialists working in Egypt

6. Handley 2011a.
7. Maxfield 1996.
8. Peacock and Blue 2011b, p. 346.
9. Casson 1989, p. 81.

are particularly lucky to be able to draw upon the assemblage of mummy portraits discovered in western Egypt in the Fayum, which provide a rich body of evidence[10].

Much work has been undertaken into Roman dress using a combination of documentary, pictorial and archaeological sources[11]. The tunic was the basic article of both male and female clothing. This was a very simple garment, made of rectangular pieces of fabric. During the first and second centuries AD, it was generally made either from two shoulders to knee, or ankle, lengths of fabric sewn across the shoulders and up the sides; slightly later it was made of one long rectangle of fabric folded in half with a ready-made slit present for the neck hole and sewn up the sides. In both cases, the tunic was decorated with two coloured stripes which ran down the front of the garment, one on either side of the neckline, and usually continued down the back. These stripes ended either in the hem, or in some kind of motif or design, chiefly at waist height. These contrasted with the background colour of the tunic, which was usually in a range of natural wool colours or white, and made of wool or linen. Archaeological remains demonstrate that these tunics were woven from side seam to side seam, and thus the stripes would be worked horizontally as weft bands, over a very wide warp width, especially if the tunic was made from a single piece that was folded in half at the shoulder. Women also wore a tunic which was always floor length, as well as over garments such as a *stola*, which fell into a 'v' shape around the neckline[12].

Over this garment a variety of mantles, wraps, hoods and cloaks would be worn, depending on the gender and occupation of the wearer, and of course the weather. Mantles or *pallium* were rectangular pieces of fabric worn in a draped fashion in a similar way to togas and had to be held in place by hand. Women in any public situation would always wear a mantle which covered her head and fell to her knees or lower. They were sometimes decorated with woven-in motifs in each of the four corners. Cloaks were distinct from mantles as they were held in place by a brooch, thus leaving the hands free. There were many varieties, and the distinctions are not entirely clear, but the most common were *sagum* which were made in coarse fabrics suitable for the wet and cold weather of northern Europe. These were associated with ordinary soldiers and agricultural workers. They were straight edged, in contrast to other military cloaks such as the *chlamys*, and *paludamentum* which had curved edges. *Lacerna* and *laena* were civilian cloaks, and as such tended to

10. Walker and Bierbrier 1997.
11. Cardon *et al.* 2011; Croom 2010.
12. Croom 2010, p. 27.

have straight edges. A variety of cloak was the *paenula*, which was partially sewn up to make a cape, often with a hood. Like the *sagum*, they were wet and cold weather wear, made of hardwearing wool fabrics. A shorter version of the *paenula,* the *cucullus* reached down to the elbows[13].

These detailed descriptions from the documentary, pictorial and archaeological records are a good starting point for understanding the kinds of garments worn by Romans, especially the Roman soldiers, at Myos Hormos. However, this is complicated by the nature of the fragments found, most of which are simply pieces of wool fabric with no pattern or selvedge, which cover a spectrum of qualities of extremely fine, high quality and lightweight, through to coarse, heavy fabrics. The latter can probably be placed in the categories of wet and cold weather outerwears such as *sagum* and *paenula*, and the lightest and finest as women's *palla*, but in between lie a whole swathe of fabrics that could have been used as cloaks for men, mantles for men and women, and tunic fabrics. In all probability a poor-quality women's *palla* would be in a coarser fabric than a high-quality men's tunic, so there was no benefit in recording fabrics by quality to suggest use. Work on the Mons Claudianus material demonstrates the overlap between tunic and mantle fragments[14]. There is also the question of reuse, for example, a tunic found at Mons Claudianus is made from pieces of a *pallium*, retaining its gamma motifs[15], and of multiple uses, as while the desert is associated with heat, temperatures fall sharply at night, and for those with the most minimal of possessions a warm cloak would have also served as a blanket[16].

Clothing worn by other people

The clothes of non-Romans who visited and worked at Myos Hormos are harder to identify. They simply may not have deposited their clothes in the same deep rubbish dumps as the Roman's did, or may have reused fragments of textile until they completely disappeared. The indigenous population of the Eastern Desert may have lived in close proximity to Myos Hormos, and while we cannot identify what they wore, it is likely that they were responsible for the production of a range of hardwearing textiles associated with the transport of goods across the desert, a traditional Bedouin activity across the Middle East[17]. Their clothing may have reflected this and be based on animal

13. Cardon *et al.* 2011.
14. Bender Jørgensen 2004a, p. 73.
15. Mannering 2000, p. 289.
16. Sumner 2002, p. 15.
17. Sheffer and Granger-Taylor 1994, p. 232.

fibre fabrics and skins such as those of camels and goats. People who worked on boats such as the crew on the large ocean-going ships, fishermen, sailors involved in coastal trade, and boat repairers, probably wore minimal clothing on board, due to poverty and the hot climate. They probably had sets of clothes to wear on land, and these must have reflected their diverse origins from India, the Arabian Peninsula and East Africa. All of these places had traditions of textile production based on vegetable fibres, and climates which suited the lightweight garments that these produced.

The finds from Myos Hormos

Roman tunics and fragments of tunics

Just under 1000 of the textiles found at Myos Hormos were made from a plain, slightly weft-faced tabby sheep's wool fabric. These pieces are probably the remains of tunics or light outerwears.

Almost all the wool tabbies are weft faced, that is, with more weft threads per cm than warp threads, which is typical of wool weaves in Egypt. Almost all of the warp thread counts fell between 9 and 18, with most of the weft thread counts between 11 and 29. Sixty-eight percent of the wool tabbies had thread counts that fell between these two parameters. The remaining 32% were either coarser fabrics with the same proportion of warp to weft threads, or had the same warp counts, but with more weft threads, or in other words, finer, more weft-faced fabrics.

During this period the direction of the spin of the threads making up the textiles gives some indication of origin of production, with Egyptian spinners during this time period spinning in an 's' or clockwise direction. Given

Table 1. Proportion of wool tabbies, based on the spin direction of the warp and weft threads

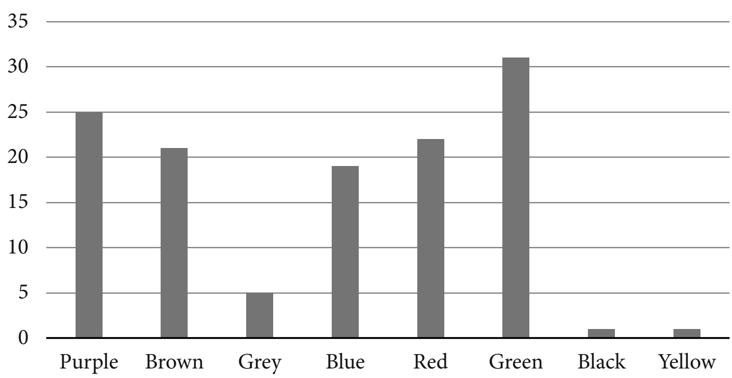
Spin direction of warp and weft	**% total**
s/s	58
s/z	21
z/z	16
z/s	2
Sz2/s	2

that 58% of the fragments had 's' spun threads in both the warp and weft (s/s) (Table 1), it can be surmised that the majority of these fabrics were produced in Egypt.

About 30% of the s/s wool tabbies had warp thread counts of 10-15, and weft thread counts of 14-26, and while this is a broad range it reflects the quality of an average wool tunic at Myos Hormos, and is similar to the background weaves of the fragments of stripes from tunics. Of the fragments with stripes, 135 fragments survived, with 125 of these examined in detail. These were distinguished from other striped wool fabrics, such as soft furnishings, by qualities such as the background weave, an increased density of weft in the colour stripe, and often the appearance of a 'shadow' of denser background weave on either side of the stripe. The most popular stripe colour was green (25%), though closely followed by purple, red, brown, blue, and red at 20, 18, 17, 15% respectively (Graph 1). Other colours were grey, black and yellow, and the total for red included two examples of pink. Almost all of these were on an undyed background, which survives as an off-white or brownish-yellow colour. This background tunic colour is associated with soldiers[18]. The range of widths of the stripes was consistent through all of the different colours and measured from about 0.3 cm to 5 cm wide. However, the frequency of widths within this range did vary from colour to colour (Table 2).

Green, the most popular colour[19], is also the narrowest type of stripe, while brown and red are the broadest. Purple is also quite narrow, with a higher average but a smaller range of widths than blue. Dye analysis undertaken

Graph 1. Frequency of stripe colours in tunic fragments



18. Cardon *et al*. 2011, p. 284.
19. In contrast, green was not a numerous colour at Didymoi, Cardon *et al*. 2011, p. 285.

TABLE 2. Average width of tunic stripes by colour

Stripe Colour	**Average width in cm**
Green	1.6
Purple	1.9
Blue	1.7
Brown	2.1
Red	2.3

on the striped fabrics found in Roman forts in the Eastern Desert and from Quseir[20] has found that almost none of the purple was the very expensive 'true' purple made from the *murex* species of shellfish, but rather a mixture of blue and red dyes. This is interesting when considered in the context of the background fabrics of the weaves. Taking a weft thread count of 30 or above as a rough indication of a high-quality fabric, 46% of purple stripes and 45% of red stripes have high-quality background weaves. It may be that there were two sorts of high-quality tunic, those with generally broad red stripes, and those with thinner purple stripes. Even though broader purple stripes would have been cheap to produce as they were a mixture of blue and red dyes, the fashion was for thin stripes emulating the stripes made with the more expensive kind of dye.

The spin of the background fabric may give some indication of the origin of the different tunics (TABLE 3). This is not conclusive data, but it suggests that

TABLE 3. Proportions of fabric type based on spin, by the colour of the stripe: i.e. 35% of all the s/z striped fabrics have a brown stripe. Largest percentages are in bold.

	% of s/s	**% of s/z**	**% of z/z**
black	1	0	0
blue	18	10	8
brown	13	**35**	17
green	**28**	15	17
grey	5	5	0
purple	18	20	**42**
red	16	10	8
pink	0	5	8
yellow	1	0	0

20. Cardon *et al.* 2004; Vogelsang-Eastwood 2004.

the purple striped tunics are more likely to have been made outside Egypt (i.e. with higher proportions of 'z' spun threads), while the green striped tunics are more likely to have been made in Egypt. It may be that green, blue and brown striped tunics were more ordinary, perhaps made and bought in Egypt, while broad red and narrow purple striped tunics were of a higher quality and status and came from further afield.

The following examples represent some of the more complete tunic fragments found at Myos Hormos. Notably, the most complete example (FIGS. 1 and 2) is quite small, with a width extrapolated from the remains of about 52 cm, and is probably an adolescent's. The smaller size of children's garments meant that there were fewer opportunities for them to be cut up and reused, unlike larger adult clothes. This is a high-quality garment and is the only example at Myos Hormos which is obviously constructed to be worn with a cloak, with twined reinforcing, a decorative cord and a tapestry woven swastika motif to support and highlight the brooch. Tunics decorated with short notched *clavi* with arrowheads or swastikas, under a cloak that was fastened by a brooch on the right shoulder were characteristic outfits of soldiers[21]. In contrast, the next example (FIG. 3) is coarsely made. The substantial reinforcing of the areas around the shoulders suggest that the person wearing the garment was carrying heavy loads on (presumably) his shoulders, perhaps moving goods around the port.

There are two examples that highlight the tailoring techniques used in creating tunics, ranging from fine piped edging to coarse sewing, and two examples which show that some tunics had separate sleeves that were sewn on. Many tunics were simply folded rectangles with a slit for the neck hole, with the sides sewn up leaving gaps for armholes, or woven to shape including sleeves. The remains of these sleeves in wool fabric suggests that traditional patterns were modified at Myos Hormos, perhaps through the influence of more tailored garments worn by non-Romans (see Cat. 18). Most tunics would have been held in at the waist with a belt, and many examples of possible belts have been found, though they are hard to distinguish from the many other straps and belts that would have been used in saddlery and at the port, but one is presented here (see Cat. 7).

1. Large fragment of the front of a tunic, for a young person, decorated with red stripes, and a red tapestry-woven swastika motif. The two broader red stripes extend the length of the tunic, and each has two finer stripes on

21. Cardon *et al.* 2011, p. 294-295.

either side which extend about 20 cm towards the waist. Their ends (and therefore any finishing motifs) do not survive. A blue and yellow cord forms at least a section of the neckline, and supports what would have been the brooch attachment. It is placed on top of a line of twined reinforcement, which runs over the top of another reinforcement, probably in supplementary weft. There is another line of twining 2 cm further round the neckline towards the centre of the body. Both these lines of twining extend about 12 cm towards the waist. This combination of cord, and twined and supplementary weft reinforcement creates a clear area (FIG. 2) of support for the brooch pin where there is a small hole, and distributes the strain of the weight of the cloak across the tunic fabric. Two further lines of twining run down the weft selvedge on the right hand side of the tunic, ending at the waist. A short fragment of the blue and yellow cord is attached here on the inside of the garment and may have reinforced the support for a belt loop on the exterior of the tunic.
Sheep's wool, tabby weave, 13 warps/cm, 34 wefts/cm (56/cm in stripe and motif). Spin of warp 's', spin of weft 's' ('s' in stripe and motif)
Size 69 x 36 cm, 6 x 7 cm
Trench 6HX, context 4080, QAQ nos 02T128, 130
FIGS. 1 and 2.

2. Fragment of a tunic with a broad red stripe running across the shoulder and a thin stripe running down the front and back. The area on both sides of the neckline is well worn with lines of reinforcing which run in the direction of the warp.
Sheep's wool, tabby weave, 18 warps/cm, 52 wefts/cm (52/cm in stripe). Spin of warp 's', spin of weft 's' ('s' in stripe)
Size 10 x 10 cm
Trench 6J, context 4040, QAQ no. 01T195
FIG. 3.

3. Shoulder of a tunic showing that it was made from two pieces sewn across the shoulder, the stripe does not continue down the back. The remains of a sleeve are present and it appears to have been sewn on at the same time as the back. The stripe is 0.5 cm wide in grey wool. The fabric is a fairly even weave with a fine feel.
Sheep's wool, tabby weave, 20 warps/cm, 28 wefts/cm (52/cm in stripe). Spin of warp 's', spin of weft 'z' ('z' in stripe).
Size 7 x 11 cm
Trench 6P, context 4100, QAQ no. 02T385.

Fig. 1. Tunic fragment, reverse side (Cat. 1) (Scale = 5 cm).

Fig. 2. Tunic fragment, showing detail of the area where a brooch would have been attached (Cat. 1) (Scale = 5 cm).

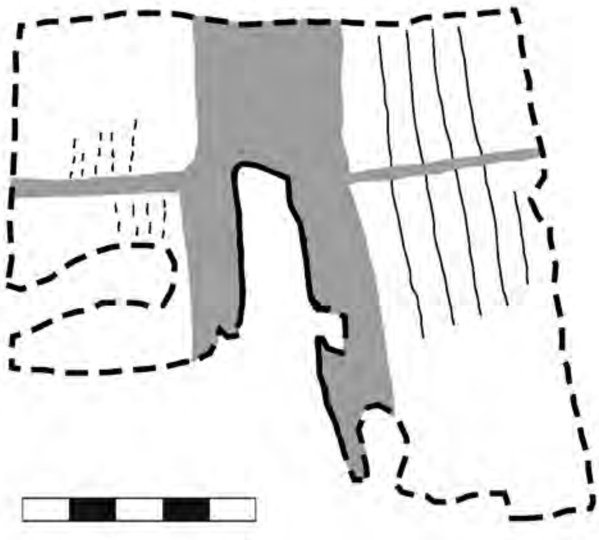


FIG. 3. Tunic fragment, showing stripes in grey, reinforcements in short dashed lines and incomplete edges in longer dashed lines (Cat. 2) (Scale = 5 cm).

FIG. 4. Decorative seam of piped edges with matching running stitch (Cat. 4) (Scale = 2 cm).

4. Fragment of a tunic with a piped seam, probably originally in white with blue piping and stitches. It was perhaps a shoulder seam of a tunic or part of a light cloak. The fabric is in a very fine, weft faced, yellow wool with Zs3 green piping and line of green running stitches.
   Sheep's wool, tabby weave, 18 warps/cm, 30 wefts/cm. Spin of warp 's', spin of weft 's'
   Size 11 x 3 cm
   Trench 6P, context 4100, QAQ no. 02T334
   Fig. 4.

5. Fragment of a tunic seam. The corded warp ends are sewn together to make the side seams of a tunic and are held together rather coarsely with rough running stitches.
   Sheep's wool, tabby weave, 20 warps/cm, 26 wefts/cm. Spin of warp 's', spin of weft 's'
   Size 7 x 25 cm
   Trench 6DE, context 4015, QAQ no. 00T415.

6. Cuff end of a sleeve with run and fell seams. The fabric has a medium feel and quality.
   Sheep's wool, tabby weave, 14 warps/cm, 17 wefts/cm
   Spin of warp 's', spin of weft 'z'
   Size 10 x 20 cm
   Trench 6P, context 4105, QAQ no. 02T403

7. Two fragments of a woollen broad belt, 8 cm wide, woven in tabby to this width. One fragment is cut at one end, and at the other end is pulled into a tongue shape with a series of rough stitches, presumably to make it easier to pull through a buckle.
   Sheep's wool, tabby weave, 11 warps/cm, 16 wefts/cm
   Spin of warp 'Sz2', spin of weft 'z'
   Size 25 x 8 cm, 39 x 8 cm
   Trench 6J, context 4040, QAQ nos 01T109, 110.

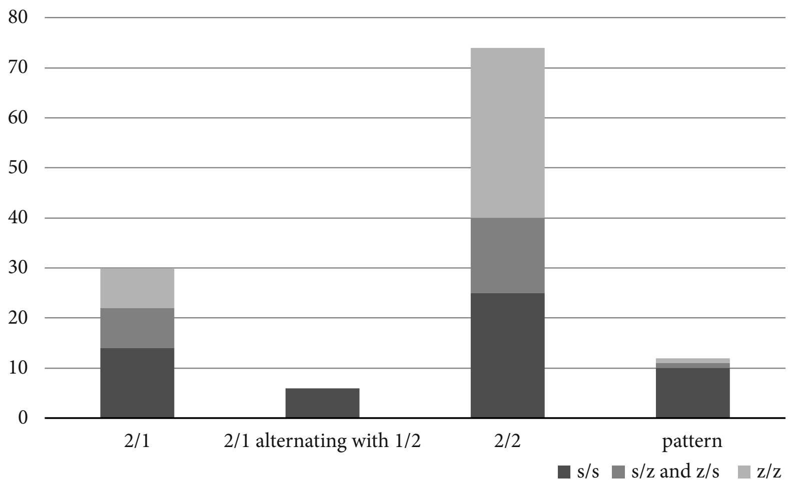
Roman outerwear: cloaks, capes and mantles

Distinguishing the majority of the fragments of Roman outerwear such as cloaks (held with a brooch on the right-hand shoulder), mantles and *palla* (which were draped and had to be held in place by hand) is perhaps impossible, especially as large, unseamed fragments of cloth would be very likely to be reused in other garments or in saddlery padding. However, some outerwear fabrics, especially cloaks, are distinguishable through their heavier weight, decoration, or weave structure.

Outerwear in twill weaves

Twill weaves from this period are associated with cloaks worn by soldiers[22]. The twills are woven in several ways, with variations based on 2/1 twills (under two wefts over one), rows of 2/1 alternating with 1/2 twills to give a striated appearance, and 2/2 twills (under two wefts, over two wefts), and more complicated variations of these known as pattern twills. At Myos Hormos 160 woollen twill fabrics were found and 122 were complete enough to examine in detail. As in the tunic fabrics, the spin of the threads used in creating the twill fabrics can also give some indication of where the textile was produced (GRAPH 2).

GRAPH 2. Numbers of examples of different types of twill, broken down into warp and weft thread spin direction.



Overall, 's' spun threads were in the majority, suggesting production in Egypt. However, the most common combination was z/z in an 2/2 twill with 34 examples. The spin direction, and the 2/2 twill structure suggests an origin outside Egypt, and it seems likely that these textiles travelled to Myos Hormos on the backs of soldiers as *sagum*. Of the 34 examples 18 are visually very distinctive, in undyed wool, with an obvious and even diagonal

22. Bender Jørgensen 2004b; Sheffer and Granger-Taylor 1994.

twill pattern due to the thick threads used and a lack of surface felting (Fig. 7, Cat. 13). This type has also been recognised at Mons Claudianus[23] and at Didymoi[24]. Interestingly, there are six examples of similar even 2/2 twills, but in this case with threads spun in an 's' direction, and this may indicate Egyptian production using the imported examples as a design guide.

At the high end of the quality spectrum several examples had a very thick feel with well beaten wefts that disguise the twill pattern. The examples are colourful in reds and dark blues, some with fringes shaped into circles (Figs. 5 and 6). Similar examples were found at Didymoi[25], and these garments would have been worn by higher ranking military personnel or civilians.

Several of the fragments are in the shape of long strips, which reveal something of the lifecycle of cloaks. They tend to drag on the ground and get stepped on or snagged, resulting in ragged edges, which were then trimmed to leave long strips. As these were too narrow to be reused, they were thrown away. Several of these have been found at Didymoi, Maximianon, Krokodilô and Mons Claudianus[26] and one with evidence of reuse from Xeron[27].

8. Fragment of the edge of a dark blue cape with fringed edge. The twill weave is hard to discern as the surface is very felted, however, the fringe runs along a curved edge showing that this was woven to shape. It has been cut off the main garment and discarded. However, a deep fold suggests that this was not a fringe that hung below the garment, but perhaps a way of easily creating a selvedge along the curve, that was first neatened by folding, then later trimmed off. Similar examples have been found at Didymoi[28].
   Sheep's wool, unknown twill weave, 24 warps/cm, 38 wefts/cm
   Spin of warp 's', spin of weft 's'
   Size 9 x 6 cm
   Trench 6HX, context 4080 QAQ no. 02T117
   Fig. 5 (top).

9. Fragments of a cloak, constructed in 2/1 twill in red wool with a thick feel. The cloak was woven to a curved shape with the edge secured by twisting about four ends into a Zs4 cord (nb. the corded edge has twisted back on

23. Bender Jørgensen 2004b, p. 97, see MC 1068.
24. Cardon *et al.* 2011, p. 340, D98.1431.6
25. Cardon *et al.* 2011.
26. Cardon *et al.* 2011, p. 324.
27. Cardon *et al.* 2010, p. 7, Xeron.506.07.1.
28. Cardon *et al.* 2011, p. 323-329, D99.3327.1A, D99.4319.5, D2000.1553.15, D99.1418.1.A+B+C, D99.1547.7A+B+C+D, D99.4415.1.

itself and looks like a seam but is not). The three long fragments suggest this was trimmed from a cloak, and the angle at which the warp enters the cord suggests that this would have hung at the sides of the wearer in the original garment. One of the fragments ends with a large self-knot. Cardon

FIG. 5. Strips of cloak fragments (Cat. 8 [above] and Cat. 11 [below]) (Scale = 5 cm).

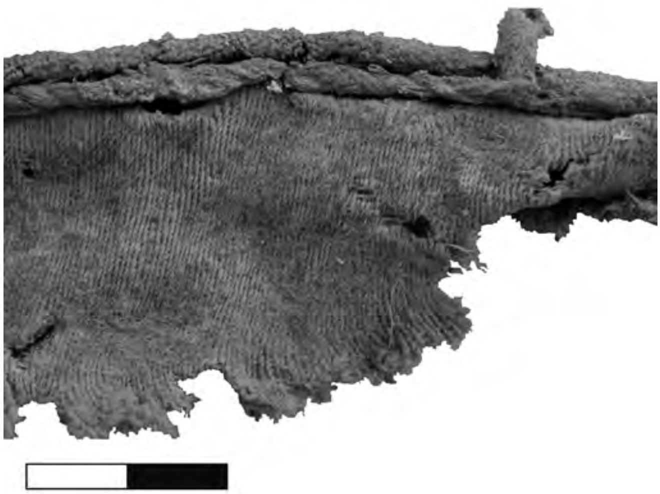


FIG. 6. Red cloak fragment in a thick twill weave with a corded edge seam (Cat. 9) (Scale = 2 cm).

et al.[29] have suggested that densely woven red cloaks are a distinctive type, and these fragments would support this. Comparators with corded edges are found at, e.g., Didymoi[30] and held in the British Museum[31].
Sheep's wool, 2/1 twill, 16 warps/cm, 61 wefts/cm
Spin of warp 's', spin of weft 'z'
Size 14 x 4 cm, 25 x 6, 5 x 3 cm
Trench 6HX, context 4080, QAQ nos 02T139, 140, 141
Fig. 6.

10. Fragment of a cloak edge in bright red well-felted 2/1 twill. This section appears to have been cut off and discarded. See comments for no. 9, above.
Sheep's wool, 2/1 twill, 16 warps/cm, 24 wefts/cm
Spin of warp 's', spin of weft 's'
Size 3 x 12 cm
Trench 6L, context 4075, QAQ no. 01T251.

11. Fragment of a cloak in indigo wool in a 2/1 twill weave. The fabric has a medium to thick feel, and has been woven with a curved edge.
Sheep's wool, 2/1 twill, 16 warps/cm, 22 wefts/cm
Spin of warp 's', spin of weft 's'
Trench 6D, context 4070, QAQ no. 01T248
Fig. 5 (bottom).

12. Fragment of a cloak in 2/1 twill in an unevenly spun thick brown wool. The fabric has a medium to thick feel. There is cord reinforcement in two places which, when the fabric was folded, probably acted as a brooch attachment.
Sheep's wool, 2/1 twill, 10 warps/cm, 7 wefts/cm
Spin of warp 'z', spin of weft 'z'
Size 10 x 24 cm
Trench 6J, context 4040, QAQ no. 01T164
Fig. 7 (bottom left).

13. Fragment of a cloak in a thick natural coloured wool in a distinctive even 2/2 twill with an attachment of a 'tab' of the same material. This is probably a fragment of a *sagum*.
Sheep's wool, 2/2 twill, 6 warps/cm, 7 wefts/cm
Spin of warp 'z', spin of weft 'z'

29. Cardon *et al.* 2011, p. 332.
30. Cardon *et al.* 2011, p. 330, D99.3329.8.
31. Granger-Taylor 2007, p. 31, British Museum EA68977.

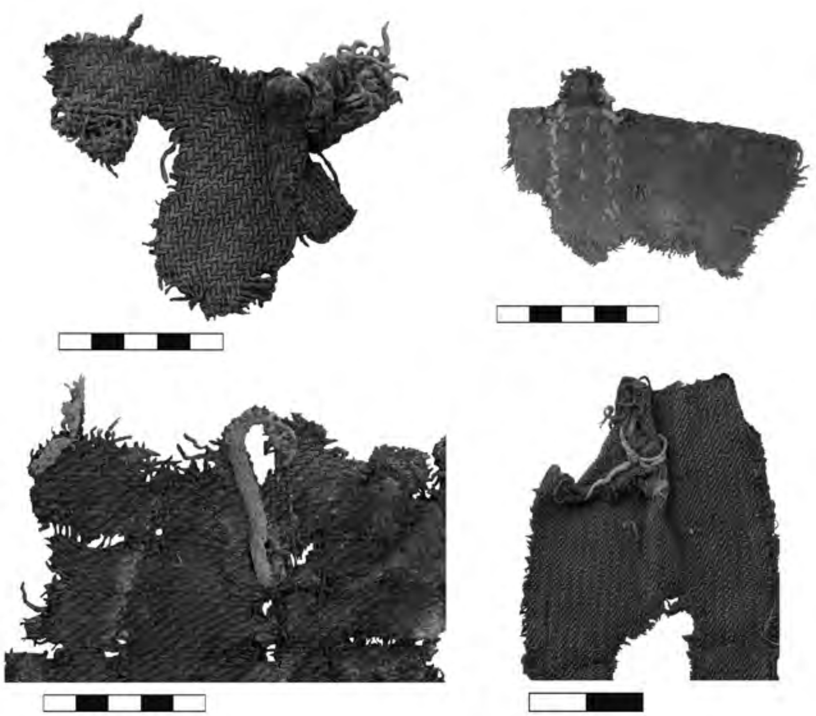


FIG. 7. Cloak fragments in twill weaves showing a variety of brooch supports (Clockwise from top left: Cats 13, 15, 14, 12) (Scales = 5 cm and 2 cm [Cat. 14]).

Size 9 x 6 cm
Trench 6H, context 4030, QAQ nos 00T334-337
FIG. 7 (top left).

14. Fragment of a brown wool cloak in a 'striated' twill. There are the remains of a roughly sewn attachment in 's' spun bast fibre. The attachment reinforces a fold in the fabric, and one edge may have been an unseamed one that was folded under and held in place by the knot, which was presumably also the support for a brooch.
Sheep's wool, 'striated' twill (3 wefts of 2/1 twill alternating with 3 wefts of 1 /2) 15 warps/cm, 24 wefts/cm
Spin of warp 's', spin of weft 's'
Size 5 x 10 cm, 4 x 7 cm
Trench 5, context 3024, QAQ nos 00T104, 105
FIG. 7 (bottom right).

15. Fragment of a natural-coloured wool cloak in a 2/2 very weft-faced twill. The fabric has a fine feel with a tab coarsely sewn on.
Sheep's wool, 2/2 twill, 24 warps/cm, 40 wefts/cm
Spin of warp 's', spin of weft 's'
Size 7 x 9 cm
Trench 6J, context 4040, QAQ no. 01T206
Fig. 7 (top right).

Other outerwears

Mantles (*pallium* and *abolla*) were outerwears that were draped around the body. During this period they were often decorated with woven-in patterns. These include a range of standardised motifs, including 'L' shaped gammas with or without notched ends, and six of these were found at Myos Hormos. The remains of one substantial piece of mantle had been reworked into a hooded cape. This was the largest piece of Roman textile excavated at Myos Hormos that, although fragmentary, measured over 110 cm in length. It was recycled from two pieces of one mantle, with an extra piece, probably in the same fabric, added as a hood. Although it was formed from quite a large piece of fabric, it would have made a short cape, reaching down about 40 cm from the neckline where it was attached to the hood, all the way round. While the edges are very fragmentary it is possible to see where the square corners of the mantle were rounded off to make a shape that draped better. The schematic diagram of a hooded cloak in Cardon *et al.*[32] shows this for a cape that would hang further down the arms, and additional examples of hooded semicircular cloaks have also been published[33], drawing on Hero Granger-Taylor's work[34]. As in the Mons Claudianus example of a mantle reworked into a tunic[35], no attempt appears to have been made to place the gamma decoration symmetrically in the reworked garment; one was placed near to the neck, the other half way round the body under the arm.

The other example of a mantle is a much lighter weight wool fabric with broad stripes and a fringe comparable to a scarf in the Whitworth Gallery[36]. Its narrower width and lighter weight would make it suitable for a head covering, so may have been worn by a woman.

32. Cardon *et al.* 2010, fig. 7.
33. Cardon and Cuvigny 2011.
34. Granger-Taylor 2007.
35. Mannering 2000, p. 289.
36. Pritchard 2006, p. 117, T.9869.

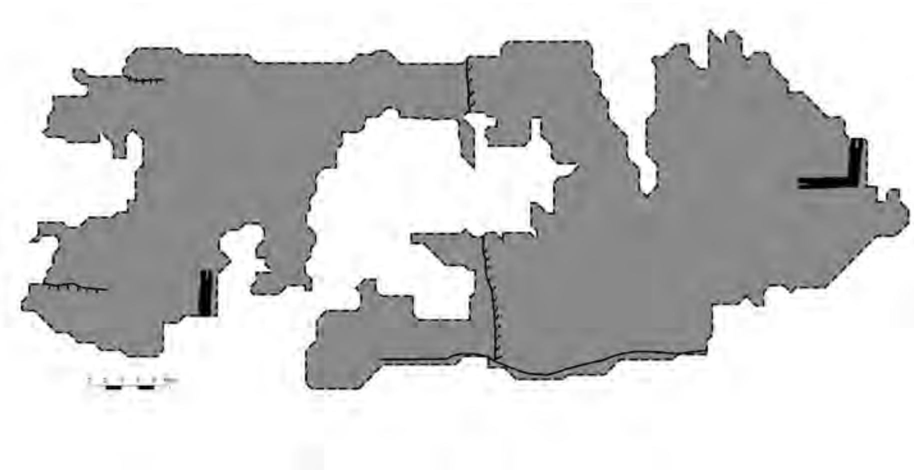


FIG. 8. Cape fragment with incomplete edges in dashed lines, seams and repairs in solid lines. The hood would have continued below the bottom solid line (Cat. 16).

FIG. 9. Fragment of a fringed mantle (Cat. 17) (Scale = 5 cm).

16. Hooded cape, constructed from three fragments of one mantle decorated with a notched gamma mantle and reassembled into a cape, sewn together in coarse stitches. The two gamma decorations are in green wool, woven with a paired warp which extended into the background weave to create a shadow effect. There are no intact edges or hems, but it appears that the square corners of the recycled mantle have been shaped into a curve, and there are two coarsely sewn repairs.
Sheep's wool, tabby weave with tapestry decoration, 19 warps/cm, 20 wefts/cm (14/cm in decoration)
Spin of warp 's', spin of weft 's' ('s' in decoration)
Size 110 cm x 40 cm
Trench 8, context 8000, QAQ no. 01T40
Fig. 8.

17. Fragment of a mantle, in wide red and blue stripes, fringed, and of medium quality. The weft is paired in the background weave and single in stripe, producing a denser colour.
Sheep's wool, tabby weave, 9 warps/cm, 20 wefts/cm
Spin of warp 'z', spin of weft 'z' ('z' in stripe)
Size 15 x 13 cm
Trench 6H, context 4030, QAQ no. 00T325, also referred to as T0039 in the excavation archive
Fig. 9.

Non-Roman clothing

There are a few examples of clothing that the non-Roman visitors and residents of Myos Hormos wore. Some of them would have been wearing garments made of blue and white checked or plaid linen and cotton fabrics. Two pieces were found in the Chicago excavations at the site[37], but they are more frequently found at the port site of Berenike[38] further south than Myos Hormos (and not at all at the inland sites in the Eastern Desert). It may be that these represent a shift in local clothing style in progressively warmer climates. However, they would also be suitable as clothing worn by sailors, and thus could be the clothing worn by people from further down the East African coast, or from the Arabian Peninsula, or India. The 'z' spun cotton fabric suggests that the origin of the textile may have been India[39], although the garment need not have been worn by an Indian.

37. Vogelsang-Eastwood 2004, p. 282, Cat. 78/23, p.523, Cat. 82/32.
38. Wild and Wild 2005.
39. Wild 2013.

18. Fragment of a fitted upper body garment, from either the shoulder area or possibly from under the arm. It is seamed with neat run and fell stitches.
Cotton fibre, tabby weave, 26 warps/cm, 16 wefts/cm
Spin of warp 'z', spin of weft 'z'
Size 21 x 15 cm
Trench 6P, context 4105, QAQ no. 02T410.

19. Fragment of a garment fabric in blue and white plaid, four shots of blue and four shots of natural in both directions. The fabric is of poor quality.
Cotton fibre, tabby weave, 11 warps/cm, 10 wefts/cm
Spin of warp 'z', spin of weft 'z'
Size 6 x 2 cm
Trench 6P, context 4105, QAQ no. 02T394

20. Fragment of a garment fabric in blue and white plaid. The fabric has a medium feel, and is of medium-poor quality.
Cotton fibre, tabby weave, 8 warps/cm, 14 wefts/cm
Spin of warp 'z', spin of weft 'z'
Size 9 x 3 cm
Trench 6P, context 4105, QAQ no. 02T395.

FIG. 10. Fragment of a trouser leg (Cat 21) (Scale = 5 cm).

There is one very interesting example of a tailored cotton garment at Myos Hormos. It is a fragment of a pair of trousers, consisting of an ankle cuff, one side of a leg extending to the groin, where the tailoring around the crotch can be seen (FIG. 10). It is made from a good-quality white cotton, with a slightly thick, soft feel. Its dimensions show that this was an article of children's clothing. It is so strikingly different from Roman garments that it is worth repeating the differences here: it is in cotton (not linen or wool), it is extremely well tailored to a complex design (rather than simply seamed or shaped on the loom) and created a garment which fell in baggy folds to be caught at the ankle.

Tailored trousers of this type are associated with residents of the Middle Eastern Parthian Empire who were well known for their baggy, flowing trousers inspired by Central Asian traditions. They were held by decorated cuffs at the ankle and wrist[40], and short jackets tailored with vents on the bottom edge. Both the trousers, which could be combined with boots, and the jacket style, were developed to facilitate mounting and riding horses[41].

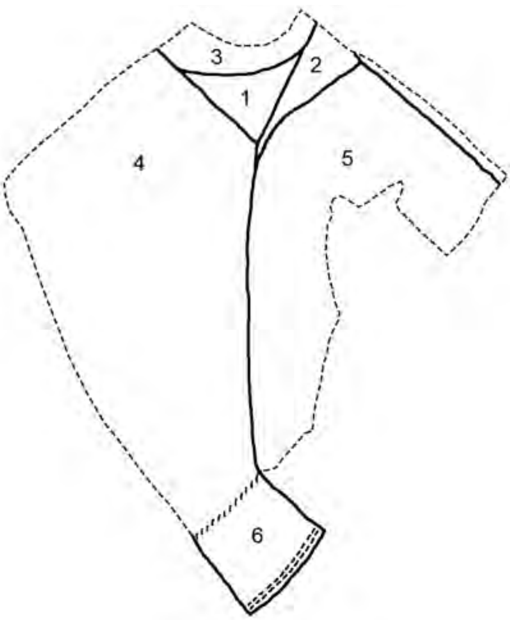


FIG. 11. Schematic drawing showing the construction of the trouser leg shown in Fig. 10 (Cat. 21).

40. Curtis 2000; Goldman 1994; Widengren 1956.
41. Beck *et al.* 2014.

Traders from Palmyra, located on the boundary of the Roman and Parthian empires were active in the Eastern Desert in Egypt, even creating a foreign colony in Coptos, the key port on the Nile[42], and Palmyrene soldiers were garrisoned at the fort at Didymoi[43]. They can be traced on the coast through the two Palmyrene inscriptions found at Berenike, and a sherd of Palmyrene pottery with an inscribed in Palmyrene Aramaic script found at Myos Hormos[44]. This fragment suggests that merchants were travelling away from colonies with their families, including children. The garment fabric (a 'z' spun cotton) may have originated from several places that the Palmyrenes were in contact with, including India, where cotton fabrics of this quality are known to have been produced.

21. Fragment of loose fitting trousers, comprised of gusset, leg and ankle cuff from one leg. As shown on FIGS. 10 and 11, Pieces 1 and 2 were sewn together, then 3, which is slightly gathered, was added. Four was sewn to this block with a new thread. Next it was stitched to 5 along the length of the trouser leg. Five was then sewn to the side of 2. The cuff (6) was added to Pieces 4 and 5. Note that in the figures the cuff is inside out. The raw edges of the trouser and cuff were turned and attached and sewn flat with a double row of running stitches. The other raw edge of the cuff was then turned and oversewn. This appears as a row of diagonal stitches on the right side of the cuff in FIG. 10.
    The preservation of the fragment shows that the trouser was worn with a boot, which protected the cuff. There is a coarsely sewn repair along the line of the seam near to the cuff. The fragment has been knotted, suggesting some form of reuse before it was discarded.
    Cotton fibre, tabby weave, 30 warps/cm, 18 wefts/cm
    Spin of warp 'z', spin of weft 'z', spin of sewing thread 's'
    Size approximately 35 cm x 23 cm
    Trench 6D, context 4070, QAQ no. 01T237
    FIGS. 10 and 11.

HEADWEAR

There are only two identifiable examples of headwear in the textile assemblage, as well as a previously published example of a straw hat[45]. One is a fairly coarse example of the remains of a simple hood (FIG. 12), possibly just two squares

42. Casson 1989, p. 34.
43. Cardon *et al.* 2011, p. 294,
44. Tomber *et al.* 2011.
45. Handley 2011b, Cat. 105.

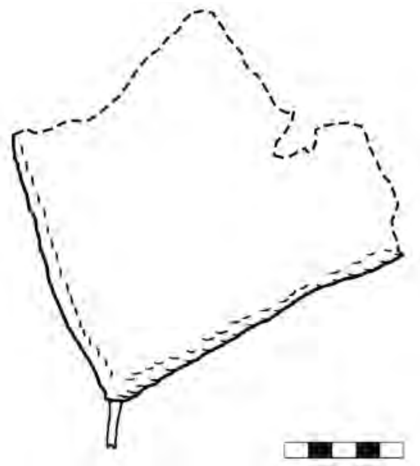


FIG. 12. Fragment of a hood (Cat. 22; second piece not shown) (Scale = 5 cm).

FIG. 13. A fragment of armour padding (Cat. 23) (Scale = 5 cm).

of fabric sewn together on two edges. The other piece is more interesting. The shaping of two crescents (e.g., FIG. 13) suggests that they were ear flaps from a hat, while their preservation suggests, unusually, that these crescents were protected rather than hanging free. This points to them being part of a protective padded hat that went under a Roman helmet[46]. A much more elaborate cap found at Didymoi shows similar patterns of wear[47]. The distinctive basket weave of the fabric (paired threads in both warp and weft) highlights a use for this fabric, usually identified as a packaging or saddle packing textile.

22. Two fragments of what may have been a 'hood', with under-chin ties at the corners.
    Sheep's wool, tabby weave, 10 warps/cm, 18 wefts/cm
    Spin of warp 's', spin of weft 's'
    Size 14 x 10 cm, 12 x 8 cm
    Trench 6J, context 4031, QAQ nos 01T279, 280
    FIG. 12.

23. Fragments of a hat worn under a helmet. Two crescent shapes, each ending in a small tassel. Each shape is made from one piece of fabric, folded and seamed along the long edge of the crescent shape, then reversed, with the fabric pushed through to make the pointed end, which was reinforced with a small tassel.
    Bast fibre, full basket weave, 10 warps/cm, 18 wefts/cm
    Spin of warp 's', spin of weft 's'
    Size 8 x 11 cm
    Trench 6HX, context 4085, QAQ no. 02T161
    FIG. 13.

UNDERWEAR

Two examples of underwear were found, both of them very simple long triangles (FIG. 14). The larger piece, which presumably belonged to an adult, is made from a 'z' spun cotton, suggesting that the origin of the fabric was India. Other 'z' spun cotton fabrics found at Myos Hormos are generally sails[48], which have a slightly coarser texture than this example, so this may be a fabric designed to be used as a garment, rather than a repurposed scrap of sail. The other example is much smaller, half the size, and is more likely to have been worn either by a woman as sanitary protection, or by a child as a

46. Sumner 2003, p. 37.
47. Cardon *et al.* 2011, p.345, D99.2511.4.
48. Handley 2011a; see Whitewright, fig. 6, this volume.

nappy. Again this is a slightly higher quality of fabric than other bast fabrics at the site, and the remains of both a seam and a decorative stripe in a denser weave of the original fabric suggest that this was a reused piece of fabric such as a towel. Granger-Taylor suggests that a much-mended fragment of towel found in a cache of women's personal possessions at the Cave of Letters was used as a sanitary towel[49].

FIG. 14. Two loincloths (Cat. 24 [below], Cat. 25 [above]) (Scale = 5 cm).

24. Loincloth. This is a very long triangle shape, and a suitable size, to be worn by an adult. The fabric is an even weave in very fluffy cotton thread, with a medium to thick feel that is well beaten. It is roughly sewn together with Sz2 cotton thread. There is a small piece of twine attached which may be the remains of the waist cord.
Cotton fibre, tabby weave, 12 warps/cm, 12 wefts/cm
Spin of warp 'z', spin of weft 'z'
Size 50 x 7.5 cm
Trench 6P, context 4100, QAQ no. 02T350
FIG. 14 (bottom).

25. Loincloth. This is a long triangle shaped piece of cloth, probably child sized. The fabric is warp faced, with a medium to fine feel, and is high quality. There is a self stripe of 4 weft shots. It has been reused from another garment as it incorporates a seam of 2 simple weft selvedges sewn together. The piece has been folded to make it narrower.

49. Granger-Taylor 2006, p. 124.

Linen fibre, tabby weave, 30 warps/cm, 20 wefts/cm
Spin of warp 's', spin of weft 's'
Size 8 x 27 cm
Trench 6P, context 4105, QAQ no. 02T412
FIG. 14 (top).

FOOTWEAR

The one small sock published here (FIG. 15) is the only example of single needle knitting or *nålebinding* and the only sock found at the site. Other footwear found include a child's shoe, a fragment of a boot, and numerous leather parts of sandals[50], as well as two examples of rope sandals, and coarsely sewn rope sandal soles, probably used to protect feet in the long march across the hot desert sand[51].

FIG. 15. Child's sock (Cat. 26) (Scale = 5 cm).

26. Child's sock constructed in *nålebinding* finished at the opening with a multiple thread. It is constructed in yellow, brown, red, and green stripes. The yellow wool is 's' spun, 0.06 cm wide; brown 'Zs2' 0.05 cm; red 's', 0.06 cm; green 's' 0.06 cm. It is in two pieces but complete.
Sheep's wool, *nålebinding*, 5 rows per cm, 7 stitches per cm
Size 11 cm x 5 cm
Trench 6GH, context 4095, QAQ no. 02T61
FIG. 15.

50. Phillips 2011.
51. Handley 2011b.

Concluding discussion

So what did people wear at Myos Hormos? In terms of Roman dress, there is a picture from the archaeological remains of a standardised soldier's outfit based around a pale coloured tunic decorated with green, brown or blue stripes, combined with a fairly poor-quality twill-woven cloak. Other Romans, including women, would have had higher quality tunics with red or purple stripes, and better quality, and more brightly coloured cloaks and mantles. In contrast, those involved in more physical labour were wearing Roman tunics that were heavily worn and reinforced to make them substantial enough to be used in carrying heavy loads around the port, and their smarter outfits, if they had them, were perhaps recycled items of clothing.

These Roman outfits of wool cloth contrasted with the lighter fabrics and tailored garments of others at the port. The cotton trousers whose stylistic origins are in the horse riding communities of Central Asia are a very clear reminder of how visually distinct different groups of people were. Trousers of a similar style worn by adults would have been made from more richly decorated, higher-quality fabrics than the white cotton pair discovered. In contrast, many inhabitants would have been distinct by their lack of clothing. Sailors probably did not wear much beyond a loincloth or waist wrap while on ship, and probably had minimal further garments to wear on land. It seems likely that shirt-like blue and white garments in coarse cotton fabrics would have been part of these outfits, and similar quality fabrics were perhaps used as waist wraps in combination with these.

The trousers, small size garments, and tiny sock are also an indication of the presence of children at Myos Hormos. The possibility remains that some of these fragments arrived as packing material in saddles rather than as clothing, and perhaps some were worn by adolescents travelling with adults, but it is hard to believe that the tiny sock was not lost at Myos Hormos from a tiny foot. The town may have been filled each year with temporary residents drawn from a wide geographic area, but this small discovery highlights the role of family life amongst this transient population.

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AFRICAN AMPHORAE IN THE EAST

A VIEW FROM ALEXANDRIA*

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Introduction

Ancient Alexandria was a nexus of long-distance trade. Her role as an enormous commercial centre can hardly be overestimated. The city was a large entrepôt and port of exchange between East and West for a very long time: from the Ptolemaic age until late antiquity. Profuse evidence, both historical and archaeological, confirms its standing in both regional and long-distance trade. But Alexandria, in spite of her major role in redistribution, was first and foremost a huge consumer site.[1] Even without going into the controversial issue of population size, we are certainly looking at a great metropolis, second only to Rome or Constantinople.[2] In other words, a city with an economy marked by a high level of demand for foodstuffs that had to be imported either from the Egyptian hinterland or from other more distant regions of the Empire.

Even bearing in mind the serious limitations and hazards of misinterpretation, pottery, and amphorae in particular, are perhaps the best proxy indica-

* Parts of this paper were presented at the LRCW5 conference, April 2014.
1. The term assumes a certain terminological neutrality, contrary to the more controversial 'consumer city' notion. On opposing views on the Weberian 'consumer city' economic model, see Finley 1977; Morley 1996; Whittaker 1990; Erdkamp 2001; Wilson 2002.
2. On the population of ancient Alexandria, see Delia 1988; Bowman 2000, p. 178; Manning 2007, p. 441; Rathbone 2007, p. 706.

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tors, reflecting on the nature and volume of the commercial exchange.[3] More importantly, out of the Mediterranean 'triad' of basic foodstuffs: wine, oil and grain, only the latter cannot be appraised with the help of amphorae as far as the volume of trade is concerned. Once *salsamenta* are added to the list of goods transported in amphorae, the overall picture of mass commercial exchange elicited in this way can hardly be overstated.

The absence of an Alexandrian *Monte Testaccio* does not imply a shortage of data for illustrating the scale and dynamics of the overseas trade. On the contrary, transport amphorae, although not in quantities comparable to Rome, are nevertheless a fairly common find in excavations carried out throughout the city, regularly adding to the available database.

The distribution of African pottery and above all fine wares in Egypt was recently studied by Pascale Ballet, Michel Bonifay and Sylvie Marchand.[4] The present article, focusing on amphorae, is but a modest contribution in the debate on Alexandria's commercial links with Africa, based on finds from the Polish Centre of Mediterranean Archaeology University of Warsaw excavations at the Kom el-Dikka site.[5] The finds come from various contexts: dwelling houses, civic buildings (like baths, cisterns and auditoria) and late Roman urban dumps. The observations are based on an analysis of selected contexts, including more than 80,000 amphora fragments in total. Consequently, they may be treated as a fairly extensive and reliable sample. The writer's intention is not so much a detailed qualitative and quantitative analysis of all groups of amphora finds, but rather an overview of types and forms identified at the site, complemented by highlighting some variations and trade patterns.

Our current studies on amphorae from Kom el-Dikka are admittedly focused on vessels from the Eastern Mediterranean. The reason behind this is as obvious as it is practical: namely, it all comes down to the number of finds. Amphorae originating from the East (Egypt included) are a far larger group when compared with vessels from the western provinces (Italy, Gaul, Spain and Africa combined). One of the 5th century AD assemblages from the great urban dump explored in the central part of the site is perhaps the best case in point.[6] The figures speak for themselves. The overwhelming majority of sherds in that context comes from the East. They represent mostly LRA1, LRA3 and

3. For use of amphorae for studies of trade patterns, see Mattingly and Hitchner 1995, pp. 198–204; Bonifay 2003, pp. 113-114; Wilson 2009.
4. Ballet *et al.* 2012.
5. See annual reports published regularly since 1989 in *PAM*.
6. Majcherek 2011, pp. 38-41.

LRA4 vessels, accounting for about 70% of the total of amphora finds.[7] Next there is a considerably smaller group of Egyptian amphorae, mostly exemplified by earlier LRA7 versions, followed by a small set of African vessels, numbering as many as 8 MNI (minimum number of individuals), but not exceeding 1% of the total RBH (rims, bases, handles) count.

Nevertheless, the relative frequency of African amphorae (Tripolitanian included) is usually not so dramatically low, as in the context above. When compared with the remarkably common African fine wares, African amphorae tend to be reported rather occasionally from eastern sites.[8] The geographical distribution map is limited to a number of isolated examples. In this context, Alexandria's position takes on significance, even with the relatively small number of finds.

North Africa is considered here territorially in the modern geographical sense, rather than a historical one (meaning *Africa Proconsularis*, including later transformations resulting from Diocletian's reform). Thus, the vessels discussed here cover not only the territory of modern Tunisia and Libya (*Regio Tripolitana)*, and *Mauretania Caesariensis*, but also *Cyrenaica*, which is formally assigned to *Pars Orientalis*.[9]

Roman Africa produced great quantities of foodstuffs: grain, olive oil, fish products, as well as wine on a smaller scale. In addition to regional consumption, a large share of agricultural surplus was exported. Grain and olive oil were naturally included in the *annona* sent to Rome. Only a portion of these basic goods, as well as wine and *salsamenta*, were marketed.[10] Therefore, it is obvious that Italy, as well as the western part of the Empire (Gaul and Spain) as a whole, were the essential zones of economic activity for the African provinces.

Alexandrian trade exchange was generally based on sea-going trade, materially manifested in imported amphorae. These containers constitute a major group in the finds, which, barring some variation in particular periods, may reach as much as 85% of the RBH of all the transport vessels.[11]

7. Such a high share of eastern amphorae was also noted on some western sites. In a 6th century context from Classe, amphorae from the East amounts to 85% of finds, see Cirelli and Cannavici 2014.
8. For a stark contrast between the frequency of ARS and amphorae reported from the eastern sites, see Bonifay 2003; Bonifay and Tchernia 2012; Smokotina 2014.
9. Within a dichotomic division like this into the East and the West, Cyrenaica should be considered a transitional zone; for a similar opinion, see Bes and Poblome 2009, p. 78.
10. On commodities shipped in African amphorae, see Bonifay 2007b.
11. For published pottery assemblages from various sectors, see Majcherek 1992, 2004.

It is assumed that trade exchange in the Roman world was stimulated, among other things, by an existing regional specialisation in agricultural production, that very often generated a surplus or local shortages simultaneously.[12] Egypt is a good example, because it was among the greatest producers of grain and at the same time suffered from acute olive oil shortages.[13] Climatic conditions and agriculture in Egypt depended on irrigation, which did not encourage the cultivation of olive trees. In spite of cultivation existing in the Fayum, in the vicinity of Alexandria, and even in the Western Desert oases, olive oil was still a deficit product. The bulk of oil consumed in Egypt came from seeds of other plants. It was generally a vegetable oil (*lachanon*) that was consumed, obtained mostly from lettuce seeds and radish, but there was also sesame and castor oil, widely consumed either as food or for lighting.[14] Consequently, import remained the main, effective way of balancing Egyptian olive oil shortages.[15]

Early and Middle Roman periods

North Africa enters the Alexandrian commercial scene in its traditional guise as a great olive oil producer and exporter. The means was an early Tripolitanian I amphora, evidence for which from the site is still fairly marginal. A significant shift occurred in the first half of the 2nd century AD when regular supplies of olive oil started coming from Roman Africa, along with wine and fish product deliveries on a slightly smaller scale.

Tripolitanian amphorae are increasingly noted in 2nd–3rd century AD contexts, reaching up to 5-6% of the total RBH index for amphorae in deposits from the 3rd century AD. All three basic types of Tripolitanian containers are present in the collective ceramic record: 'classic' Tripolitanian I, Tripolitanian II belonging to a long tradition of Punic amphorae (one in a series that may have been used for transportation of products other than olive oil),[16] and Tripolitanian III. In the case of the latter, two fabric variants

12. David Mattingly's ideas on factors explaining the olive oil trade (1988, pp. 34-35) can be applied to wine exports, but apparently not to the grain trade. Generally, on East-West trading, see Wilson *et al*. 2013.
13. In Roger Bagnall's words, in Egypt 'olive oil was always in somewhat short supply', Bagnall 2005, p. 197; see also Bonifay 2005a, p. 575.
14. Bagnall 1996, pp. 29-31; Mossakowska 1994; Brun 2004, pp. 169-183.
15. Bonifay 2003, p. 120. Contrary to other eastern sites, the majority of African containers recorded in Alexandria were oil amphorae.
16. Bonifay 2004, pp. 89-92.

were identified, obviously pointing to two different manufacturing centres in the territory of *Regio Tripolitana*.[17]

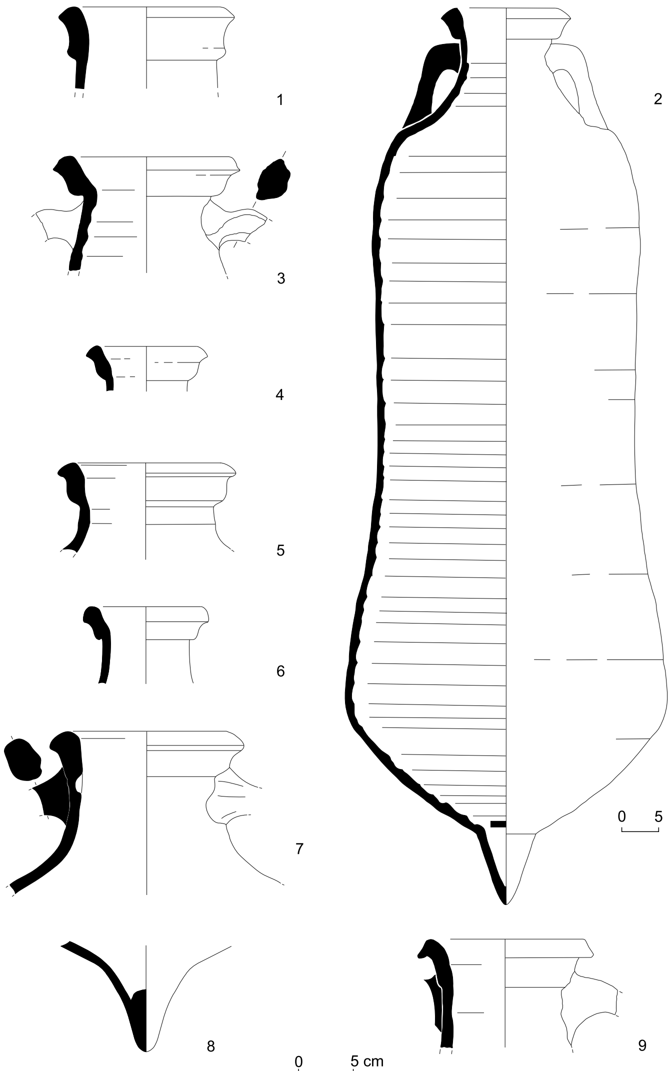

FIG. 1. Tripolitanian amphorae. **1-3**: Tripolitanian 1; **4-6**: Tripolitanian II; **7-8**: Tripolitanian III; **9**: late Tripolitanian (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

17. Bonifay 2004, pp. 105-106: Zitha/Ziana (southern Tunisia) has also been pointed out, in addition to the traditional manufacturing centres located around Leptis Magna.

It appears that this 'olive oil province', following David Mattingly's expression,[18] was Alexandria's main olive oil supplier in the Middle Roman period, replacing sources from Apulia (Brindisi) and Spain that were active in the late Ptolemaic and early Roman periods.[19] Tripolitanian amphorae are recorded on many sites in the eastern part of the Mediterranean, albeit in rather limited numbers.[20] Their share in Beirut has been estimated at only about 0.5-0.7% of the total amphora RBH.[21] The frequency of these amphorae in Alexandria is visibly unique, especially when compared to other sites in Egypt.[22] All of this indicates that Tripolitania gradually ousted Spanish olive oil from the Alexandrian market, starting in the 3rd century AD. An analysis of amphora stamps leads to the same conclusions. E. L. Will determined that most of the published Baetican Dr 20 amphora stamps from the eastern Mediterranean came from Alexandria, and were dated mostly to the 1st–2nd century AD.[23] However, the ratio of stamped to non-stamped amphorae remains an open question, and the overall quantity of vessels is difficult to establish. In Kom el-Dikka Dressel 20 amphorae are found occasionally in contexts from this period, whereas in the following century Spanish products are almost completely absent from the ceramic assemblages, contrasting with an increasing number of Tripolitanian vessels. In both groups, those from Kom el-Dikka and from other Alexandrian sites, their share is exceptionally low and does not exceed 0.5% RBH.[24]

Tripolitania was not the only source of African olive oil on the Alexandrian market, but its unique position was never endangered; it was merely supplemented with oil from other production areas, specifically those located in central and southern Tunisia (Sahel). Surveys in this region by David P.S. Peacock, Fathi Bejaoui and Nejib Ben Lazreg revealed the existence of many potential amphora manufacturing sites.[25] Olive oil from this area was delivered to the city in another type of container: Africana I, a medium-sized cylindrical amphora (*piccolo*).

18. Mattingly 2005, p. 223.
19. Cipriano and Carre 1989, on Brindisi amphorae in Egypt. On Brindisi stamps from Kom el-Dikka, see Sztetyłło 1978, pp. 308-309, nos 111 and 115.
20. For Tripolitanian and other North African amphorae found in shipwrecks from the Aegean, see Koutsouflakis and Argiris 2015.
21. Reynolds 2010, table 1, only three fragments in 3rd century AD contexts in Beirut.
22. Senol 2007; Ballet *et al.* 2012.
23. Of the 84 stamps published by E.L. Will (1983), at least 60 were from Alexandria. It should be kept in mind, however, that the provenance of many objects from the Benachi collection is uncertain and some may have come from other Egyptian sites.
24. Dr 20 amphorae account for only 0.21% of the overall quantities of transport amphorae from the Old Diana Theatre site, Senol 2007, p. 69, diagram 5.
25. Peacock *et al.* 1989.

Both of the distinguished variants of the Africana I amphorae are present in almost every context dated to the Middle Roman period. Similarly, the Tripolitanian III is quite commonly distributed in Alexandria in the 3rd century AD, when it reached almost 4% of the RHB for all amphorae, corresponding with a manufacturing peak in Tunisia.[26]

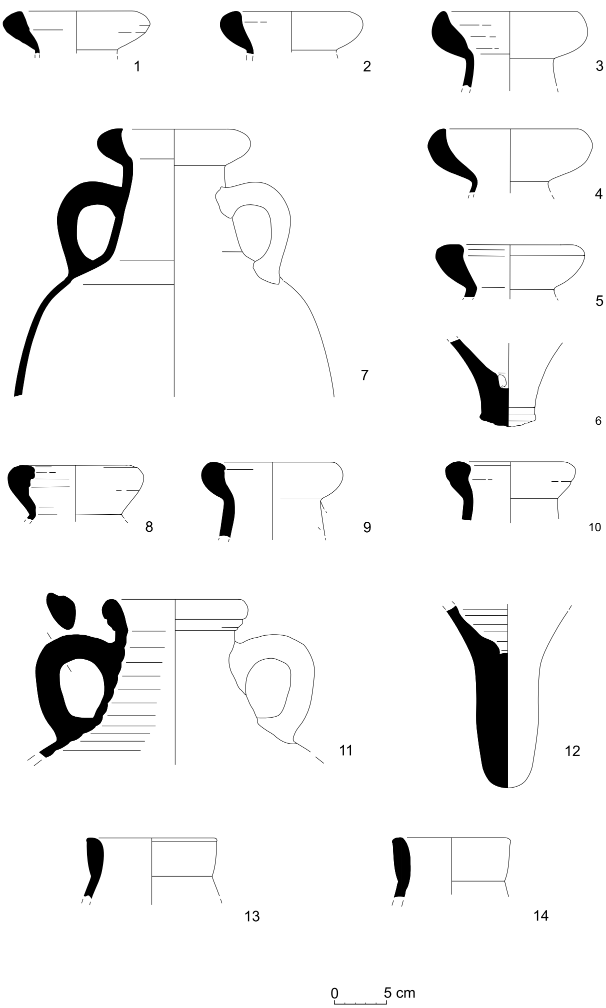

FIG. 2. Africana I and Africana II amphorae. **1-4**: Africana IA; **5-7**: Africana IB; **8-10**: Africana IC; **11-12**: Africana IIA; **13-14**: Africana IID (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

26. Bonifay 2004, p. 107.

Yet another amphora type, the Africana II (*grande*), appears for the first time in contexts from the turn of the 2nd/3rd century AD. It is a considerably larger vessel than the *piccolo* type, as the name itself implies, comprising a significantly broader set of subtypes (A–C) and variants as well. In other words, it is a veritable morphological maze, most probably reflecting diverse manufacturing centres, from Nabeul to Hadrumetum and Sullectum.[27]

The presumed content of these amphorae is a matter of dispute. Theoretically (and not unrealistically) every subtype manufactured in a particular centre was designed for the transportation of different commodities. Some Africana IIA fragments bear an inner coating of tar or resin and this usually suggests wine as the transported commodity.[28] So far, however, the Kom el-Dikka site has yielded no such examples. The IIB amphora content is equally mysterious. As for the Africana IIC amphorae, *salsamenta* appear to be the most probable content as suggested by finds from wrecks.[29]

Africana II vessels make for a rather limited group, in the 3rd century AD assemblages. They are also noted in contexts dated to the next century, whereas some residual fragments, indirectly attesting their earlier high frequency, are still found in 5th century AD strata.

Another type identified in the 3rd century AD ceramic material is the Dr 30 amphora, which is quite common throughout the Mediterranean. While not a match for the widely copied

Dr 2–4, the form was certainly manufactured in different regions, of which *Gallia Narbonensis* (Gauloise 4) is the best recognised.[30] Other than that, such amphorae were also manufactured in the Iberian Peninsula,[31] and possibly even in Cilicia.[32] They were also produced in *Mauretania Caesariensis*[33] as well as in several Tunisian centres.

27. Bonifay 2004, pp. 107-118; Nacef 2015.
28. Bonifay 2004, p. 111. Recent chemical analyses of sherds from Sagalassos, however, proved that pitch coating in amphorae is not always indicative of wine content; it may be also used in the case of oil storage, see Romanus *et al.* 2009.
29. Bonifay 2007b, pp. 13, 20, fig. 8.
30. Laubenheimer 1985.
31. Bernal 2000, 2017; Fabião 2008.
32. Tomber 2009, p. 153.
33. Laporte 1980, 2010.

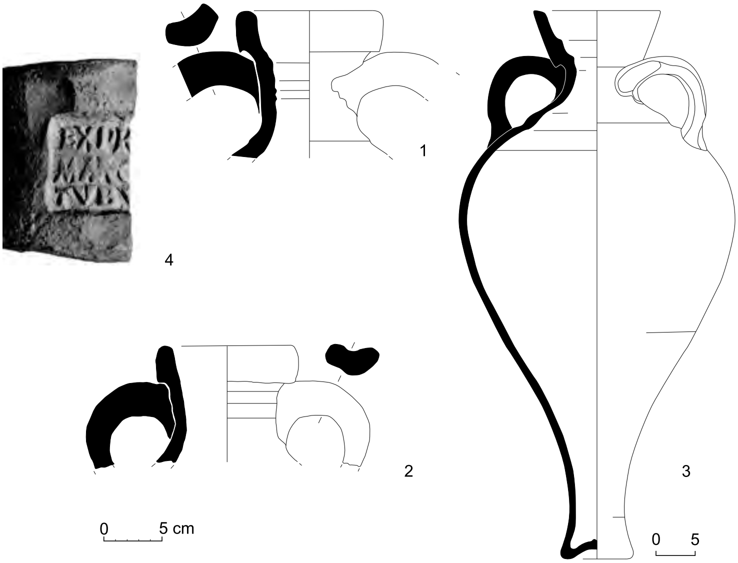

FIG. 3. Mauretanian amphorae. **1-2**: Keay 1A; **3**: Keay 1B; **4**: Mauretanian stamp (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

Workshops manufacturing Dr 30 amphorae were identified in Nabeul,[34] Cap Bon[35] and Sullectum.[36] However, the distribution of vessels produced at these sites was mostly local, with finds from outside the region rare. Only a few dozen fragments of amphorae from this group were identified at Kom el-Dikka. Some of them are apparently poorly fired, making proper identification tentative at best. There is no doubt, however, regarding the origin of another group of finds attributed to Mauretania,[37] in particular objects sharing the same petrographic properties as a stamped handle bearing the inscription: *EX PR[OV] MAVR[CAES] TVBV[S]*.[38] This Mauretanian stamp may be added to the collection of such stamps from Alexandria held by the Graeco-Roman Museum.[39]

The presence of these amphorae, generally dated to the 3rd century AD, is rather limited and does not exceed 0.5% RBH. As such, it remains in stark

34. Ghalia *et al.* 2005; Bonifay *et al.* 2010.
35. Ben Lazreg *et al.* 1995.
36. Gibbins 2001, p. 313; Nacef 2015.
37. Bonifay 2004, pp. 148-151.
38. Laporte 1980, p. 137: see a similar stamp, type 5.
39. Laporte 1980, p. 149, mentions three other stamps found in Alexandria.

contrast to the results from the Old Diana Theatre site, where their share in the 1st–3rd century AD deposits was quite surprisingly estimated at 10% of all amphora finds.[40] The Mauritanian amphorae are commonly identified as wine vessels,[41] however, their distribution in Alexandria is not a match for wine imported from the Aegean or the Levant.

Nevertheless, amphorae referred to as *Maurai* are the only examples of geographical names preserved in the papyri that may be attributed to any amphorae of African origin. This can easily be taken as a measure of their popularity. Interestingly, all four cases using this term occur in 3rd–4th century AD sources.[42]

It may be assumed that Alexandria was the main re-distribution centre for Mauritanian amphorae, or rather the commodity they contained, in the East. Apart from several finds from Egypt,[43] these containers have been reported from Meroe in Upper Nubia, far up the Nile Valley.[44]

Located further east from Roman Africa, Cyrenaica played neither a substantial role in the Mediterranean trade nor had any close economic ties with Egypt, despite its proximity. A detailed overview of these relations is not the purpose of this paper and it will suffice to say that political relations dated back to the Ptolemaic period.[45] Tabulating archaeological data is a better way in this case to illustrate trade contacts. The MR8 cylindrical amphora first classified by John Riley is probably the best recognised transport container from Cyrenaica.[46] Vessels of this kind, 'the most frequent of the very few local amphora types', quoting Riley, reach up to 4% RBH in contexts of the mid 3rd century AD in Benghazi; this period is at the same time considered the floruit of its production.[47] Workshops manufacturing MR8 amphorae were discovered in Tocra,[48] Apollonia and Lathrun,[49] in other words throughout the territory of the Pentapolis. The distribution of these amphorae shows a

40. Senol 2007, p. 70.
41. Lequément 1980; some of these amphorae may have been used for oil, cf. Peacock and Williams 1986, p. 171.
42. For a discussion of assumed Mauretanian amphorae in Egypt, see Rathbone 1983, p. 97; Kruit and Worp 2000, p. 121.
43. Tomber 2009, pp. 153-154, on Dr 30 finds from Egypt.
44. Several examples, including a stamped one, were found in the graves at the necropolis in Meroe, see Dunham 1957, p. 188, fig. 122, Dunham 1963, p. 345, fig. 1.
45. Bagnall 1976, pp. 25-37; Reynolds 1984; Laronde 1999.
46. Riley 1979, pp. 193-194.
47. Riley 1979, fig. 36.
48. Riley 1979, p. 193.
49. Mazou 2016, pp. 186-189.

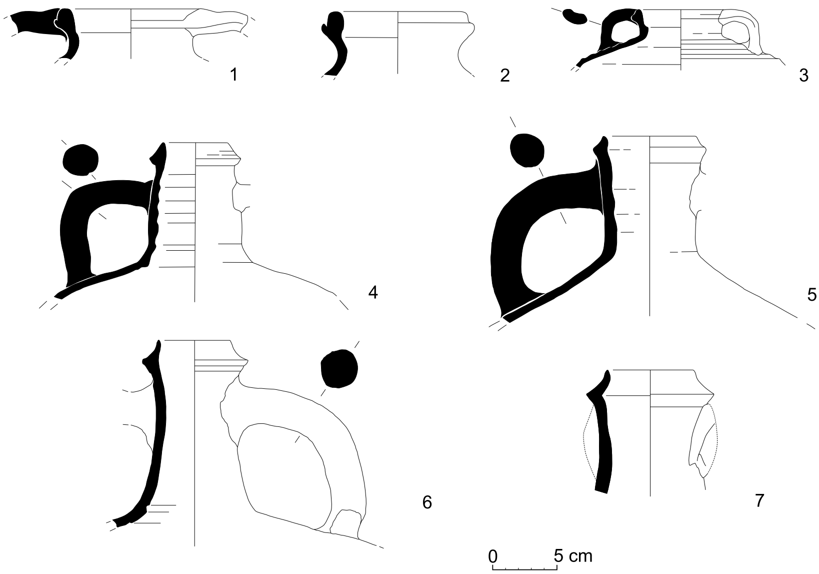

Fig. 4. Mid Roman amphorae 8 and 1. **1-3**: Mid Roman 8 from Cyrenaica; **4-5**: Mid Roman 1 from Cyrenaica; **6-7**: Mid Roman 1, possibly Sicilian (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

major concentration in the central Mediterranean. Apart from Ostia, Rome and the Veneto region, MR8 amphorae are quite profusely found on coastal sites in the Adriatic, whereas they are almost totally absent from the East. The only exception is Marina el-Alamein, where the ubiquity of such amphorae is well attested, as well as Alexandria, where several examples from the 3rd century AD complexes were identified. Quite recently, MR8 amphorae were also recognised in Buto.[50]

Cyrenaica was home to yet another amphora type: local imitations of the widespread and often debatable MR1 (Agora M254) amphora.[51] Loïc Mazou recently identified a kiln-site near Apollonia.[52] The bulk of the sherds found in Alexandria could be considered as Cyrenaican, whereas some other examples with different petrographic properties can be attributed to an original series manufactured in Sicily (Catania and Naxos).[53] The frequency of these

50. On the distribution of MR8 amphorae, see Mazou 2016, p. 190.
51. Riley 1979, pp. 177-180.
52. Mazou and Capelli 2011.
53. For Sicilian production, see Wilson 2000, pp. 361-363; Malfitana *et al.* 2008, pp. 174-178; Franco and Capelli 2014. For possible North African production, see Bonifay 2004, pp.

amphorae is slightly higher than those described above, although it still does not exceed 1% RBH in assemblages from the 3rd century AD. Their geographical range, like that of the MR8, covers a significantly vast area with a pronounced dominance in the West. These finds are reported from the Adriatic to Catalonia,[54] reaching even into northern France.[55] Examples from the eastern sites are sparse. There is no obvious way to know the percentage of all noted examples coming from Cyrenaican workshops, but it may be assumed to be significant. In both cases of amphorae from Cyrene the content is unknown. It could have been wine or olive oil from Cyrenaica, mentioned by Synesius in the 4th century AD,[56] or possibly fish products.[57]

Going in the opposite direction, Egyptian pottery finds from Cyrenaica, particularly from Berenike (Benghazi), exemplify that trade relations with Egypt were definitely of a small scale. They are limited to AE3, LRA5/6 and LRA7 amphora fragments, as well as, examples of fine wares.[58] This picture confirms the widely accepted view of the region's relative isolation, a view that is invoked in its metaphorical comparison to an island.[59]

It is highly probable that Cyrenaican amphorae reached Alexandria as a result of small-scale cabotage trading, rather than the regular long-distance trade.[60] Such a trade model is attested not only by wrecks, on which products coming from several regions and transported from one port to another are often found, but also by historical sources. Tramping is mentioned in late antique *katarchai* (horoscopes).[61] One such *katarchè* dated to AD 475 describes the voyage of a vessel skirting the southern Mediterranean coast. The vessel transports a very mixed cargo: camels (interestingly, the animals are most probably from Cyrenaica), textiles and silver goods collected en route in Alexandria. It then sails directly to Athens. Another similarly dated document of this kind mentions an analogous cabotage ship sailing from Alexandria to Smyrna, and calling at western Asia Minor ports.[62]

146-148; Capelli and Bonifay 2007, p. 554.
54. Keay 1984, pp. 94-99.
55. Galliou 1990.
56. Roques 1987, pp. 114, 399: Synesios mentions (letters 45 and 66) both wine and oil exported to Alexandria.
57. Wilson 2004, p. 148, n. 15.
58. For Benghazi, see Riley 1979, pp. 208-209, fig. 89, pp. 224-225, fig. 92; Kenrick 1985, pp. 402-404; for Ptolemais, see Domżalski 2012, p. 340; for Apollonia, see Caillou and Mazou 2012.
59. Fulford 1989, p. 169.
60. For different models of sea-trade, including cabotage, see Nieto 1977; Arnaud 2011.
61. Dagron and Rougé 1982, pp. 123-131.
62. Cf. *supra* 61.

All the above listed figures show the exceptionally high frequency of amphorae used in olive oil shipping throughout the 2nd–3rd century AD. *Oleum Afrum* was apparently the most important product on the Alexandrian market. The share of wine amphorae is substantially lower, especially when compared with imports from other regions, in particular from the Aegean. Generally, amphorae from Tunisia and Tripolitania (both wine and oil carrying vessels) reach about 11-12% of the total RBH index in this period. Other provinces, both distant *Mauritania*, as well as neighbouring *Cyrenaica*, participated in this trade on a very limited scale.

Late Roman period

The 4th century AD opened an entirely new chapter in Alexandrian economic relations with the West. It was a period (especially the second half of the century) distinguished by rapidly growing fine ware imports from North Africa (ARS).[63] The phenomenon was not limited to Egypt, being equally well recognised on almost all sites in the Eastern Mediterranean.[64]

The appearance of the most widespread Hayes 50 form, launched ARS on the Alexandrian market, its dominance lasting until at least the middle of the 5th century AD.[65] The decrease in the influx of African ceramics in that period, also experienced in the whole East, is usually related to the Vandal invasion cutting Africa off from the Mediterranean trade.[66] In a later period (6th–7th century AD), despite a continuing strong presence, ARS yielded to Late Roman D (LRD) production. Fine wares coming from other regions, particularly from the Aegean (LRC), played a decisively minor role in Alexandria.[67]

It was repeatedly suggested in the past that the African ceramic influx noted in Alexandria did not result from direct contacts between these two regions as might be expected. It was rather due to the *annona* delivered to *Italia*,

63. Ballet *et al.* 2012.
64. Bes and Poblome 2007, 2009; Bes 2015, p. 92.
65. Hayes 1972, pp. 69-73. Hayes 50 form started to be imported by the 3rd century, but it is the 4th century that brought massive influx of this central Tunisian ware, see also Reynolds 2010.
66. Importation of African Red Slip wares in Egypt was, however, largely unaffected, see Hayes 1972, p. 417-423; Abadie-Reynal 1989, p. 150; Ballet *et al.* 2012, p.93. For evidence of a possible decline of ARS imports in other regions of the Mediterranean, see Dossey 2010, pp. 23-24; Bes 2015, p. 92.
67. On the distribution of the three main groups of Late Roman table wares (ARS, LRD and LRC) in the Eastern Mediterranean, see Bes and Poblome 2007.

with both Rome and Alexandria serving as major redistribution centres.[68] Accordingly, fine wares were first transported to Ostia/Rome, probably as secondary cargo, accompanying the African grain *annona*, only to be reloaded onto empty Egyptian grain ships sailing back to Alexandria.[69]

We should bear in mind that the Egyptian *annona* stopped being sent to Rome in AD 330 and was diverted to Constantinople. Such a radical change in trade relations on a macro-scale must have had direct bearing on the structure of the Alexandrian trade, and most probably laid grounds for a rapid increase of imports from the East.[70]

However, it is not easy to find an explanation for the diminished African amphora imports in this context. It could be the manifestation of the phasing out of the production of older Mid Roman types (Africana I and II), in other words, a transitory period that opened the way for new forms and new manufacturing centres, rather than a weakening of the relationship between Alexandria and the western provinces. Irrespective of the explanation, and requiring more detailed research, the 4th century AD meant the beginning of a decisive domination of the eastern provinces in the trade, a domination which became even more firmly established in the following century.

Alexandria experienced a veritable expansion of the wine and oil trade coming from the East. Amphorae from this part of the Empire constitute a sizeable group, totalling some 60-75% of the finds overall. This index is three times as high as in the case of Egyptian vessels. The diminished import of oil from the West was most probably compensated for by supplies from Cilicia and Cyprus, transported mostly in LRA1,[71] whereas Palestine became the main exporter of wine, as evidenced by an influx of Gazan LRA4 and of North Palestinian LRA5/6 on a smaller scale.

The expansion of eastern products is clearly observed even in Africa. Carthaginian contexts from that period demonstrate a significant increase in the numbers of eastern amphorae. Their frequency reaches 40%, equal to

68. Bes and Poblome 2009, pp. 88-89. A similar model of distribution with Ostia/Portus functioning as an entrepôt for a cargo of African oil and table wares was suggested also in the case of Sicily, see Fentress *et al.* 2004, pp. 157-158.
69. For a 'secondary cargo' model see Reynolds 1995, pp. 4-34; Bonifay 2003; Tchernia 2007; Bonifay 2007a.
70. For similar conclusions, see Abadie-Reynal 1989, pp. 158-159.
71. LRA1 is predominantly a wine amphora, however some of these vessels could also have been used for oil transportation, cf. van Alfen 1996, p. 208; Pieri 2005, p.85.

the contemporary regional amphorae.[72] Western trade appears to be limited to some wine and perhaps fish products. Especially in the latter case, Africa retained its traditionally strong position on the market.

A major player on the 4th-century AD scene is the characteristic Keay 25 amphora of medium size, the last in a long evolutionary line of cylindrical vessels.[73]

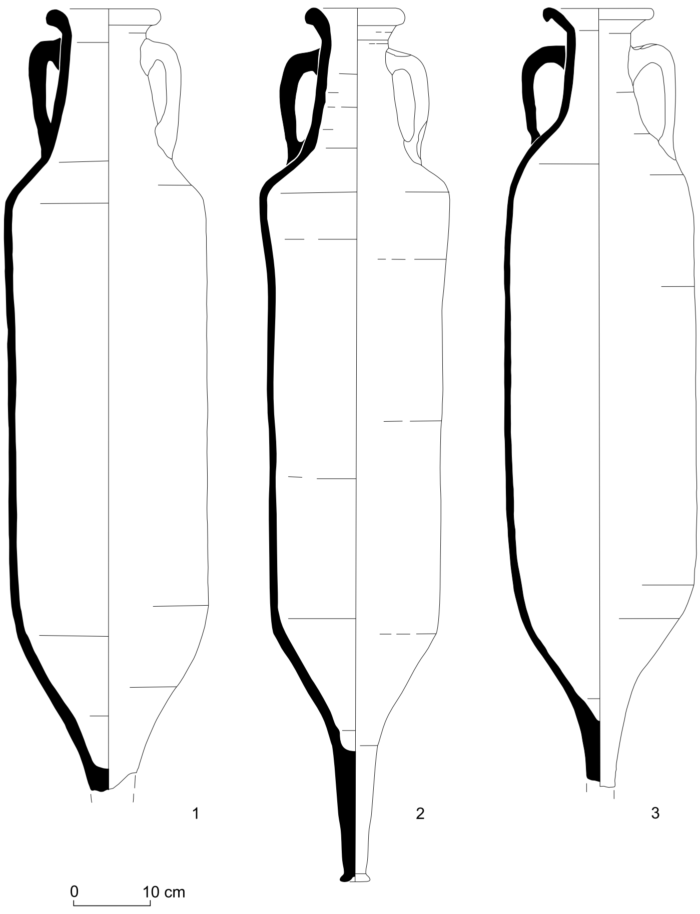

FIG. 5. Africana III amphorae. **1**: Africana IIIB; **2-3**: Africana IIIC (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

72. Expansion of eastern products is clearly observed even in Africa. Carthaginian contexts, dated to the 5th century, demonstrate a significant increase in eastern amphorae, see Fulford and Peacock 1984, p. 258.
73. Keay 1984, pp. 184-212, distinguished as many as seven morphological subtypes.

Whereas subtype A of this amphora, classified as Africana III (Keay 25.1) by Michel Bonifay,[74] is rather moderately represented in the material, his subtype B (Keay 25.3) is relatively abundant. The quite frequently recorded C version (Keay 25.2) appears to be a direct predecessor of the widespread *spatheia* class, which is characterised by a tall cylindrical neck, flared rim and small handles attached to the neck.

The common view is that Africana III amphorae were used mostly for wine transportation, although olive stones were also identified in several amphorae coming mostly from shipwrecks.[75] Most of the finds recorded in Kom el-Dikka originated from Nabeul. Byzacene workshops are also suggested (Africana IIIA and IIIB, and probably some examples of IIIC). Thus, identified amphora production centres demonstrate an excellent geographical correlation with wine cultivating areas, clustered chiefly in southern and central Tunisia. Africana III enjoys a relatively high frequency in Alexandria, reaching 3% RBH in 4th–5th century AD contexts.

The typological borderline between Africana III amphorae and *spatheia* is blurred, and the relationship between these two types is insufficiently recognised.[76] This generic name denotes a class of three vessel types, manufactured in the 5th-7th century AD, related mostly by a morphological likeness.[77]

Spatheion 1, the larger version (overall height ranging from 70 cm to 90 cm), is generally dated to the 5th century AD and is rather well attested in the Kom el-Dikka assemblages. It comprises up to 2-2.5% RBH and is almost on par with the Africana III amphorae. The vessels present four morphological modifications (A–D), generally varying in rim shape. Notwithstanding the different fabrics, they nearly always share the same technological features.[78] One such feature, a characteristic surface finish consisting of parallel vertical cuts ('steccature' in Clementina Panella's words) is almost a trademark for this amphora type, largely facilitating its field identification even from small fragments.[79]

74. Bonifay 2004, pp. 119-122; Freed 1995, p. 181, suggested a slightly different typology for Keay 25 amphorae.
75. Bonifay 2003, p. 25, n. 84; see also Woodworth *et al.* 2015, conclusions based on chromatographic analysis of a large series of vessels covering all three Keay 25 subtypes.
76. Bonifay 2004, p. 125, considers *spatheia* as a smaller module of the Africana III amphorae.
77. More on the term *spatheion* in epigraphic sources in Manacorda 1977, pp. 211-221; Bailey 1998, pp. 120-121.
78. *Spatheion* 1 was manufactured in the Nabeul region, see Ghalia *et al.* 2005.
79. Panella 1982, p. 179. Similar properties are also demonstrated by *Spatheion* 2 amphorae.

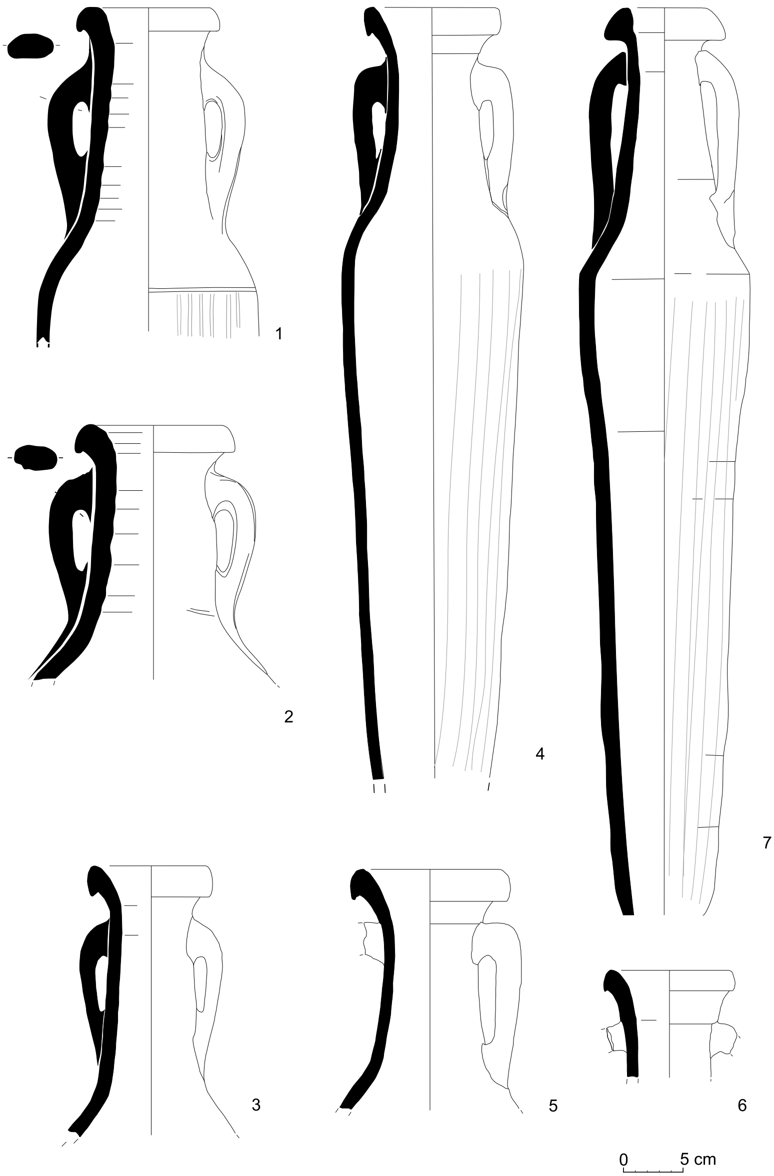

Fig. 6. *Spatheia*. **1-6**: *Spatheion* 1A; **7**: *Spatheion* 1C (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

Spatheion 2 is definitely less tangible in the excavated material. The large diversity of the type, including morphologically distant forms, often results in many fragments being classified mistakenly as examples of forms 1 or 3.[80]

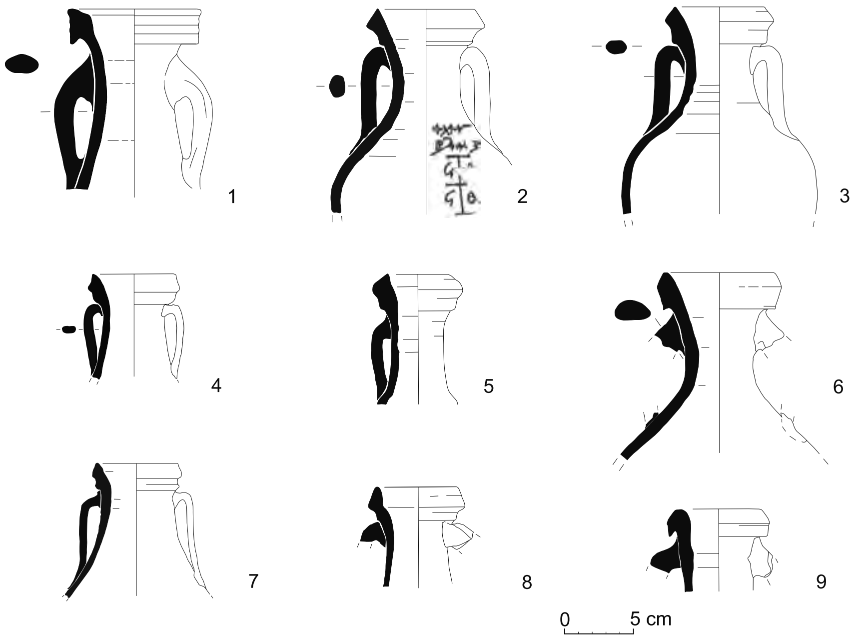

FIG. 7. *Spatheia*. **1**: *Spatheion* 2; **2-9**: *Spatheion* 3 (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

Spatheion 3 is a miniature version dated to the 6th–7th century, height not exceeding 40–45 cm, and is the most common type. This type again reveals a huge diversity of morphological alternatives, varying in general contour, rim form and handle shape.[81] The same can be said about the fabrics that undoubtedly epitomise several manufacturing centres. Despite reservations and a prolonged discussion of the provenience of this amphora, we may now be sure that even the examples featuring a light-coloured fabric originated from Africa.[82] Workshops producing *Spatheion* 3 were discovered both in

80. Bonifay 2004, pp. 125-127. Taking into account basic morphological features, some examples of *Spatheion* 2B could easily be considered a size variant of *Spatheion* 3.
81. Bonifay 2004, p. 127.
82. Capelli 2001, Italian workshops for at least some such examples have commonly been suggested.

Byzacene (Moknina) and *Zeugitana* (Nabeul).[83] Despite being relatively common, this form was never as popular as the earlier African and Tripolitanian vessels. Its share in the total RBH does not exceed 2%.

Identifying *spatheion* content is again problematic, since the available sources are rather ambiguous,[84] and it is still not clear whether and how the geographical diversity of workshops and the prolonged date range had an effect on the choice of products that were transported in vessels of this kind.[85] *Dipinti*, often found on the necks of such vessels (always in Greek, using black ink), give very limited information. Notwithstanding religious formulas, such as *Theou Xaris* and some isopsephic notes (*xmg*), vessel capacities expressed in *xestai/sextarii* are also mentioned.[86] Examples of such annotation were also found in Alexandria.[87] *Spatheion* 3 amphorae were supposed to carry commodities like wine or garum.[88] A *dipinto* deciphered on an example from Antinoupolis seems to refer to a fish sauce.[89] Fish residues were identified in another amphora from the same site. In 5th–7th century AD contexts, *spatheia* are definitely the largest group of African commercial vessels in terms of quantity.

When discussing the late antique period, the successors of Africana I (*piccolo*) and Africana II (*grande*) amphorae cannot be ignored. Such late series are usually referred to as cylindrical large-sized vessels.[90]

In this case we are also faced with a broad spectrum of morphological developments representing various manufacturing centres. Several of these late Roman forms (Keay 8, 36, 39, 55 and 57), were identified in Alexandria.[91] An important feature is the noteworthy presence of Keay 62 amphorae, consid-

83. For Moknine, see Bonifay 2004, p. 35; for Nabeul, see Bonifay 2005b, p. 453.
84. Olive stones were found in amphorae from the Dramont E, suggesting *defrutum* as the content, see Santamaria 1995, p. 123.
85. The practice of reuse or repurposing of amphorae was quite common, for example typical wine amphorae, LRA4, from Caesarea carrying fish, see Zemer 1977, p. 61; and similar amphorae from Rome containing sesame oil, see Rotschild-Boros 1981, p. 86. Several Africana I and Tripolitanian I amphorae from the Grado wreck were loaded with sardines and mackerels, see Auriemma 2000.
86 *Dipinti* are also found frequently on LRA1 and LRA4 amphorae, see Derda 1992. *XMG* is sometimes interpreted as an acronym for *Christos Marias genna.*
87. Derda 1992, pp. 142-143. The capacity of a *Spatheion* 1 amphora was specified as 36 *sextarii*, approximately 14.5 litres, assuming that the African *sextarius* was used.
88. Olive oil is rather excluded, see Bonifay 2004, p. 129.
89. Fournet and Pieri 2008, pp. 180-184, 207.
90. Keay 1984, pp. 126-128, 240-245, 250, 289-293, 298-299; Freed 1995.
91. Keay 1984, pp. 307-350. For late African amphora production and content, see Bonifay 2016. For similar finds from Alexandria, see Bonifay and Leffy 2002.

FIG. 8. Late Cylindrical amphorae. **1**: Keay 8B; **2**: Keay 36; **3**: Keay 39; **4**: Keay 55; **5**: Keay 57; **6**: Keay 62Q? (E.Czyżewska, A.Dzwonek, A.Wieczorek, Z.Zdziebłowski, K.Pawłowska, K.Kapiec).

ered typical of the late Vandal and Byzantine period.[92] Nevertheless, large-sized amphorae are generally fragmentarily preserved and their detailed typological attribution is not always possible. Some of the types are represented by several better preserved examples (particularly Keay 62Q, Keay 8B) and a substantial number of fragments; other types are represented by a very limited quantity of broken sherds. Thus, it was inevitable that this series was treated as one group during excavation, even allowing for limitations and imperfections, resulting from such a decision. The presence of the whole group is quite well evidenced, although it never exceeded 3% of the total amphora count in this period.

Summary

Alexandria was always considered as 'next to' Egypt, and such a definition is also relevant when reviewing ceramic finds. In terms of the amphora repertoire and quantities, as well as economic impact, many more facets have separated Alexandria rather than linking her to the rest of the country. The city's position is unique for several reasons, not only in Egypt, but also in the Eastern Mediterranean as a whole.[93] A high share of imported amphorae in the total number of finds clearly corresponds to Alexandria's rank as a great metropolis functioning in the economic area of the Empire. In this regard, Alexandria appears to be closer to Rome or Ravenna rather than to Hermopolis.

Quantitative variations in the influx of African amphorae can obviously be interpreted as reflecting changing volume of imported foodstuffs. Altering sources of imports can in turn reflect not only the evolving demand on the Alexandria market, but also production fluctuations in given regions.

Olive oil demand is a very good example, generally met by supplies from Tripolitania (Tripolitanian I and III) and *Byzacene* (Africana I) in the 1st–3rd century AD. Deliveries from the Egyptian hinterland remain practically unnoticed in the archaeological material.[94] The African olive oil influx

92. Freed 1995, pp. 166-177.
93. For Alexandria's role in redistribution, and specifically in the Red Sea trade, see Ballet 1996; Tomber 2008.
94. Egyptian amphorae manufactured in this period were obviously not intended for olive-oil transportation. It is assumed that the olive-oil production level in Egypt was very low in this period, whereas vegetable oils only provided a cheaper, poor quality substitute. Tripolitanian amphorae found in the Western Desert oases probably reached their destination by a land route. For an opinion to the contrary, see Ballet *et al.* 2012.

in this period correlates well with the introduction of African fine ware. Nevertheless, most of this ware comes from Zeugitane workshops and this would confirm the secondary cargo thesis of transportation not directly from African ports, but via Ostia.[95] Importation of other products is of lesser importance. Alongside Mauritanian (Dr 30) and *Byzacene* (Africana II) wine, *garum* and other fish products were also supplied in small quantities (Tripolitanian II and Africana II).

In the later period (4th–6th century AD), the import structure became more diversified. Olive oil was still the most important commodity supplied by Africa, but its place of origin had shifted. It was brought not only from *Byzacene* (Africana IIIB), but also from the western *Zeugitana* and perhaps even from the territory of neighbouring Numidia (Keay 8B). Playing a more prominent role, wine started to be supplied both from *Zeugitana* (Africana IIIA, B, C) and *Byzacene* (Africana IIIA, C).In the 6th century, African wine was still appreciated by Alexandrian consumers despite daunting competition from Palestine (LRA4), as well as Cilicia and the Aegean.

*Salsament*a (*Spatheia* 1-3), occurring for the first time in considerable quantity, were a novelty, and were present on the Alexandrian market well into the 7th century AD,[96] in other words, even after the import of fine wares (ARS) ceased. A significantly diminished import of African olive oil in this period is rather puzzling. We still do not know whether it resulted from lowered demand or from altering sources of supply. Part of the demand could have been met with products imported from Cilicia/Cyprus (LRA1), or the Aegean (LRA2 and LRA13). On the other hand, the revival of olive oil production in Egypt during this period may be a partial explanation of this phenomenon.

The extent to which fluctuations in the long-distance trade were tied to certain political events remains an open question. The shift in the direction of the *annona*, changing Rome for Constantinople, may be a key to this issue.[97] No less important apparently was the economic revival of the eastern provinces and the political disintegration of the western part of the Empire following the barbarian invasion.

95. Higher figures for wine amphorae might result from higher consumption levels. Wine consumption in antiquity is estimated as approx. 100 litres per person per annum, compared to 20 litres of olive oil, see Aldrete and Mattingly 1999, pp. 194-195.
96. *Spatheion* 1 amphorae have been recently interpreted as *space fillers* rather than vessels destined for a particular commodity, see Bonifay 2016, p. 603.
97. See *supra* notes 66 and 67.

The case is illustrated best perhaps in the second half of the 5th century AD when the Vandal invasion on Africa appeared to have direct impact on the export of agricultural products from the province.[98] The process may be responsible for the low figures for large-size amphorae found in Alexandrian contexts in the late 5th/early 6th centuries AD. The same can be said of the almost complete absence of *Spatheion* 2 forms.

The diminished volume of import from Africa was also apparently due to the severe economic crisis brought about by a pandemic of the bubonic plague that struck during the reign of Justinian.[99] In this context, however, how should we explain the continued uninterrupted arrival of African fine wares originating from central Tunisia in this period? [100]

Justinian's reconquest brought back Africa and several other formerly lost western provinces under central rule. It led, however, to what was only a partial reconstruction of the trade relations between the two parts of the Empire.[101] Among other things one should list perhaps a noticeable presence of *Byzacene*-produced *Spatheion* 3 amphorae on the eastern sites.

Despite various political and economic fluctuations, Until the end of antiquity Alexandria remained closely tied in with the pan-Mediterranean trade network. Radical change came only with the Arab conquest, cutting the city off for a long time from the traditional markets, that is, the Aegean, Asia Minor and Africa.

98. Reynolds 1995, p.112. The agricultural export drop, however, may have begun even earlier, for current opinion, see Bonifay and Tchernia 2012, p. 328.
99. Durliat 1989; Little 2006.
100. Group C of African Red Slip Ware (Hayes 82-84) and Group D (Hayes 96-99 and 103-104) were apparently produced at the same time and exported to the Eastern Mediterranean, see Bonifay 2004, pp. 165, 181-183; Ballet *et al.* 2012, pp. 93-96.
101. The appearance of the Keay 62Q amphora (manufactured in the Sahel territory) on the Mediterranean markets is usually considered as related to the reconquest.

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