Volume 118, Number 4
October 2014

AMERICAN JOURNAL OF ARCHAEOLOGY

The Journal of the Archaeological Institute of America

www.ajaonline.org

AMERICAN JOURNAL OF
ARCHAEOLOGY

Africa in the Roman Empire: Connectivity, the Economy, and Artificial Port Structures

DAVID L. STONE

Abstract

The relationship between connectivity and economic activity is a subject of current debate in Mediterranean archaeology, and recent scholarship has shown the significance of this topic for North African studies. This article approaches the issue through a body of evidence that has hitherto been overlooked: artificial port structures, such as jetties, quays, enclosures, and breakwaters. I identify 29 definite, and 16 possible, structures between Cyrenaica and Mauretania Tingitana dating between the fourth century B.C.E. and the sixth century C.E. I demonstrate that the archaeological evidence for these structures is a more reliable source of information than the ancient literary evidence and discuss how the picture drawn from the latter has misled earlier scholars. I argue that wharf length is the best measure of the size of port structures, and I use that concept to outline the role that individual ports and broader regions played in Mediterranean commerce. By relating artificial port structures to the major production centers of exported goods, I enhance the picture of the North African economy both before and during the Roman empire.*

INTRODUCTION

In the last 15 years, connectivity has become a key theme in research on the Mediterranean. The subject, which may be defined as the ease, frequency, and extent of communications between cities and regions, has come to characterize how Mediterranean communities were bound together through coastal interaction.[1] Such connectivity cannot be taken for granted, and its diachronic fluctuation offers an interesting means of understanding the historical trajectories of cities and regions. Shaw recently proposed that, during the Neolithic era and Bronze Age, North Africa remained apart from the rest of the Mediterranean, its territories consisting of three separate "islands" that were rarely influenced by outsiders.[2] According to Shaw, these islands—Cyrenaica (modern northeastern Libya), the central Maghreb (modern Algeria, Tunisia, and northwestern Libya), and the western Maghreb (modern Morocco)—gradually became connected to the Mediterranean world in the first millennium B.C.E. For Shaw, this initial phase of connectivity corresponded to, and resulted from, the period of Phoenician, Punic, and Greek colonization (which I define broadly as the late ninth through the sixth century B.C.E.) During this time, Shaw argued, the North African islands experienced comparatively dramatic social and economic changes as they "caught up" with the major shifts in cultural complexity that had taken place elsewhere over longer timescales. Shaw thus drew attention to the first millennium B.C.E. as a period of "rapid and fundamental social transformation," when new economies, identities, and social relations became established.[3]

In this article, I evaluate a second major phase of connectivity in North Africa that built on earlier developments but also far surpassed them. In the first half of the first millennium C.E., different economic strategies, identities, and patterns of social relations came into existence, as Rome interacted with Africa in a far more systematic fashion than external powers previously had. Many elements of this interaction, such as the extensive involvement of African cities in the *annona* and in seaborne commerce, have been recognized. My focus here is on the dramatic reconfiguration

*I thank especially David Mattingly, Steven Tuck, and the anonymous reviewers for the *AJA* for their helpful comments on an earlier draft of this article. I am grateful to David Davidson, Robert Yorke, and Mohamed Hesein, who all offered comments and shared their research with me prior to publication. They have all assisted me in clarifying my argument and improving my understanding of key issues. An audience at Birkbeck, University of London, provided useful feedback after I presented a Rome in Bloomsbury Seminar on this topic. The opinions expressed here and any remaining errors in the article are my own. Figures and translations are my own unless otherwise noted.

[1] On connectivity, see Horden and Purcell 2000, 123–72.

[2] Shaw 2003. Quinn (2009, 271) has evaluated Shaw's ideas and concluded that the paradigm of connectivity was increasingly relevant to this region in the first millennium B.C.E.

[3] Shaw 2003, 105–6.

of many African harbors through the addition of artificial port structures. This "infrastructure," including jetties, quays, breakwaters, and ancillary buildings, can be definitively identified at 29 port towns between Mauretania Tingitana and Cyrenaica.[4] A further 16 ports may have possessed artificial port structures, but the material traces are not conclusive. Such structures facilitated an expansion of contacts between African port towns and the rest of the Mediterranean by making the loading and unloading of vessels easier and faster, by enabling larger ships to dock, and by enhancing the safety of ships docked in port. Evidence of this expansion can be seen in the high percentages of ceramics originating in North Africa that are found in many coastal settlements of the western Mediterranean, as well as the large number of Africans voyaging abroad, as evidenced by inscriptions and ancient authors.[5] This period is also closely associated with the urban development of African cities, which reached far greater levels than under the Carthaginian or Numidian rulers of the first millennium B.C.E. Connectivity spread much farther geographically, and the interior lands of North Africa, including the Algerian and Tunisian tells, the Tunisian steppe, and the Sahel and Djeffara plains, were now more closely linked with coastal settlements. Wider trade networks including the Sahara and territories beyond also underwent greater development during this period.[6] At the same time, African elites, whose wealth was generated from the surplus production and export of agricultural and maritime commodities, rose to prominent positions in the Roman empire.

My focus on African harbors comes at a time when the economy has emerged as one of the most active subfields of research on Roman-period North Africa. Important publications of primary evidence and syntheses of larger data sets have appeared with regularity during the last 30 years. These publications have shown a significant rise in the total volume of agricultural and craft production from the first to fourth centuries C.E., with the most probable causes being higher populations in the African provinces, increased demands from Rome, and greater export possibilities. Although each study has raised new questions, we are now much better informed about many topics, including olive oil, wine, fish products, amphoras, African Red Slip Wares, African cookwares, imperial estates, settlement patterns, and economic growth.[7] Yet one related area where neither the primary evidence nor a synthesis has been developed is ancient harbors. Our understanding of them has been hampered by a focus on a narrow range of ancient texts and by a lack of archaeological fieldwork on port structures. These limitations have made it difficult to comprehend the scale of investment in harbor facilities. If we are to understand the expressions of connectivity not only in terms of the economy, on which I concentrate here, but also in terms of the spread of ideas and the mobility of people, attention to the expanded role of harbors and artificial port structures throughout North Africa is essential.

PREVIOUS RESEARCH ON NORTH AFRICAN HARBORS

It has long been recognized that coastal settlements in North Africa originated during the period of early colonization.[8] Both major cities and minor towns were established, very often through the coalescence of local and newly arrived peoples. In an examination of Phoenician and Punic westward expansion, Cintas advanced the idea that coastal settlements were founded approximately one day's sail (ca. 40 km) apart from one another and generally were situated in the shelter of an island, promontory, or estuary. His ideas were predicated on the assumption that boats navigated close to shore and required protection from the prevailing winds each evening.[9] Cintas' conclusions are still accepted in some quarters but have been challenged by Aubet, who pointed out several instances in which settlements were located less than 10 or more than 150 km apart. Aubet also noted that Phoenician and Punic sailors must regularly have traveled long distances, across open water and through the night, to reach the islands of the western Mediterranean.[10] Her revised view of the pattern of Phoenician and Punic colonization implied that occupants of early

[4] Ancient Egypt, which is generally treated separately from the rest of North Africa, is not included in this discussion.

[5] Lassère 1977, 626–43; Reynolds 2010, 15–24, 68–119; Handley 2011, 75–8; Conant 2012, 67–129.

[6] On connectivity via roads in North Africa, see Hitchner 2012, 228–30. On connectivity across the Sahara, see Fentress 2011; Schörle 2012.

[7] Olive oil: Mattingly 1988. Wine: Brun 2004, 185–259. Fish: Slim et al. 2004, 264–97. Amphoras: Bonifay 2004, 2007a. African Red Slip Wares: Fentress and Perkins 1988; Mackensen 1993; Bonifay 2004. Cookwares: Leitch 2011. Imperial estates: Kehoe 1988. Settlement patterns: Leveau 1984; Dietz et al. 1995; Barker et al. 1996; De Vos 2000; Fentress et al. 2009. Economic growth: Hitchner 1993, 2005; Stone and Mattingly 2011.

[8] Cf. Gsell 1920, 359–73 (with references to ancient sources on foundation histories).

[9] Cintas 1949, 270–75.

[10] Aubet 2001, 167.

settlements were interested in control of terrestrial resources as well as maritime ones. The most recent examination of this period, Carayon's Ph.D. dissertation, has catalogued in detail the evidence of each Phoenician and Punic port.[11] All in all, scholarly treatment of the colonization phase between the ninth and the fifth centuries B.C.E. has covered ports throughout North Africa and looked at the major issues of how connectivity along the coastline was created as port towns joined the mainland and the sea. The long-term impact of this phase was striking: very few port towns were established in North Africa after the period of Greek, Phoenician, and Carthaginian colonization, and the number of ports that went out of existence during antiquity was also quite small.[12]

Maritime connectivity among North African ports in the Roman period has not been treated systematically. Some modern scholars, particularly those primarily influenced by textual sources, have not always recognized the significance of artificial port structures in North Africa and have written about African harbors in a dismissive fashion. The reasons for these critical opinions are not clear, but they may be attributable to several factors. First, and perhaps most important, was the impression created by a few ancient authors writing between 50 B.C.E. and 80 C.E. who described the North African coast as "inportuosus" (harborless). Although several later authors offered contradictory evidence, the texts of the earlier and better-known authors were regarded as more convincing and cited more often.[13] Second, archaeologists have concentrated their excavations on Apollonia, Carthage, and Lepcis Magna and have eschewed less prominent ports.[14] Construction of the first two has been dated prior to the mid second century B.C.E., and thus their technological advances have been attributed to Greek or Punic inhabitants. Lepcis Magna was regarded as a showcase for imperial ideology rather than much of a working port, and it was argued—incorrectly, it now is clear—that it stopped functioning shortly after its monumentalization in the reign of Septimius Severus.[15] Third, and perhaps most insidious, was a reluctance on the part of modern scholars to attribute sophistication or wealth to the inhabitants of ancient North Africa.

Each of these tendencies to comment negatively about African ports may be found in Rougé's synthesis of ancient Mediterranean maritime commerce. Rougé discussed the North African coast's "natural harborlessness," "disorganized small ports," and "poor general appearance."[16] Few, if any, African specialists would support Rougé's positions today. Nevertheless, there has been little attention to the material remains of African harbors or to the contradictions in textual sources, and his views on harbors have not been directly challenged.[17]

Rougé derived his conclusions from the credible, but misleading, testimony of a narrow range of ancient authors.[18] His comments echoed those of Pliny the Elder, who wrote that "North Africa, in comparison to other parts of the earth, has the fewest harbors,"[19] and Pomponius Mela, who stated that the lesser Syrtis "has no ports and is frightening and dangerous because of the shallowness of its frequent shoals and even more dangerous because of the reversing movements of the sea as it flows in and out." Pomponius Mela also claimed that the greater Syrtis is "equal in name and nature to the first, but approximately twice as large."[20]

There are two main reasons why Rougé's argument is flawed. First, he placed undue emphasis on authors who wrote before most of the artificial port structures in North African harbors were built. To generalize

[11] Carayon 2008.

[12] It is, of course, possible to cite some later foundations: e.g., Hadrianopolis in Cyrenaica and Caput Vada in Byzacena. Kerkouane on Cap Bon may be the best-known abandoned settlement.

[13] As, e.g., in Gsell's (1913, 33–5) influential history of North Africa; see also infra n. 18.

[14] Apollonia: Flemming 1971; Laronde 1996; Sintès 2010. Carthage: Hurst 1994, 2010. Lepcis Magna: Bartoccini 1958.

[15] Salza Prina Ricotti (1973, 95–101) developed the idea that the harbor suffered from siltation shortly after construction. This incorrect theory has been repeated often. See Giardina (2010, 53) for the most recent discussion. On the evidence for continued use of the harbor in late antiquity, see Laronde 1988, 344–48; Beltrame 2012, 322.

[16] See Rougé's (1966, 133–34, 144–45) comments on North Africa in his overview of the central and western Mediterranean: "côte importueuse par suite des conditions naturelles" (133); "petits ports . . . assez mal organisés" (134); "mauvaise allure générale de la côte" (134).

[17] For a briefly stated rejection of Rougé's position, however, see Le Bohec 2005, 150.

[18] Primarily Sallust's *Bellum Catilinae* (ca. 40 B.C.E.), Strabo (ca. 15 C.E.), Pomponius Mela (ca. 40 C.E.), and Pliny the Elder (ca. 75 C.E.).

[19] Plin., *HN* 5, pref.: "nec alia pars terrarum pauciores recipit sinus."

[20] Pomponius Mela 1.30–2 (translation by Romer 1998, 45): "Syrtis sinus est . . . verum inportuosus atque atrox et ob vadorum frequentium brevia, magisque etiam ob alternos motus pelagi affluentis ac refluentis infestus. . . . Syrtis nomine atque ingenio par priori, ceterum altero fere spatio qua dehiscit quaque flexum agit amplior." Similar passages from Sallust (*Iug.* 17.5) and Strabo (17.3.20) probably also influenced Rougé.

from their comments to the entire period of Roman rule, as he did, was inappropriate.[21] Indeed, although the texts from the second through sixth centuries are itineraries, letters, and religious writings very different in character from the earlier geographies and histories, we find that they reveal a world full of frequent maritime travel and connectivity. Augustine's letters document numerous ventures along the North African coast and between Carthage, Rome, and Constantinople. Synesius, bishop of Ptolemais, described transport and travel along the coastline of Cyrenaica. The peripatetic life of Fulgentius of Ruspe involved two journeys from Carthage to Cagliari and one from Carthage to Syracuse, as well as others along the coastline of Byzacena.[22] It would be equally dangerous, of course, to generalize from the comments of three bishops writing between ca. 390 and ca. 520 C.E., but it is not incorrect to point out that, by highlighting activity at both large and small ports, these texts provide effective counterpoints to the earlier observations of Sallust, Strabo, Pliny the Elder, and Pomponius Mela.[23] Also worth mentioning is that the main phase of African exports has been recognized as the second to the fourth century C.E., well after the early authors rendered their observations about the North African coastline.[24]

The second flaw in Rougé's argument was his neglect of the archaeological evidence for artificial port structures in favor of written sources. The latter are extremely rare, and Appian's (*Pun.* 96) detailed description of the ports at Carthage during the Third Punic War, although one of the most famous discussions of harbors from antiquity, is very much an exception:[25]

> The harbors communicated with each other, and there was an entrance to them from the sea, 70 feet wide, which they closed with iron chains. The first harbor was given up to merchants, and contained all kinds of mooring-cables; in the middle of the inner harbor was an island, and both island and harbor were lined at intervals with large quays. The quays were full of slipways built for 220 ships and storerooms over the slipways for the triremes' gear. In front of every shipshed stood two Ionic columns, so that both harbor and island appeared to be lined with a colonnade. On the island had been built the Admiral's Headquarters; from here the trumpeter had to signal and the herald proclaim orders and the admiral supervise. The island lay opposite the entrance, and rose to a great height, so that the admiral could observe everything going on at sea, while approaching voyagers could not clearly see what was going on inside. The docks were not immediately visible even to merchants who had sailed in, for they were surrounded by a double wall, and there were gates which gave merchants access to the city directly from the first harbor without their going through the docks.

Appian was nevertheless Rougé's main source of evidence about North African port structures. The lack of written sources on ports and port structures elsewhere enabled Rougé to dismiss much of Mauretania Tingitana, Mauretania Caesariensis, and Africa Proconsularis as of "minimal economic value" and to claim that the size of the major port at Carthage rendered harbors elsewhere in the region "unnecessary."[26] His view was, in fact, well off the mark, but it is only by considering the archaeological evidence in full that we can demonstrate a high level of investment in African port structures.

A large-scale consideration of the archaeological evidence has not been attempted, but several studies have made important contributions to our understanding of North Africa's ports in the Roman period. One was an underwater survey conducted by Cambridge University in the 1960s to map the surviving structures at ports along the North African shoreline. The surveyors produced a series of short articles at that time and afterward.[27] Lassère's book on the demography of Roman-period North Africa focused on the roles of ports in trade and redistribution, considering the types of traditional agricultural and marine products they exported to locations across the Mediterranean.[28] It presented a description of the physical remains of several ports and the textual evidence for the roles of merchants and other officials mentioned in inscriptions. It also argued that the heavily indented north coast of North Africa between Cap Spartel and Cap

[21] As Davis (2007, 16–23) has recently shown, modern examinations of a parallel topic, the ancient environment, have reached misguided conclusions by failing to critique the testimony of ancient authors in a similar fashion.

[22] See Conant (2012, 67–129) on these and other writings related to travel to and from Africa during the Vandal era. On Fulgentius' travels more specifically, see Conant 2012, 100–1.

[23] See Quinn (2011, 12) for a discussion of how the testimony of several ancient authors on the Syrtes could be interpreted in contradictory fashion.

[24] On the chronology of African exports, see Bonifay 2004, 477–85.

[25] Translation by Blackman 1982a, 79–80.

[26] Rougé 1966, 133–34: "de valeur économique à peu près nulle" (133); "la prépondérance du port de Carthage, au Nord, rendait inutile" (134).

[27] Yorke 1967, 1973, 1986; Yorke and Little 1975; Yorke and Davidson 1985; Davidson and Yorke 2013. Two important reports from this survey have not appeared in print. One (Yorke 1966) is available online. I thank D. Davidson for sending me a copy of the other (Yorke and Davidson 1969).

[28] Lassère 1977, 370–85.

Bon was better suited to harbors than were the straight coasts of Byzacena and Tripolitania. Other commentators have taken into account distinctions among regions. Drawing on the results of excavations at harbor towns, Fulford posited a lack of exchange between Tripolitania and Cyrenaica, since deposits of the Hellenistic to Late Roman period contained assemblages from different origins. He attributed the differences to difficulties of navigation across the greater Syrtis, which served as a "barrier between Greek and Punic communities."[29] In a reevaluation of Fulford's work, Quinn demonstrated that sailing between these regions was more common than previously thought. She described an especially intensive exchange of goods during the last three centuries B.C.E. but acknowledged that less extensive evidence existed during the Imperial period, as Fulford had shown.[30]

At a smaller scale, several regions within North Africa have been the focus of studies that have paid attention to ports, among other features of coastal settlements. Jones and Little considered the archaeology of coastal settlements in Cyrenaica.[31] Mattingly summarized the ports known from Tripolitania.[32] Slim et al.'s survey of the Tunisian littoral examined coastal change since antiquity by studying the types of archaeological remains found along the modern coastline (generally cities, ports, quarries, and installations associated with fishing) together with geological evidence for shoreline displacement (generally erosion, siltation, or sea-level rise).[33] Other scholars, such as Blackman and Wilson, discussed the construction techniques and economic importance of artificial port structures along the eastern coast of Tunisia.[34] The situation is least clear in Mauretania Caesariensis. Both Bouchenaki and Ferdi lamented the lack of attention given to port structures in this region.[35] In Mauretania Tingitana, a recent project used underwater survey equipment to document submerged finds but has not found any artificial port structures.[36]

Despite the laudable efforts in these studies, no synthesis of North African ports of the Roman period has appeared. To undertake a more systematic approach based on archaeological data, I collected information about ports in the region in a standardized fashion and constructed a database with basic information about each port: size, periods of occupation, elements of harbor construction, production of export commodities, literary and epigraphic references, results of previous investigations, and the like. In the next sections of this article, I present the evidence from the database and my key conclusions regarding harbors with artificial structures.

HARBORS WITH ARTIFICIAL PORT STRUCTURES

I have positively identified the remains of artificial harbor structures in 29 different cities or towns, some with multiple examples—a higher density of harbor works in North Africa than previously known (tables 1, 2).[37] I also detected an additional 16 harbors with possible artificial port structures.[38] Since my aim is to lay the groundwork for a consideration of the significance of all the artificial harbor structures, I do not discuss each site in depth.[39]

Before proceeding further, it is necessary to define the terminology used to describe elements of ports in this article, since the meaning of these terms varies in previous scholarship on this subject.[40] "Enclosure" refers to an artificial basin for mooring boats that is

[29] Fulford 1989, 189.

[30] Quinn 2011; see also Fulford 1989.

[31] Jones and Little 1971; Little 1977.

[32] Mattingly 1995, 116–37.

[33] Slim et al. 2004. Although the coastline survey directed a certain amount of attention toward ports, its primary purpose was to study the roles of both people and the climate in contributing to coastal change (or stability). It mainly considered those ports whose position offered evidence for coastal progradation or regression, and it largely excluded those whose remains have been obscured by modern construction activities (such as Hadrumetum, probably the second-largest port within its study area in antiquity).

[34] Blackman 1982b, 193; Wilson 2011a, 47–50.

[35] Bouchenaki 1971, 56; Ferdi 2004, 205. The survey of ports in Algeria conducted by Yorke and Davidson (1969) investigated 17 sites; at three of them, remains were positively identified.

[36] Erbati and Trakadas 2008.

[37] Tables 1 and 2 list their physical characteristics and include all relevant dimensions known from previous reports or ascertained via satellite imagery. Grounds for inclusion in the table were the physical presence of a feature that had been identified as a port structure in previous reports. I have not inspected each port structure myself but have relied on published identifications. In some cases, port structures identified and published by earlier investigators, especially 19th-century amateur archaeologists, have been included below under "possible" harbors, since the evidence could not be confirmed (e.g., Utica, Zarzis).

[38] Although these lack the evidence of physical remains necessary for inclusion in this section and tables 1 and 2, there is additional evidence, such as historical sources or antiquarian reports, that implies that they may have existed. I therefore consider them separately in the next section.

[39] Readers wishing further information are referred to tables 1 and 2 and the references in the footnotes of this section and the next.

[40] The problem is in part one of differences between English and other languages and in part one of a lack of specificity (e.g., see infra n. 42 on the use of the term "quay").

Table 1. Harbors with Artificial Port Structures in Africa Proconsularis.

Harbor	Cothon/ Enclosure (ha)	Quay (m)	Jetty (m)	Platform (m)	Breakwater (m)	Wharf Length (m)[a]	Other Features
Acholla	–	–	230[b]	70 x 100	–	560[b]	–
Carpis	–	–	–	–	300, 250	–	–
Carthage (all harbor facilities)	6 (rectangular), 7 (circular)	3,000	75, 90, 200	–	–	4,730	slipways, cisterns, storage facilities, temple, sanctuary, marketplace
Cercina	1.3?[c]	100[c]	70[b, c], 110[b, c]	–	100	460[b, c]	–
Gigthis	–	–	17 x 140	diam. 45 (semicircle)	–	240	–
Hadrumetum	15?	550?	200?, 300[b]?	–	500?	1,050–1,550[b]	lighthouse?
Hippo Regius	–	50[b]	–	–	–	50[b]	–
Homs	–	–	3.3[b] x 17[b]	–	–	34[b]	–
Lepcis Magna	10.2	220, 310	280, 360	50 x 100?	200?, 280?	1,200	storage facilities, cisterns, temples, lighthouse
Leptiminus	–	–	10 x 370	80 x 100	–	720	fish-salting tanks
Mahdia (Gummi?)	0.8	125	–	–	–	250	shipwreck
Meninx	–	–	5[b]	–	–	10[b]	storage facilities
Misua	–	–	10 x 150	–	–	300	–
Oea	–	–	100[b], 200[b]	–	–	600[b]	–
Ras Segala	–	–	9 x 320 (S), 7 x 90 (N)	18 x 35 (S), 16 x 32 (N)[c]	–	490 (S), 170 (N)[c]	cisterns
Ruspina	0.13[c]	45[c]	–	–	–	100?[c]	quarries
Sabratha	–	?	75	–	320	150	lighthouse
Sullecthum	–	–	9 x 260	–	–	520	fish-salting tanks
Thabraca	–	–	100[b]	–	–	200[b]	storage facilities, cisterns
Thapsus	–	–	5 x 90, 43 x 300, 9 x 960?	–	–	2,700?	lighthouse

[a] Wharf length was calculated by adding the length of quays, jetties (both sides), and jetties with platforms (outer half of the jetty plus platform). Breakwaters were not included in the calculation of wharf length.
[b] Structure continues but could not be measured any farther.
[c] Number was ascertained via satellite imagery, not a previous publication.

Table 2. Harbors with Artificial Port Structures in Mauretania Caesariensis, Cyrenaica, and Mauretania Tingitana.

Harbor	Cothon/ Enclosure (ha)	Quay (m)	Jetty (m)	Platform (m)	Breakwater (m)	Wharf Length (m)[a]	Other Features
Mauretania Caesariensis							
Iol Caesarea	9	60, 70	120, 310	–	50	990	sanctuary, lighthouse, shipwreck
Ras el Meskouta	–	–	150	–	–	300	cistern, fish-salting tanks, kilns, press, church, villa
Thalefsa	–	–	25	–	–	50	kilns, press, villa
Tipasa	2.5	?	50, 80, 100	–	70	460	quarries
Cyrenaica							
Apollonia	10	120, 140	160	–	100, 50	580	lighthouse, storage facilities, slipways, 2 shipwrecks, fish-salting tanks, quarries, towers, temple
Phycus	–	–	150	–	–	300	storage facilities, lighthouse?, shipwreck?
Ptolemais	–	50	125	–	80, 150	300	quarries, lighthouse, shipwreck
Taucheira	–	–	100?	–	–	200?	–
Mauretania Tingitana							
Lixus	0.11	–	–	–	60	100	fish-salting tanks

[a] Wharf length was calculated by adding the length of quays, jetties (both sides), and jetties with platforms (outer half of the jetty plus platform). Breakwaters were not included in the calculation of wharf length.

connected to the sea by one or more channels. They were created in some cases through the construction of jetties and breakwaters and in other cases through the excavation along the foreshore of a basin, which was then connected to the sea. A "cothon" is a type of enclosure excavated behind the shoreline, generally on the sheltered side of a promontory.[41] "Jetty" refers to an artificial structure that extends from the shore into the water, providing a landing pier and sheltering boats on its leeward side. "Platform" refers to a broad structure that terminates a jetty while expanding its width to maximize docking space in deep water; most of the platforms considered here were rectangular. A "breakwater" is a wall that is not connected to the shore; most of the breakwaters studied here ran parallel to the shore at a distance from it, as their function was to protect the area where boats were moored by reducing the force of waves. The placement of jetties and breakwaters together could form a rectangular enclosure. A "quay" is a mooring dock constructed on the shoreline.[42] An "artificial port structure" is any man-made structure found in the water at a harbor, including an enclosure, jetty, breakwater, or quay. "Wharf length" refers to the total length along which boats may have docked so their cargoes could be loaded or unloaded. It applies to all sides of a jetty, jetty with

[41] On the cothon, see Carayon 2005.

[42] In this article, "quay" does not refer to mooring space along a jetty or breakwater, but this use is widely found elsewhere.

platform, or quay that touched the water.[43] I discuss below why wharf length best indicates the capacity of an ancient harbor to import or export goods, and I base my comparison of North African ports on it in the conclusion to this article. "Mole" refers to any artificial landing pier in the water, whether or not it is connected to the shore. Since it can indicate a jetty that extended from the shore or an unconnected breakwater at which ships could dock, its meaning cannot always be precisely understood, and for this reason my use of it will be limited.

Africa Proconsularis

Africa Proconsularis possessed the most developed maritime infrastructure in the North African provinces (see fig. 1 for the locations of both the definite and possible harbors).[44] Harbor structures were built in 20 cities along its approximately 1,900 km long coastline. Carthage's harbor was exceptional in size; few Mediterranean ports could rival its combination of enclosures, jetties, and quays, which provided 4,730 m of docking space.[45] Indeed, the long quay and jetties of the Roman period more than tripled the space available in the Punic harbors (fig. 2). The harbor at Lepcis Magna offered 1,200 m along which boats could dock, and the port at Hadrumetum, whose poor preservation makes it difficult to assess with precision, probably had between 1,000 and 1,600 m of docks.[46] At Thapsus, the jetty that stretched 960 m is the longest recorded example from the Roman empire. The same harbor had two smaller jetties of 90 and 300 m and a separate artificial island where a lighthouse may have been situated.[47] Within Africa Proconsularis, there were five other harbors with more than 500 m of wharf length: Acholla, Leptiminus, Oea, Ras Segala, and Sullecthum.[48] Another at Cercina had nearly this amount (460 m).[49]

In addition to having the largest numbers of port structures, Africa Proconsularis also contained the greatest variety. The earliest, those at Carthage, Mahdia (fig. 3e), and Ruspina, were cothons.[50] Similar in function were enclosure ports, though these date later and were built out from the shore rather than behind it. Enclosure ports were rectangular (Cercina, Hadrumetum) or circular (Lepcis Magna). Each had one or more quays for docking close to the shoreline and additional space for docking at a jetty. Enclosures offered protection from wind and waves but ran the risk of siltation if the current was insufficient to carry away waterborne sediments. Breakwaters were identified at four harbors (Carpis, Cercina, Hadrumetum, and Sabratha). At Carpis and Sabratha, the practice most typical of other breakwaters in the Mediterranean was followed: the gaps in natural offshore reefs were filled in with ashlar blocks or mortared rubble.[51] Since breakwaters were the outermost harbor structures, they were often semipermeable, allowing water to pass through but reducing its quantity and strength. The breakwaters at Carpis appear to have been the sole artificial structures in the port, so ships must have drawn up along the shore there; at the other ports, however, they are one element of the whole.

[43] Wharf length was calculated by adding the length of quays, platforms, and jetties. Both sides of jetties were counted, since in good weather during the summer sailing season it may have been possible for ships to dock on either side. In the case of jetties with platforms, which were all found in shallow water, my method has been to assign the wharf length to be equal to half of the jetty's length, plus the perimeter of the platform. In other words, the method assumes that only the outer half of the jetty was serviceable for docking (see further explanation of jetties with platforms later in this section). Breakwaters were not included in the calculation, since boats did not dock alongside them to load and unload.

[44] The subject of provincial boundaries in North Africa raises several issues, which I do not attempt to consider here. Interested readers may turn to Briand-Ponsart and Modéran (2011), among others. During the long time period under study here, several boundaries were in effect, and I have used those that best apply to the first to third centuries C.E., the period when most of the artificial port structures were built. Thus, for present purposes, Africa Proconsularis extends from the Oued Ampsaga to the legendary Arae Philaenorum (perhaps modern Ras Lanuf). These are the commonly accepted coastal boundaries of the province prior to the creation of Numidia in 198 C.E.

[45] App., *Pun.* 96; *CIL* 14 4549, line 18: "Navicul(ari) Karthag(inenses) de suo"; Hurst and Stager 1978; Hurst 1994, 2010.

[46] Lepcis Magna: Bartoccini 1958; Laronde 1988; Beltrame 2012. Hadrumetum: Caes., *B Afr.* 62.5, 63.4–5 ("Hadrumetum in cothonem se universae contulerunt"); Carton 1907, 145; Foucher 1964, 80–4.

[47] Yorke 1967; Younes 1999, 213–34; Slim et al. 2004, 243; Davidson and Yorke 2013. I thank D. Davidson and R. Yorke very much for sending me their article in advance of publication.

[48] Acholla: Yorke 1966, 12; Slim et al. 2004, 138, 242. Leptiminus: Davidson 1992; Stone et al. 2011, 142–45. Oea: Mattingly 1995, 123. Ras Segala: Slim et al. 2004, 104. Sullecthum: *CIL* 14 4549 23 ("[Navic]ulari Syllect[ini]"); Slim et al. 2004, 146–47.

[49] Chelbi 1995, 132; Slim et al. 2004, 126–27; Trousset 2005, 4160.

[50] Carthage: supra n. 45. Mahdia (Gummi?): *CIL* 14 4549, line 17 ("Naviculari Gummitani de suo"); Oueslati 1993, 166–73; Slim et al. 2004, 151; Carayon 2005, 8. No publications of the cothon of Ruspina have appeared to date.

[51] Carpis: Slim et al. 2004, 192. Sabratha: Yorke 1986, 243–45. Mediterranean breakwaters: Blackman 1982b, 196–99.

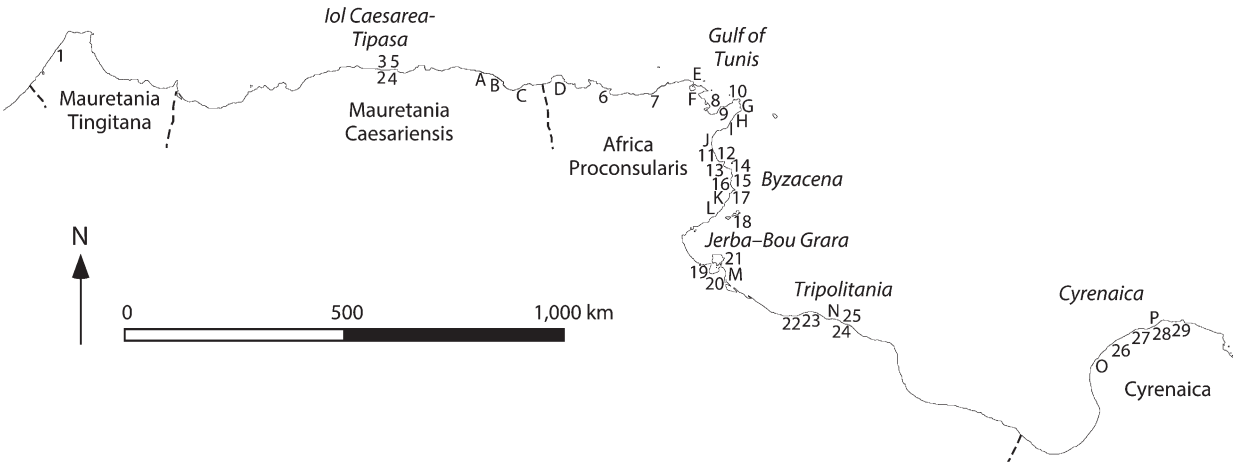

Fig. 1. Location of harbors with artificial port structures in North Africa, provinces (in roman), and regional clusters of harbors (in italics): *1*, Lixus; *2*, Iol Caesarea; *3*, Ras el Meskouta; *4*, Thalefsa; *5*, Tipasa; *6*, Hippo Regius; *7*, Thabraca; *8*, Carthage; *9*, Carpis; *10*, Misua; *11*, Hadrumetum; *12*, Ruspina; *13*, Leptiminus; *14*, Thapsus; *15*, Mahdia; *16*, Sullecthum; *17*, Acholla; *18*, Cercina; *19*, Gigthis; *20*, Ras Segala; *21*, Meninx; *22*, Sabratha; *23*, Oea; *24*, Homs; *25*, Lepcis Magna; *26*, Taucheira; *27*, Ptolemais; *28*, Phycus; *29*, Apollonia; *A*, Iomnium; *B*, Saldae; *C*, Musluvium; *D*, Rusicade/Stora; *E*, Hippo Diarrhytus; *F*, Utica; *G*, Clipea; *H*, Curubis; *I*, Neapolis; *J*, Horrea Caelia; *K*, Thaenae; *L*, Macomades; *M*, Zarzis; *N*, Villa dell'Odeon Maritima; *O*, Euesperides/Berenice; *P*, Haniya.

Jetties built straight out from the shore were common; seven ports in Africa Proconsularis used this type of structure: Carthage (three examples, in addition to the rectangular and circular harbors), Thapsus (three examples), Oea (two examples), Misua, Sabratha, Sullecthum, and Thabraca (one example each).[52] The "jetty with platform" was a variation on the straight jetty that may be classified as its own type, because it terminated in a large platform.[53] Five jetties with platforms were found at four harbors (Acholla, Gigthis,[54] Leptiminus, and Ras Segala [see fig. 3a]). Two further possible examples may have existed at Lepcis Magna and Macomades. The use of the platform, which is unparalleled elsewhere in the ancient world, appears to be related to the depth of water off the eastern shore of Tunisia. Because of the extension of the continental platform into the sea, this is one of the shallowest regions of the Mediterranean. At 500 m from the shoreline today, depths of 1–2 m are common. A study of the Tunisian coastline has estimated that the sea level has risen 0.50–0.75 m during the last 3,000 years at most of these harbors, meaning that the depths would have been even shallower in antiquity.[55] Although ancient ships typically had very shallow drafts, they would have had difficulty docking in the water here. By combining a long jetty with a platform, this design created additional docking space in deeper water. The shapes and sizes of the jetties and platforms varied (see fig. 3b, c, g), but each appears to have been faced with ashlar blocks and to have employed a fill of underwater concrete mixed with rubble in its interior.

There is one location in Africa Proconsularis where artificial port structures have not previously been recognized. At Misua, the identification of an underwater structure extending 150 m between the coastline and an offshore island has been disputed (for a plan of the structure, see fig. 4, top). Davidson identified this structure as a series of fish tanks because it possessed internal chambers.[56] The French-Tunisian coastlines survey regarded the structure as a road (*chaussée*) across a bay, comparing it to the ancient roads that led across salt flats (sebkhas) to fish-salting "factories" on the southern side of Cap Bon.[57] I argue that it should

[52] On Thabraca, see Rebora 1884, 122–26; Toutain 1892, 189–90; al-Hamawi 1955, 4:516; al-Maghribi 1970, 147; Longerstay 1988, 244; Slim et al. 2004, 220.

[53] See Stone (forthcoming) for a study of this type of port structure.

[54] Constans 1916, 70; Slim et al. 2004, 105–6.

[55] Slim et al. 2004, 229–54.

[56] Davidson 1992, 172–74.

[57] Slim et al. 2004, 184–85.

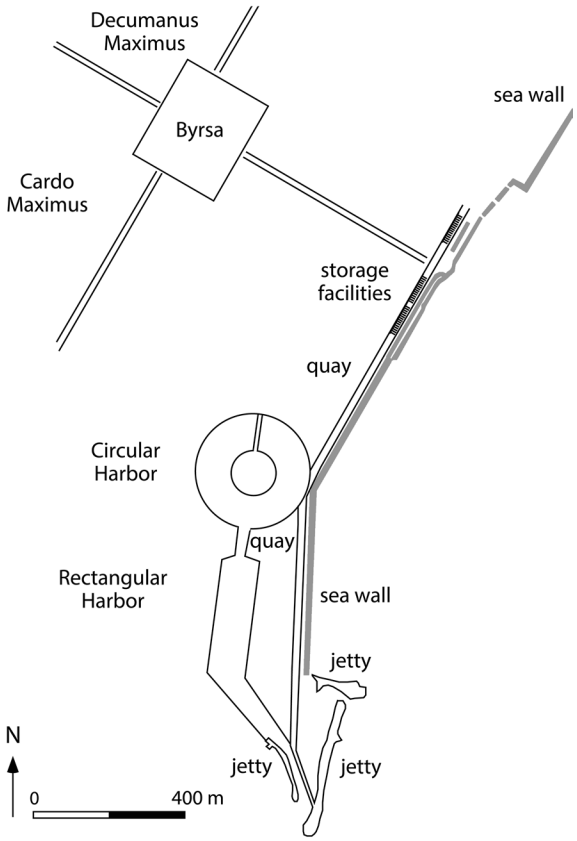

Fig. 2. Plan of the artificial port structures at Carthage (after Hurst 2010, fig. 4).

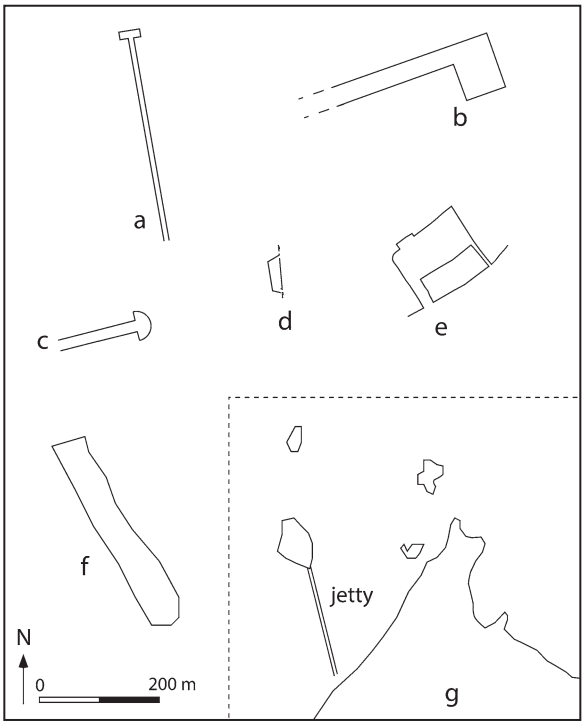

Fig. 3. Plans of several harbors with artificial port structures in North Africa, at the same scale: *a*, Ras Segala South (after Slim et al. 2004, fig. 73); *b*, Acholla (after Davidson 1992, fig. 7); *c*, Gigthis (after Slim et al. 2004, fig. 74); *d*, Lixus (after Tissot 1878, 75); *e*, Mahdia (after Carayon 2005, fig. 5); *f*, Sullecthum (drawing by D. Stone); *g*, Ras el Meskouta (after Leveau 1984, fig. 49).

be identified as a jetty, since jetties at Iol Caesarea, Ras el Meskouta, Thalefsa, Thabraca, Sabratha, Ptolemais, and Phycus offer similar plans, all linking the coastline with offshore islands (cf. figs. 3g [Ras el Meskouta]; 4, bottom [Iol Caesarea]).[58] Furthermore, it does not compare precisely with roads or fish tanks. At 10 m in width, the structure at Misua is much larger than the roads across sebkhas, which are no more than 5 m wide.[59] While it appears to possess internal divisions that could house fishponds, it also has a wide solid feature on the east side that appears to be the paved surface of a jetty. An inscription naming the *Naviculari Misuenses* was found at one of the *stationes* in the Piazza delle Corporazioni at Ostia.[60] This inscription indicates a level of commercial organization at Misua. Although the inscription does not confirm my identification of the structure at Misua as a jetty, it is consistent with such an identification.

Structures can be identified at three additional ports in Africa Proconsularis, but because of their incomplete preservation it is not possible to classify these harbors as a particular type or to measure the size accurately. These harbors include Hippo Regius, where a section of a sea wall or quay has been identified, and Homs and Meninx, each of which possessed a short wall that may have been the beginning of a jetty.[61]

Mauretania Caesariensis

Four harbors with artificial port structures have been identified along the approximately 900 km long

[58] Additionally, the harbor at Lepcis Magna linked the coast with an offshore island, although its plan involved a more complex arrangement of encircling arms creating an enclosure.

[59] Examples of such roads may be found between Curubis and Clipea (Slim et al. 2004, 170–76 [sites 138, 139, 142, 145, and 149]).

[60] *CIL* 14 4549, line 10.

[61] Hippo Regius: Procop., *Vand.* 4.4.33–41; Marec 1954, 44–5, 125. Homs: Di Vita 1974; Mattingly 1995, 118. Meninx: Drine 2007; Fentress et al. 2009, 153–59.

coastline of Mauretania Caesariensis.[62] The largest was at Iol Caesarea, the provincial capital (see fig. 4, bottom). The harbor was framed by artificial port structures that linked the coast with two offshore islands, one on the east side and one on the west. The arrangement created both an inner and outer enclosure, which has led to the suggestion that, like Carthage, this port possessed both military and commercial installations. Walls of the inner "military" harbor on the west were visible in the 1840s, before the construction of the modern port. They can no longer be seen, although portions of the outer jetty on the east are intact.[63] No evidence of shipsheds or other naval facilities has been discovered, but Ferrero concluded based on epigraphic evidence that detachments of the Roman imperial navy from the eastern Mediterranean were stationed there.[64] Excavations on the îlot de Joinville identified the remains of a sanctuary and lighthouse from the reign of Juba II (25 B.C.E.–23 C.E.).[65] There is some additional evidence that may relate to this harbor. An amphora bearing the label "M C" was depicted in mosaic on the floor of one of the *stationes* at the Piazza delle Corporazioni in Ostia. At the time of excavation a century ago, these letters were interpreted as "Mauretania Caesariensis," and the *statio* was thought to be the office of traders from the province. Bonifay recently suggested that they may refer instead to the city C(aesarea) M(auretaniae) and that amphoras bearing similar stamps may have been produced at Iol Caesarea.[66] Since many *stationes* refer to cities rather than provinces, Bonifay's suggestion appears more convincing.

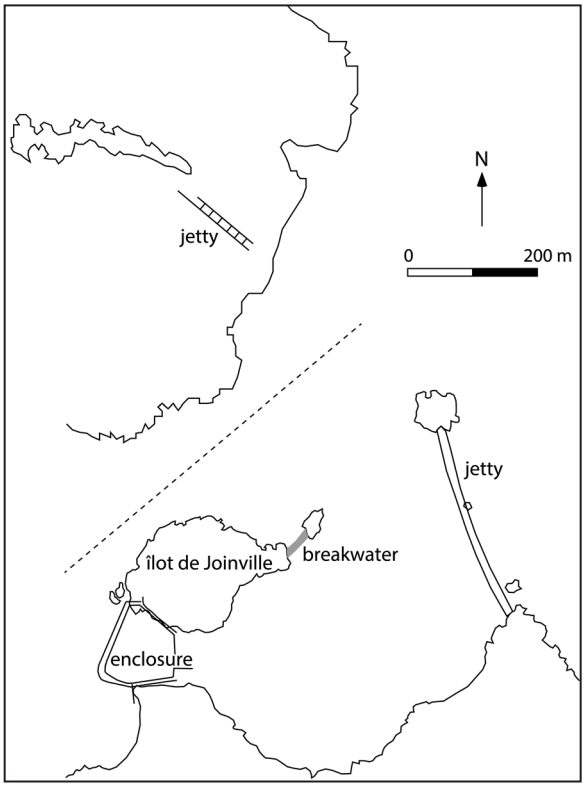

Fig. 4. Plans of the artificial port structures at Misua (*top*) and Iol Caesarea (*bottom*), at the same scale (*top*, after Davidson 1992, fig. 8; *bottom*, after Cagnat 1912, 338).

Three other ports were located within 30 km of Iol Caesarea. The considerable similarity of their plans, which include jetties connecting to offshore islands, suggests that the design of the provincial capital's harbor, which was almost certainly the earliest, influenced the others. The harbor at Tipasa included three jetties and a breakwater sandwiched between the mainland and two offshore islands. Two jetties attached to islands may have provided docking space, while one emerging from the mainland perhaps served for the loading and unloading of vessels.[67] Between Tipasa and Iol Caesarea there were two small rural harbors at Thalefsa and Ras el Meskouta.[68] Both have been found at sites with a range of productive equipment, architectural elaboration, and luxury goods, which have been identified as "villas." Such villa ports are rare even in areas of the Roman empire with dense networks of harbors and are almost nonexistent elsewhere in North Africa.[69] In this region of Mauretania Caesariensis, they offer a good indication first of surplus production of agricultural goods for export and second of the development of elite lifestyles.

[62] For the purposes of this study, Mauretania Caesariensis extends from the Oued Moulouya to the Oued Ampsaga. These are the commonly accepted boundaries of the province.

[63] Cagnat 1912, 344–47 (see esp. the extraordinary color drawings between pp. 338 and 339 produced from the illustrations of Ravoisié [1846] and others); Leveau 1984, 47–50.

[64] Ferrero (1884, 172–81) demonstrated that nine of the 18 inscriptions from Africa relating to the imperial navy were from Iol Caesarea.

[65] Lassus 1959, 220–24.

[66] *CIL* 14 4549, line 48; Vaglieri 1913, 133; Bonifay 2004, 18–19. For a different suggestion linking the *statio* and these stamps with the region of Tubusuctu and Saldae in Mauretania Caesariensis, see Panella 1973, 603. On the port at Saldae, see the section "Harbors with Possible Artificial Port Structures" herein.

[67] Bouchenaki 1971, 54–6; Ferdi 2004.

[68] Thalefsa: Leveau 1984, 257, 446. Ras el Meskouta: Leveau 1984, 248–53, 446.

[69] See Schörle's (2011, 101–3) comments on villa harbors in Italy.

Cyrenaica

Four ports with artificial structures have been identified along the approximately 650 km long coastline of Cyrenaica.[70] Extensive studies of the port of Apollonia have revealed it as one of the largest and most complex in North Africa.[71] It had two natural bays formed by promontories and was partially sheltered by two offshore islands. After the construction of shipsheds in the fourth century B.C.E., the port appears to have undergone substantial development in the second century B.C.E., when a lighthouse, a fortification wall, and a channel connecting the two bays were all built. Later expansion of the port under Rome included quays, storage facilities, breakwaters, and a jetty protecting the outer bay. Smaller harbors at Ptolemais and Phycus consisted of jetties connecting to islands. The provision of lighthouses and storage facilities at both of these harbors is an indication of exports.[72] The letters of the bishop Synesius document the importance of commercial shipments from Phycus in the early fifth century C.E. Interprovincial travel from Cyrenaica is also a feature of Synesius' letters (e.g., *Ep.* 101, 129). Jones and Little located a "breakwater" more than 100 m long at the harbor of Taucheira (Tocra). Yorke's discussion of the site indicated two "quays" and a "mole" as long as 220 m.[73]

Mauretania Tingitana

Current evidence suggests only one port structure was built in the approximately 550 km long region of Mauretania Tingitana.[74] This quasirectangular (18 x 56 x 26 x 60 m) structure was discovered by Tissot in the 1870s (see fig. 3d).[75] It was situated not on the coastline but adjacent to the site of Lixus in the Oued Loukkos, 5 km from the Atlantic Ocean. For small craft, the wide river was navigable to this point. The structure is not visible today but, according to Ponsich, "affleurements de gros murs" remain.[76] Excavations at Lixus' fish-salting installations revealed at least 142 vats with a combined capacity of 1,013 m^3.[77] Combined with the plan Tissot published, this evidence weighs in favor of identifying the structure as a port.[78] This identification has been accepted by archaeologists currently working at the site, who have included loading docks on their plans at the location of Tissot's discovery.[79] Earlier investigators, however, considered the mouth of the Oued Loukkos a more likely position for a port.[80]

Although Mauretania Tingitana has not been studied as thoroughly as other provinces, no other investigations have found artificial port structures. The recent Morocco Maritime Survey has confirmed the picture in a 110 km long region from the Oued Tahadart in the Atlantic to Cape Mazari in the Mediterranean. The project discovered shipwrecks, anchors, and amphoras but no artificial port structures.[81] Ancient testimony also provided very limited evidence of ports in Mauretania Tingitana. Between Lixus, which the *Periplous* of Pseudo-Skylax (112) named as a port, and Rusaddir, which Pliny the Elder (*HN* 5.18) called "oppidum et portus," only a handful of other places are mentioned as ports in ancient sources.[82]

HARBORS WITH POSSIBLE ARTIFICIAL PORT STRUCTURES

A further 16 ports with artificial port structures may have existed in North Africa in antiquity. All lack identifiable physical remains as a result of poor preservation, geomorphological change, or post-Antique development. Antiquarian evidence or ancient texts suggest the presence of port structures, and therefore I consider each one briefly here as a possible artificial port structure. More substantive proof of any of these would provide an even stronger argument for the significance of North African port structures. The largest number of possible port structures is again in Africa Proconsularis, but several examples come from other provinces.

[70] For the purposes of this study, Cyrenaica extends from the Arae Philaenorum (Ras Lanuf) to the Darnis (modern Derna). These are the commonly accepted boundaries of the province.

[71] Flemming 1965; 1971, 95–126; Laronde 1996; Laronde and Sintès 1998; Sintès 2010; Tusa 2010.

[72] Ptolemais: Jones and Little 1971, 72; Nasgowitz 1981, 20–1; Beltrame 2012. Phycus: Jones and Little 1971, 73–4; Tusa 2010. I thank D. Davidson and R. Yorke for discussing Ptolemais with me.

[73] Jones and Little 1971, 71; Yorke 1973, 201. I have listed the more conservative estimate of Jones and Little in table 2. Further research is necessary to identify the type of port structures and to acquire accurate measurements; the terminology used by these authors may not match what I have defined above.

[74] For the purposes of this study, Mauretania Tingitana extends from the Oued Sebou to the Oued Moulouya. These are the commonly accepted boundaries of the province.

[75] Tissot 1878, 75–6.

[76] Ponsich 1982, 836.

[77] Ponsich and Tarradell 1965; Trakadas 2005, 66–7.

[78] Tissot 1878, 75; Ponsich 1982, 837.

[79] Aranegui and Mar 2009, 32; see also Villaverde Vega 2001, 126.

[80] Cf. Gsell's suggestion (1920, 174) that the modern port of Larache covered the ancient port of Lixus.

[81] Erbati and Trakadas 2008, 59.

[82] Investigations at Rusaddir have not revealed built structures (Gonzalbes Cravioto 2005).

Africa Proconsularis

Utica has long been regarded as a likely location of unidentified port structures because of its early urban development, its historical significance as the first Roman capital in North Africa, and its position on a headland at the mouth of the Bagrada River, which flowed through very fertile agricultural land. Several literary sources mention ships sailing to Utica's harbor, though none clearly refers to port structures.[83] Archaeologists have speculated that a port existed on the northern shore of the headland, but searches have not resulted in a discovery.[84] Yet, since the probably contemporaneous harbors at Carthage, Mahdia, and Hadrumetum were all located on the southern side of a headland, it may make the most sense to search for a harbor on the southern shore of Utica. A major impediment to the discovery, however, is that extensive siltation of more than 400 km^2 has dramatically altered the coastline near Utica and throughout the adjacent Gulf of Tunis, leaving the former harbor more than 10 km inland.

Like Utica, Thaenae is one of the larger cities in Africa Proconsularis where port structures have yet to be identified. In several respects, the site is comparable to other coastal towns in Africa Proconsularis that had artificial port structures: it produced olive oil, wine, and fish sauce; it manufactured Africana I, II, and III amphoras; and it had a building boom in the second and third centuries C.E. However, modern salterns installed adjacent to the ancient site have hindered the examination of any features along its coastline.[85] A third important town was Hippo Diarrhytus (modern Bizerte), where a major harbor was developed in the 19th century. This modern harbor may obscure traces of an ancient port. Nearby sites for fish salting resemble features found in the vicinity of other harbors with artificial port structures.[86] The presence of the inscription"Naviculariorum Diarry(to)" in the *stationes* at Ostia also suggests a relatively high level of commercial organization.[87]

Currents on the southern side of Cap Bon may have affected the preservation of port structures at the towns of Clipea (modern Kelibia), Curubis (modern Korba), and Neapolis (modern Nabeul). Published accounts have claimed that structures are no longer visible at Clipea and Neapolis but may be buried beneath the sands.[88] Unpublished reports have suggested that offshore from the first there is "a jetty consisting of blocks and concrete" and that "cut blocks" and "concrete" have been found at the second.[89] A recent project to study the port of Neapolis has noted structures in the water along the ancient coastline; it appears poised to transform our interpretation of the site when more details are published.[90] Considerable evidence for exports contributes to the picture of maritime activity. Extensive remains of fish-salting installations are present along the entire southern flank of Cap Bon, and kilns at Neapolis attest to the manufacture of Africana I, II, and III, Keay 35 and 62, and Dressel 30 amphoras.[91] It is thought that both the Pampelonne and Trapani shipwrecks had been carrying cargoes consisting entirely of amphoras manufactured at Neapolis.[92] Literary sources also support an interpretation of large-scale shipping enterprises. *Navicularii* from Curubis set up a *statio* at Ostia,[93] and an inscription from Neapolis mentioned a "tr(ansvecturarius) et nav(icularius)."[94]

There is a divergence of opinion on the presence of port structures at Horrea Caelia in the nearby Gulf of Hammamet. An unpublished underwater survey described "two long lines of large concrete blocks" offshore from the modern harbor at Hergla, although a more recent publication stated that a warehouse, but no port structures, had been located.[95]

The reports by amateur archaeologists in the middle of the 19th century suggested that port structures could be found at both Rusicade (modern Skikda) and Stora, just 3 km apart. Later in that century, archaeologists searched for these remains but could not locate them.[96] More recently, Yorke and Davidson noted in an unpublished report two large areas of concrete blocks at Stora, which could have belonged to a jetty; they found no remains at Rusicade.[97] Cirta (modern

[83] E.g., Caes., *B Afr.* 62.1; Livy 25.31.13; Pseudo-Skylax, *Periplous* 111.

[84] For discussion of previous attempts to locate the port at Utica, see Lézine 1970, 9–20; Chelbi et al. 1995, 13–15. Daux's (1869, pl. 9) elaborate reconstruction drawing of the port at Utica is altogether unreliable and must be rejected.

[85] Gascou 1972, 135–36; Slim et al. 2004, 123–25.

[86] Slim et al. 2004, 202–7.

[87] *CIL* 14 4549, line 12.

[88] Clipea: Aounallah 2001, 259. Neapolis: Guérin 1862, 2: 246; Slim et al. 2004, 169.

[89] Clipea: Yorke and Davidson 1969, 21. Neapolis: Yorke 1966, 17–18.

[90] Fantar et al. 2012, 2287.

[91] Fish salting: Slim et al. 1999; 2004, 167–77. Amphoras: Bonifay 2004, 37–9; Mrabet and Ben Moussa 2007.

[92] Bonifay 2007b, 255–56.

[93] *CIL* 14 4549, line 34: "Naviculari Curbitani d(e) s(uo)"; Trousset 1994, 2157; Aounallah 2001, 249–50, 255.

[94] *CIL* 8 969, 970.

[95] Yorke 1966, 17; Bonifay and Trousset 2000, 3444.

[96] De Marcilly 1853; Vars 1896, 6–23.

[97] Yorke and Davidson 1969, 19–20.

Constantine), 65 km inland from Rusicade and Stora, was the center of a region with extensive rural settlement and estates that attracted significant investment. Milestones indicate that no later than 125–126 C.E. Cirta was connected to Rusicade by a road.[98] Given the development of this territory to provide grain, timber, and other foodstuffs to Rome, the presence of a harbor with artificial port structures in the area of Rusicade and Stora is reasonable.

A jetty with a rectangular platform at its outer end has been tentatively identified at Macomades on the basis of satellite imagery. A linear feature (a possible jetty) more than 60 m in length is connected to a rectangular shape (a possible platform) that is approximately 80 x 110 m. Both features lie underwater and have not yet been investigated; until further information is available, they must remain in the category of possible artificial port structures. Macomades is broadly similar to other ports that possessed jetties with platforms, in that it was associated with olive cultivation, fish salting, and pottery production; it also achieved some degree of stature as an urban center, attaining the rank of municipium.[99]

Another possible port lies at Zarzis. In 1906, a French officer excavating in his spare time reported the discovery of "an immense construction of stone that terminated a jetty."[100] Nearby he found several rectangular structures that may have been cisterns, *horrea*, or fish-salting vats; one of them, according to him, contained olive oil residues. The officer thus claimed that he had found some confirmation for a local legend that a river of olive oil flowed 9 km from Zitha to the port at Zarzis, where it was put aboard ships for export. There is, however, little to verify any of these ideas.

Ports at North African villas are rare, but Salza Prina Ricotti reported modifications to the coastline to accommodate a harbor at the Villa dell'Odeon Maritima near Lepcis Magna. It has not been possible to substantiate this information without photographs, measurements, or a plan, but future field-survey research in this area may provide documentation about ports at this villa or others nearby.[101]

Mauretania Caesariensis

At least three towns in Mauretania Caesariensis may have possessed artificial port structures. A variety of evidence stands in support of Saldae (modern Béjaïa) as the most probable location. In the late 19th century, Cat reported that "at the time of the French conquest, masonry remaining from a jetty or a mole could be distinguished," although he himself could see nothing.[102] Substantial medieval and modern port structures have been built at Saldae, and these may have obscured the ancient remains.[103] The port may have funneled goods from both near and far. Dressel 30 amphoras with stamps containing the name of Tubusuctu (modern Tiklat), a town 22 km inland, were exported to the Mediterranean through Saldae in the third century C.E. According to Salama, Saldae was also one of the two outlets for the agricultural production of Sitifis, a colony located 67 km inland, where many large imperial estates and rural settlements were created in the late first and early second centuries C.E.[104]

The other main port linked to Sitifis was Musluvium (Cap Aokas), just 17 km to the east of Saldae. When discovered a century ago, a fragmentary inscription in one of the *stationes* at Ostia was reconstructed as "Naviculari Mu[s]lu[vit]a[ni] hic." There has subsequently been debate about whether this inscription should be linked with Musluvium.[105] But this town was also located at the end of a road from Sitifis and appears to have served as a conduit for its exports as well.[106] Musluvium is thus a likely candidate to have functioned as a port and may have possessed port structures.

In the late 19th century, Gavault identified a "chaussée" between the tip of the cape at Iomnium (modern Tigzirt) and an island approximately 200 m offshore.[107] Underwater prospection by Yorke and Davidson found "a dozen cut blocks" and a raised bed covered with *Posidonia* weed.[108] Further work to clarify these reports could be profitable.

Cyrenaica

At two settlements in Cyrenaica, the presence of artificial port structures appears quite probable. Euesperides/Berenice (modern Benghazi) may have had

[98] *CIL* 8 10296, 10322, 22370; Gascou 1983.

[99] Trousset 2003. See the discussion of Macomades in Stone (forthcoming).

[100] du Breil de Pontbriand 1906, 252.

[101] Salza Prina Ricotti 1971, 148–49; 1973, 76–7; Schörle and Leitch 2012.

[102] Cat 1891, 87.

[103] Valérian 2006.

[104] Salama 1980, 124. On estates and rural settlements, see Février 1966; Stone 2008.

[105] *CIL* 14 4549, line 11. The reconstruction of the inscription was made by Vaglieri (1912, 210–11), but it has been questioned by Becatti (1961, 1:69), who argued that the preservation of letters was insufficiently clear to permit a reading of "Musluvitani."

[106] On the road from Sitifis, see Salama 1980, 124.

[107] Gavault 1897, 110–11. Euzennat (1955) considered the ancient name of Tigzirt to be "Rusucurru," but most scholars have not agreed.

[108] Yorke and Davidson 1969.

them in either of two places. The earlier would have been at the northern end of the Sebkha es-Selmani, by the site of Euesperides, the later nearby at Berenice, where settlement shifted in the middle of the third century B.C.E.[109] Attempts by multiple teams to locate the ports at Euesperides or Berenice have, however, not succeeded.[110] Jones and Little have claimed that a port, including a quay, storage tanks, and cisterns, might be found at Haniya (probably to be identified as ancient Aptoucha or Ausigda).[111]

HARBORS WITHOUT ARTIFICIAL PORT STRUCTURES

Houston has argued that much Roman trade occurred at harbors with minimal or no facilities. In his view, modern writers on Roman commerce have overlooked that "beaching of small merchant vessels, or mooring just off an unimproved open beach, must have played an important role—far more significant than we tend to imagine—throughout antiquity."[112] Houston's opinion that the majority of Mediterranean harbors, including under Rome, must have been natural bays where ships were drawn up in shallow water or along the shore is undeniably correct, although it does not necessarily follow that most trade took place at unmodified harbors.

We can evaluate the number of unmodified harbors on the North African coastline by examining two types of literary sources from the ancient world, geographies and maritime itineraries, as well as the results of archaeological research projects.[113] Literary sources are very useful in determining the locations and names of settlements but often less helpful when it comes to identifying port structures. That is because they often refer to harbors with terms that do not distinguish systematically between those with artificial port structures or other specific facilities and those without.[114] The *Periplous* of Pseudo-Skylax was probably written in the mid fourth century B.C.E. before the first artificial port structures were built in North Africa. It mentioned approximately 50 ports between Mauretania Tingitana and Cyrenaica, making it clear that at that time most harbors must have been natural ones.[115] Four hundred years later, the *Stadiasmus* listed 97 harbors in a more limited area, indicating a significant increase in the numbers of ports.[116] All ancient literary sources together mentioned 137 harbors within North Africa,[117] not including those with the 29 definite and 16 possible artificial structures discussed above. A further 126 harbors have been located by modern archaeological surveys but were not mentioned by ancient sources.[118] These numbers indicate a total of 308 harbors along the North African coastline in antiquity. They confirm Houston's observation that the majority of harbors (n=263) were unmodified, while the minority (n=45) may have had port structures. Future scholarship may revise these numbers, but it would take the discovery of many additional artificial structures or unmodified ports to adjust the ratio (6:1) significantly.

Very few natural harbors have been studied by archaeologists until recently, but underwater examinations in Libya and Morocco have improved our knowledge about them through discoveries of shipwrecks, amphoras, anchors, and other remains. At modern Marsa el-Brega, about 200 km south of Euesperides/Berenice, Preece located a good example of a harbor that was never modified but that was frequented in antiquity. While the reefs on the north and south sides of this harbor were treacherous, it was one of the few places offering shelter in a region without good ports. Shipwrecks of the first and sixth centuries C.E. attest to the use of this harbor.[119] At modern Janzur, about 15 km to the west of Oea (modern Tripoli), Preece found two stone anchors and numerous amphoras. The remains of one, or possibly two, anchorages were located in the harbor. Kilns and pottery

[109] Jones and Little 1971, 66–7; Lloyd 1977, 19.

[110] See the discussion in Lloyd 1977, 19–21; Wilson et al. 2001, 156.

[111] Jones and Little 1971, 74; Hesein (forthcoming). Ancient authors refer to both Aptoucha and Ausigda in this location. Since the ancient name is not certain, I have used the modern one. I thank M. Hesein for alerting me to the problems of identification.

[112] Houston 1988, 560.

[113] The most relevant ancient authors and texts include Plin., *HN*; Pseudo-Skylax, *Periplous*; the *Stadiasmus*; Strabo, *Geographica*; *It. Ant.*; and the *Tabula Peutingeriana*. The most relevant archaeological studies are Slim et al. 2004; Carayon 2008.

[114] Leonard (1997) has examined both the terminology of harbors and the extent to which it was used in a systematic fashion.

[115] Pseudo-Skylax, *Periplous* 107–12. Shipley (2011, 6–8) has recently dated this text to 338 or 337 B.C.E. The earliest port structure in North Africa, at Apollonia, may have been constructed at around this date (Laronde 1996, 11–13).

[116] The *Stadiasmus* mentioned its 97 harbors between Ficu (eastern Libya) and Utica (northern Tunisia). This is an area for which Pseudo-Skylax mentioned no more than 34 harbors. Uggeri (1996, 284) has dated the *Stadiasmus* between 50 and 60 C.E.

[117] Supra n. 113.

[118] My calculations are drawn from the lists in de Graauw 2011–2014.

[119] Preece 2000. The site was mentioned by the author of the *Stadiasmus* (80).

wasters on the foreshore attest to the manufacture of amphoras and therefore the probable presence of export production.[120]

Apart from Tissot's discovery at Lixus, no evidence of artificial port structures has ever been signaled in Mauretania Tingitana. The recent and thorough Morocco Maritime Survey, however, found three shipwrecks and recorded more than 65 artifacts, mainly anchors, anchor stocks, and amphoras.[121] These data have enabled Erbati and Trakadas to put forward the hypothesis that small craft brought cargoes from land for transshipment to larger vessels docked offshore. The most convincing evidence came from survey site CSP062, where the project found 46 fragmentary or complete anchors in a 120 m^2 region of the seafloor.[122] This was an area of calm seas protected by the Cap Spartel headland, with an average depth of 18 m. It lay just 0.5 km from the shore and 1 km from Cotta, where a fish-salting installation with 16 vats and a capacity of 258 m^3 has been found.[123] Given the large scale of this and other production facilities for garum and salsamenta at Essaouira, Thamusida, Lixus, Kouass, Tahadart, Sahara, Qasr es-Seghir, Septem Fratres, and Sania e Torres, it would be reasonable to think these sites were oriented toward export production.[124] Erbati and Trakadas suggested that ships anchored in bays or in the mouths of rivers while awaiting cargoes to be ferried to them by small vessels at sites on the Atlantic coast. On the Mediterranean coast, they may have anchored in bays offering shelter from strong currents in the Strait of Gibraltar.[125]

The results of the Morocco Maritime Survey offer clear evidence of the ferrying of goods by small ships to larger transport vessels stationed offshore. We can also note a cross-temporal parallel in a late 19th-century painting of the artist Charles Lallemand (1826–1904) (fig. 5), which shows oarsmen in two rowboats making their way through shallow water to large merchant ships anchored in deeper water offshore. Six or eight large barrels trail behind each of the rowboats, attached by a rope. The caption below the painting identified the vessels as "transatlantiques" and the contents of the barrels as olive oil.[126] This scene should not be taken as a faithful representation of an ancient or modern "reality," but it does signal the potential use of small service vessels in harbors without artificial port structures, since larger ships may have preferred to remain offshore rather than to navigate shallow waters.

A second method of loading and unloading ships at a harbor without port structures would have been to draw up transport vessels either directly onshore or as close to shore as possible. A mosaic found in a mid third-century C.E. tomb at Hadrumetum depicts a ship docked not at a quay or jetty but in shallow water. One worker stands on the ship unloading the cargo; two others carry the goods through water that reaches just above their ankles. To the left of the ship, a separate scene shows officials weighing the cargo. Both Houston and Wilson have argued that the mosaic supports the theory that in the Roman period light seagoing craft delivered cargoes in shallow waters or directly onshore, and this method is what we would expect to find at harbors without artificial port structures.[127]

Recent discoveries in Libya and Morocco have established without doubt that natural harbors played important roles in the economy of ancient North Africa. There was considerable import and export activity at harbors without artificial port structures, as evidenced by the remains of productive activities. While there were certainly more natural than artificial harbors in North Africa, artificial port structures are probably indicative of the largest and most active North African harbors of the Roman period.[128] In the next section, I turn to quantifiable data from harbors with artificial port structures to demonstrate these points and to improve our understanding of the relationship between ports and connectivity.

SIGNIFICANCE OF ARTIFICIAL PORT STRUCTURES

How might the significance of ancient North African ports be best evaluated? It would be most helpful to employ a variety of metrics, as modern ports do, but the evidence today is of course more extensive than that which survives from antiquity. Modern ports measure the overall volume of cargoes handled, as well as their value. They keep track of the number of boats serviced and their size. Another factor they evaluate is the efficiency of harbor operations, in terms of the

[120] Preece 2011. I have found no indication of this site in ancient texts.

[121] Erbati and Trakadas 2008.

[122] Erbati and Trakadas 2008, 50.

[123] Trakadas 2005, 66–7.

[124] Ponsich and Tarradell 1965; Trakadas 2005.

[125] Erbati and Trakadas 2008, 57–73.

[126] Lallemand 1892, 44.

[127] Houston 1988, 561; Wilson 2011a, 49. The scene has also been interpreted as a commission for the tomb of a man in the shipping business (Dunbabin 1978, 126). The identification of the cargo as either lead ingots or firewood has been debated, but for the purposes of this article it is not necessary to consider this issue. Illustrations of the mosaic may be found in Dunbabin 1978, pl. 48 n. 121; Houston 1988, 561; Wilson 2011a, 49.

[128] Of course, we cannot estimate the percentage of trade that was conducted either way, as Houston (1988, 560) has observed.

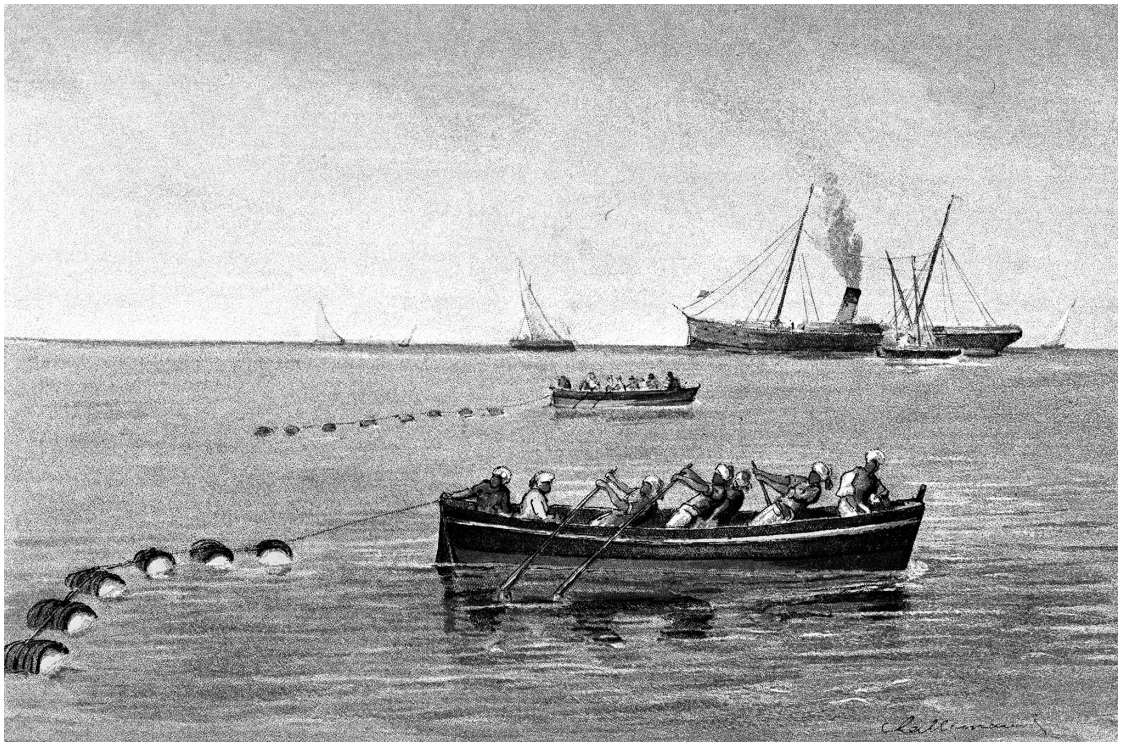

Fig. 5. Painting by Charles Lallemand (1826–1904), entitled *Transport des barriques d'huile, par chapelets flottants, à bord des transatlantiques* (Lallemand 1892, 44).

rapidity with which workers load and unload goods, inspect and inventory them, and convey them to their destination. The amount of storage available for both boats and cargo is a further consideration. Finally, the physical size of the port, measured in area as well as in wharf length, is a major point of comparison. The data that survive from the ancient world potentially relate to several of these indices: boat size, cargo volume, storage facilities, harbor area, and wharf length. However, very few records of harbor operations remain.

A brief discussion of the sort of evidence provided by boat size, cargo volume, and storage facilities will suffice to demonstrate why these measures are less useful for a comparison of harbors. Details about boat size and cargo volume are derived from shipwreck evidence and cannot normally be correlated to specific harbors. Even when they can, there is little information to be gained about the harbor itself. For instance, it has been plausibly argued that the approximately 200 amphoras on the Plemmirio B shipwreck originated at Sullecthum, but that information tells us only that this port was capable of loading a ship whose length has been estimated at 12–18 m and whose cargo weighed perhaps 13 tons.[129] The remains of the 260 m long jetty at Sullecthum (see fig. 3f), however, leave little doubt that bigger ships and larger cargoes could have been handled there. In the case of storage facilities, there are at least six harbors with these features: Apollonia, Carthage, Lepcis Magna, Meninx, Phycus, and Thabraca (see tables 1, 2).[130] The size of this sample is so small, and archaeological excavations of storage facilities have been so limited, that beyond knowledge of their existence we have very little information. Furthermore, the lack of investigations at most harbors means that we cannot rule out the presence of other storage facilities.[131]

[129] Gibbins 2001.

[130] Storage facilities are also present at Horrea Caelia and Rusicade/Stora, two harbors with possible artificial port structures.

[131] Future work on this topic is a desideratum, and the project "Entrepôts et lieux de stockage du monde gréco-romain antique" has begun to make headway (Virlouvet 2007). Synesius (*Ep.* 134) referred to the problem of crop damage resulting from the necessity of storing goods on the wharf during wartime, and harbors clearly had additional reasons to possess permanent storage depots.

Statistical Comparison

For comparing ports, the size of artificial port structures provides the most useful and reliable information available. There are two aspects to size that could potentially be useful: harbor area and wharf length. In many cases both can be determined, at least broadly, from measured drawings produced without excavation, and it is sometimes possible to estimate the size simply from satellite photography.[132] Schörle recently used "total area" to study an approximately 350 km long section of coastline in central Italy, between Puteoli and Porto Santo Stefano. This region contained nine definite harbors with artificial port structures and further possible ones whose physical traces have not survived. Thus, the density of ports in this area was almost certainly higher than in North Africa. Schörle's figures demonstrate that Italian harbors were in many cases larger than the African ones, with the largest, at Portus (enclosure: 234 ha; wharf lgth.: 13,890 m), measuring several times the size of those found at Carthage or Lepcis Magna. The eight other sufficiently documented ports included Puteoli (67.9 ha), Antium (25–30 ha), Centumcellae (enclosure: 14 ha; wharf lgth.: less than 2,000 m), Terracina (11 ha), Torre Astura (7.8 ha), Cosa (2.5 ha), Igilium (2 ha), La Mattonara (1.2 ha), and Pandateria (0.7 ha).[133] Most of these Italian ports were of the enclosure type, whose area is suitable for measuring.

In terms of size, the total wharf length at ports, rather than the total harbor area, is the yardstick that must be applied in North Africa, for two reasons. First, North African ports had many different types of artificial port structures: enclosures, quays, jetties, and jetties with platforms. Wharf length is a measure of the total length of all structures along which boats could dock and therefore is suitable for an assessment of all ports, while "area" is only suitable for a comparison of enclosures. At Iol Caesarea, for example, the total wharf length consisted of two quays (60 m and 70 m) and two jetties (120 m and 310 m).[134] Since boats might dock on either side of a jetty, the length of each jetty is doubled to produce a figure for the total wharf length at this harbor: 60 + 70 + 240 + 620 = 990 m. Second, wharf length provides a measure of the maximum total length of the vessels that can be serviced at any given time, while area is an evaluation, primarily, of the amount of shelter that can be provided to ships. Both features of a port could be important, but only wharf length offers a means of comparing the capacity of a port for loading and unloading cargo. Furthermore, the analytical value of wharf length as a metric is not affected by one's position on the issue of side-on to stern-on mooring.[135]

North African ports can be divided into several categories according to wharf length (fig. 6). The largest, Carthage, is in a class by itself. Then there are "large ports" with approximately 1,000–1,500 m of wharf length at other major cities, including Lepcis Magna, Hadrumetum, and Iol Caesarea.[136] Thapsus, which had three jetties with a total wharf length of 2,700 m, fits awkwardly in this category[137] since it was a less important city.[138] Another group of harbors, which we might call "midsized ports," clusters around 500 m of wharf length. This group includes Leptiminus, Ras Segala, Oea, Apollonia, Acholla, Sullecthum, Cercina, and Tipasa. Next there are "small ports," ranging in size from 100 to 300 m of wharf length. Among these are Misua, Ptolemais, Phycus, Mahdia, Gigthis, Thabraca, Taucheira, Sabratha, Ruspina, and Lixus. The "villa ports" at Ras el Meskouta and Thalefsa, with wharf lengths of 300 and 50 m, respectively, are small but belong in a category of their own. At the lower end, there are several ports whose full size has not been discovered; these include Hippo Regius, Homs, and Meninx. To which category they belong is difficult to determine based on current evidence.

The wharf length in each province underscores several aspects of regional economic significance (fig. 7).

[132] Table 1 indicates where I have employed satellite photography to estimate length.

[133] Schörle 2011, 96; Wilson et al. 2012, 381. Schörle has calculated harbor area in all cases, but not wharf length. Her calculations were based on previous publications or on measurements made with the Takeoff Live software program.

[134] There is also a breakwater (50 m), but since boats did not dock here, its length is not included in the calculation of wharf length.

[135] On this issue, see Blackman 1988.

[136] The full wharf length at Hadrumetum is unknown because of its poor preservation (Foucher 1964, 80–4). I use the low estimate (1,050 m) in my calculations.

[137] Since much of the largest jetty at Thapsus now lies well below the modern water level, Davidson and Yorke (2013) have suggested that it may never have been completed. If they are correct, a substantial downward revision of this port's size would be required. I do not find the evidence currently available sufficient to connect construction of the port at Thapsus with the short-lived third-century African emperors, the Gordians, as Davidson and Yorke do. The explanation for the 960 m long jetty may lie with an aim to create a deepwater port in a part of North Africa where the coast is otherwise shallow (Stone [forthcoming]). Alternatively, the structure may not have been a jetty, as three previous interpretations have suggested (Younes 1999; Slim et al. 2004; Davidson and Yorke 2013), but a breakwater at or below the water surface. The issue deserves further study.

[138] Wilson (2011b, 184) estimated the size of these cities: Lepcis Magna (452 ha), Iol Caesarea (318 ha), Hadrumetum (155 ha), and Thapsus (39 ha).

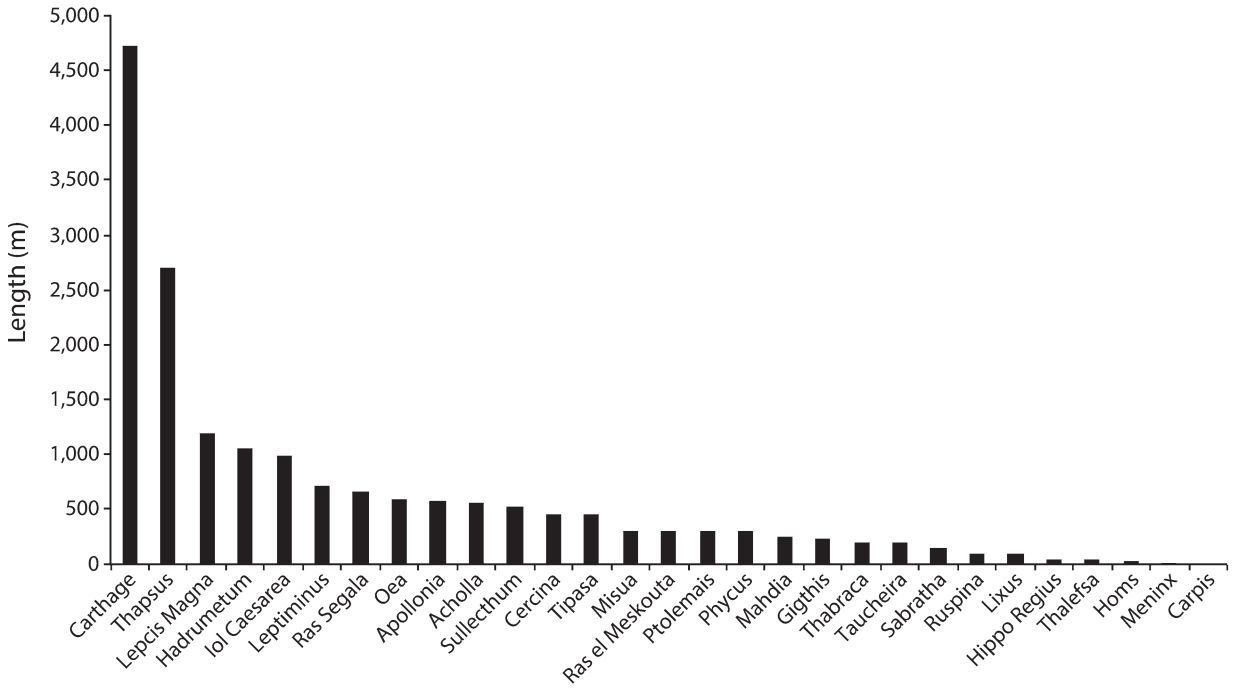

Fig. 6. Wharf length at harbors in North Africa.

First, as we have seen, most harbors with artificial port structures, especially the largest ones, were located in Africa Proconsularis. This province emerges as almost beyond comparison with the others in the provision of harbor facilities. It has 81% of the total wharf length within North Africa but 48% of the total coastline. Mauretania Caesariensis (10% wharf length, 22% coastline) and Cyrenaica (8% wharf length, 16% coastline) are roughly equal in the provision of port structures, while Mauretania Tingitana (1% wharf length, 14% coastline) cannot be said to be on an equal footing.

Within North Africa there are several distinct regional clusters of harbors with artificial port structures: Byzacena, the Gulf of Tunis, Tripolitania, Iol Caesarea-Tipasa, Cyrenaica, and Jerba–Bou Grara (see fig. 1). An additional regional cluster, with two definite harbors with artificial port structures and four possible ones, may have been located between Iomnium and Thabraca.[139] An analysis by cluster offers a different picture than one by port or province (table 3).[140] It shows that a concentration of ports could provide facilities similar to those of one or two large harbors in a region. For instance, the cluster of seven harbors in a 100 km long area of Byzacena accounted for slightly

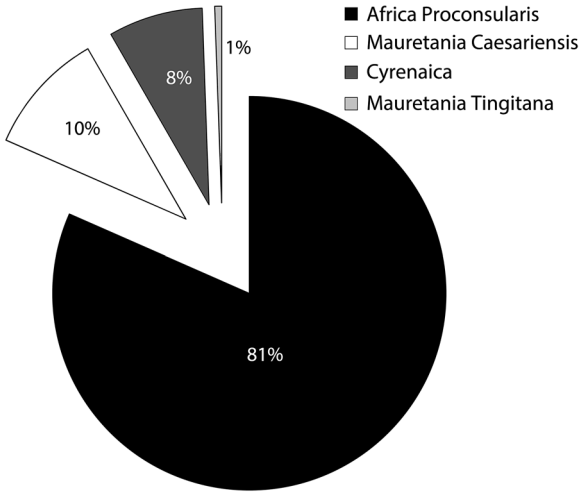

Fig. 7. Percentage of total wharf length in North Africa, by province.

[139] Nos. 6 and 7 and letters A–D on fig. 1. These are located in the areas that would later become Mauretania Sitifensis, Numidia, and northwestern Africa Proconsularis. Our knowledge of all of these ports is insufficient to reconstruct their size.

[140] Harbors with possible artificial port structures were not included in table 3 and the following analysis, as we do not know the lengths of their wharves. If we had more information about them, it might add to this picture.

Table 3. Regional Clusters of Harbors, Including Number of Harbors with Definite Artificial Port Structures, Wharf Length, and Coastline Length.

Region	No. of Harbors	Wharf Length (m)	Coastline Length (km)
Byzacena	7	5,900	100
Gulf of Tunis	3	5,030	80
Tripolitania	4	1,984	175
Iol Caesarea-Tipasa	4	1,800	30
Cyrenaica	4	1,380	140
Jerba–Bou Grara	3	910	40

more wharf length than the 80 km Gulf of Tunis region with its one very large port.[141] While Carthage served the needs of a wide region of northern Africa Proconsularis (Zeugitana), there were many outlets for the agricultural and maritime surpluses of central Africa Proconsularis (Byzacena).[142] This evidence stands in direct contrast to Rougé's view that the size of the major port at Carthage rendered harbors in Byzacena and Jerba–Bou Grara "unnecessary."[143] Although Carthage controlled an extremely large hinterland, by virtue of its geographical position and historical importance, different circumstances affected the development of other cities.[144] The pattern visible in Byzacena fits the other regional clusters. The other regional clusters had large ports (Apollonia, Iol Caesarea, Lepcis Magna), but none dominated its region quite like Carthage did. Nonetheless, as the total wharf length in each of the regional clusters indicates, all these regions were heavily engaged in maritime commerce and connectivity (fig. 8).

The identification of regional clusters implies that construction of neighboring ports may have been linked in several ways. One is contemporaneity of port construction. Another is the presence of technical expertise needed to build artificial port structures with wooden formworks and hydraulic concrete. A third is how competition among cities, or among elites within cities, may have encouraged construction of ports or competition for the accumulation of profits from maritime trade. A fourth is how the agricultural and maritime resources of a region may have developed at the same time, with a system arising to channel the surpluses produced by towns and estates within a region through ports to wider markets.

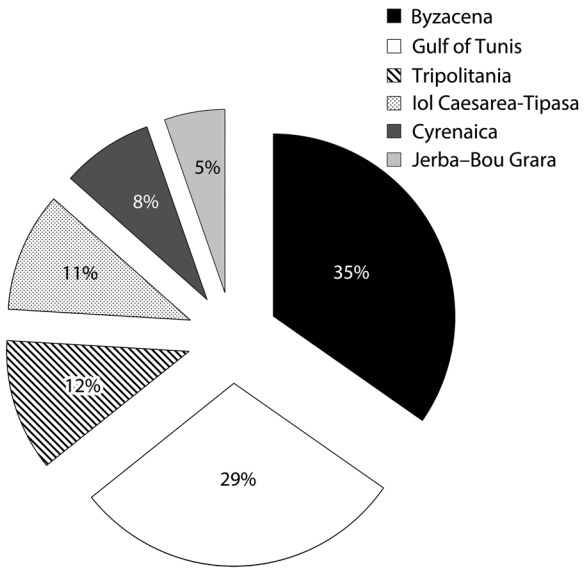

Fig. 8. Percentage of total wharf length in North Africa, by region.

Dates of Construction

Current evidence places the earliest construction of artificial port structures within North Africa at Apollonia. A unit of 10 slipways, which Laronde dates to the fourth century B.C.E., was built on an island on the outer edge of the harbor there. At 6 x 36 m each, the slipways appear to have been designed to house

[141] Length of coastline was calculated as the distance from the first to the last port.

[142] On this point, see the discussion of routes from the Tunisian steppe to the ports of the Sahel (Stone et al. 2011, 249).

[143] Rougé 1966, 134.

[144] On the size of Carthaginian territory, see Charles-Picard 1966.

the triremes of Cyrene so as to prevent damage to the hulls of these warships when they were not at sea. Additional evidence suggests that the warehouses and docks on the western edge of the port date to the Hellenistic period.[145] Another early datable example was found at Carthage, where a British team discovered that the Circular Harbor was initially dug out of a low-lying area in the first half of the second century B.C.E.[146] Some later renovations at Carthage have been dated to the reign of Tiberius, others to the reign of Commodus.[147] Italian excavations of the mid 20th century have dated the harbor at Lepcis Magna. An early phase of docks was considered to have been installed under Nero (54–68 C.E.), but most of the harbor was part of the extensive rebuilding of the city carried out under Septimius Severus (193–211 C.E.).[148] Later structures situated at the mouth of the harbor cannot be precisely dated but may broadly be placed between the fourth and the mid sixth centuries.[149]

Few harbor works in other cities can be closely dated, in part because of lack of excavation. It has been suggested, for example, that the harbor and lighthouse at Iol Caesarea were constructed during the reign of Juba II (25 B.C.E.–23 C.E.), when much of the city was built.[150] Constans dated the jetty at Gigthis to the first half of the second century C.E.[151] It would not be unreasonable to suggest that artificial port structures were in place at Thabraca by the same period. An inscription informs us that a road for the transport of Numidian marble was created between Simitthu and Thabraca under Hadrian in 129.[152]

Evidence for the dating of North African harbors is provided by the material remains of artificial port structures, as well as the extensive evidence of exported products that can be associated with these harbors (table 4). Most of the harbors date between the first and third centuries C.E., when facilities at as many as 23 of 29 harbors (79%) were newly built. Of the five harbors (17%) with artificial port structures that were constructed earlier, three (10%) were also modified between the first and third centuries C.E. The only harbors built prior to the first century C.E. and not known to have been modified were the cothons at Mahdia and Ruspina. Material remains show that after the third century C.E. at least two artificial port structures (7%) were modified, and literary evidence indicates that other harbors may have been modified or even newly constructed as late as the mid sixth century.[153] In summary, the concentration of construction at North African ports between the first and third centuries suggests a heightened period of connectivity at this time.

Materials and Techniques of Construction

Harbors in North Africa were constructed with a variety of materials and techniques, including excavation of land along the shoreline, alignment of ashlar blocks, placement of hydraulic concrete into a wooden formwork, and a combination of these techniques. Early harbors tended to use the Punic technique of digging out a basin behind the shoreline (cothon), while later harbors employed ashlar masonry. Many harbors were constructed with ashlar blocks quarried on-site, as, for example, were those at Apollonia, Ptolemais, and Tipasa (see "Other Features" in tables 1, 2). At others, the quarrying took place in the vicinity; sandstone deposits of the Rejiche formation (125 ka BP) were close to many harbors on the east coast of Africa Proconsularis and supplied ashlar blocks used in their construction.[154]

The use of underwater (or "hydraulic") concrete in North Africa probably began in the first century C.E.[155] This concrete consisted of three ingredients: lime and aggregate, which could be sourced locally, and a binding agent, such as pozzolana, which fastened

[145] Laronde 1996, 11–13; Sintès 2010.

[146] Hurst 1994, 17–18. Some scholars have put forth arguments for earlier harbors, though these have not been confirmed (Fantar 1984; Lancel 1992, 192–211).

[147] Tiberius: Bullo 2002, 240. Commodus: Hurst 2010, 55.

[148] Bartoccini 1958.

[149] Laronde 1988, 344–48; Beltrame 2012, 320–25.

[150] Lassus 1959; Roller 2003, 124.

[151] Constans (1916, 70) based his dating on the correspondence between Corinthian capitals found there and others located elsewhere on the site. Mattingly and Stone (2011, 274) suggested the harbor works at Leptiminus were completed in the second century C.E. or later.

[152] *CIL* 8 22199. As important elements of infrastructure themselves, roads merit more consideration as facilitators of connectivity to ports than it is possible to give them here. Important examples such as Capsa-Tacapae (14 C.E.), Carthage-Theveste (123 C.E.), and Cirta-Rusicade (125–126 C.E.) were broadly contemporary with artificial port structures. See Salama (1951) for evidence and discussion of North African roads, and Hitchner (2012) for their ability to facilitate connectivity.

[153] For harbor fortifications during the Byzantine reconquest of Africa, see Procop., *Vand.* 3.15.1–17, 4.26.20.

[154] Paskoff and Sanlaville 1983, 92–8, 153–57; Mahmoudi 1988; Slim et al. 2004, 256–58.

[155] The earliest well-studied example of underwater concrete was found at Cosa; it has been dated to ca. 100 B.C.E. The technique was further developed in Italy during the Late Republic. Later, it spread throughout the Mediterranean; an early example outside Italy is the harbor at Caesarea Maritima built by Herod, king of Judea, ca. 20 B.C.E. On the spread of Roman maritime concrete technology, see Oleson 1988; Oleson et al. 2004, 2011.

Table 4. Construction Dates for North African Harbors with Artificial Port Structures, by Century.[a]

Harbor	4th B.C.E.	3rd–2nd B.C.E.	1st B.C.E.	1st C.E.	2nd C.E.	3rd C.E.	1st–3rd C.E.	4th–7th C.E.
Apollonia	x	x	–	–	–	–	x	–
Carthage	–	x	–	–	–	–	x	x
Hadrumetum	–	x	–	–	–	–	*	–
Mahdia	–	x	–	–	–	–	–	–
Ruspina	–	*	–	–	–	–	–	–
Lepcis Magna	–	–	–	x	–	x	–	x
Gigthis	–	–	–	–	x	–	–	–
Acholla	–	–	–	–	–	–	*	–
Carpis	–	–	–	–	–	–	*	–
Cercina	–	–	–	–	–	–	*	–
Hippo Regius	–	–	–	–	–	–	*	–
Homs	–	–	–	–	–	–	*	–
Iol Caesarea	–	–	–	–	–	–	*	–
Leptiminus	–	–	–	–	–	–	*	–
Lixus	–	–	–	–	–	–	*	–
Meninx	–	–	–	–	–	–	*	–
Misua	–	–	–	–	–	–	*	–
Oea	–	–	–	–	–	–	*	–
Ras el Meskouta	–	–	–	–	–	–	*	–
Ras Segala	–	–	–	–	–	–	*	–
Sabratha	–	–	–	–	–	–	*	–
Sullecthum	–	–	–	–	–	–	*	–
Thabraca	–	–	–	–	–	–	*	–
Thalefsa	–	–	–	–	–	–	*	–
Thapsus	–	–	–	–	–	–	*	–
Tipasa	–	–	–	–	–	–	*	–
Phycus	–	?	–	–	–	–	?	–
Ptolemais	–	?	–	–	–	–	?	–
Taucheira	–	?	–	–	–	–	?	–

x = known date; * = probable date (indicates that the precise century of construction is not known, but a range of centuries is likely); ? = date unclear (construction suggested in two different periods)

[a] A mark in more than one column indicates multiple phases of construction.

the lime and aggregate and was capable of hardening underwater. This binding agent was probably acquired from volcanic regions in the central Mediterranean. Two other commodities would have been essential: freshwater for the mixing of concrete, and wood for the frameworks that held the concrete in place while it hardened. The availability of freshwater and wood would have varied significantly by region.[156]

[156] Although timber was felled and exported from northwest Africa Proconsularis and Mauretania Caesariensis, it is quite possible that it was a rare commodity in other regions of North Africa and needed to be imported.

It has often been said that concrete permitted engineers to build port structures on coastlines lacking natural shelter for boats, or anywhere else ports were needed. Although the use of concrete has been regarded as a technological development that was more advanced than ashlar masonry,[157] North African port structures tended to combine both techniques even after the introduction of underwater concrete. Ashlars typically formed the exterior facing walls of a jetty, while concrete and rubble made up the fill between these walls. Documented examples of this type of construction may be found at Leptiminus and Ras Segala.[158] Harbors may also have used wood without concrete for the construction of quays or jetties, but no evidence for wooden port structures have been definitively identified in North Africa.[159]

The implications of these construction methods are significant, since each required extensive time and effort. The construction of a cothon was an extraordinarily labor-intensive process requiring the excavation and removal of sediments by hand. Even at a small port such as Mahdia (62.5 x 125 m), it necessitated excavation of 15,625 m^3 of calcareous sandstone, if we assume an average depth of 2 m of water within the structure. In the Circular Harbor at Carthage, the total volume of sediment excavated, again assuming an average depth of 2 m, was 115,000 m^3, and the figure for the Circular and Rectangular Harbors combined was 235,000 m^3.[160] At Mahdia, because the material was sandstone, and at Carthage, because of the total volume, the amount of work involved in these construction feats was phenomenal.

Port structures that used ashlar masonry also required substantial quantities of raw materials and hours of labor. To obtain ashlars, thousands of blocks had to be quarried, cut to size, transported, and installed in place. Ashlar blocks in the 370 m long jetty and 80 x 100 m platform at Leptiminus were approximately 1.00 x 0.50 x 0.50 m. The total length of all walls in the jetty added together was at least 1,500 m. If we estimate that, on average, three courses of ashlar blocks would have been stacked in each wall, the quantity of sandstone quarried locally for the jetty was an impressive 1,125 m^3.[161]

Construction with concrete also required the acquisition of numerous raw materials and much labor. Let us consider these in turn. At Santa Liberata in Italy, Oleson et al. have detailed the following steps in the process of constructing an artificial jetty: preparation of lime (quarrying of limestone, burning in a kiln, slaking, and aging); procurement of lumber (felling trees, shipping timber to site, cutting to size); procurement of pozzolana; site preparation (leveling of sea floor); construction of wooden formwork; preparation of mortar; placement of mortar and aggregate; spreading and leveling of mortar; and removal of lumber.[162] The principal raw materials needed in this process were ashlars, pozzolana, lime, aggregate, and lumber, and the process as a whole is in agreement with DeLaine's discussion of concrete construction at the Baths of Caracalla.[163] A factor that may have simplified construction of a port was the ability to supply the raw materials by sea.[164] Oleson and Branton have shown that pozzolana was brought from Italy for the construction of the port of Caesarea Maritima in Israel.[165] At Santa Liberata, Oleson et al. calculated that 305 m^3 of pozzolana, 162 m^3 of aggregate, and 152 m^3 of slaked lime were required to build the jetty, whose volume was measured as 420 m^3.[166] The average length of a North African jetty was 241 m.[167] If we assume a depth and width of 1 and 10 m, respectively, a jetty of this size would have consisted of 2,410 m^3 of fill.[168] Extrapolating from the calculations made for the structure at Santa Liberata, 930 m^3 of aggregate, 1,750 m^3 of pozzolana, and 872 m^3

[157] Blackman 1982b, 193; Oleson 1988.

[158] Davidson 1992; Slim et al. 2004, 27, 104.

[159] See Lloyd (1977, 19) for timber structures on the foreshore at Berenice (Benghazi); the relationship of these structures to a port is not clear.

[160] Mahdia: Carayon 2005, 8. Carthage: Hurst and Stager 1978, 341.

[161] Volume: 1.5 x 1,500 x 0.5 m = 1,125 m^3 of sandstone. My estimate for the length, width, and height of walls is conservative, and the total quantity of material may have been considerably higher. The estimate of wall height is not clear in previously published reports on Leptiminus, but Davidson (1992, 167) provided some evidence on Walls F and G. He also mentioned that in some places on Wall A the walls were two blocks wide (Davidson 1992, 167).

[162] Oleson et al. 2004, esp. 218–19. The authors refer to the Santa Liberata structure as a "pier," but "jetty" is consistent with the terminology I have used.

[163] DeLaine 1997.

[164] In studies of antiquity, transport by sea is generally regarded to have been less expensive than transport overland. Estimates for the costs of transport are based on Diocletian's Edict on Maximum Prices (Duncan-Jones 1982, 366–69; Morley 1996, 63–8).

[165] Oleson and Branton 1992, 58–60.

[166] Oleson et al. 2004, 218–19.

[167] I arrive at this figure by averaging the total lengths of jetties in 21 harbors (data drawn from tables 1, 2). Since Carthage, Lepcis Magna, and Iol Caesarea were probably built with imperial financing, the resources available to them may not have been comparable, so I have excluded them.

[168] Depths of North African jetties have rarely been measured, but 1 m is relatively shallow and therefore a conservative estimate. Jetties with widths of ca. 10 m have been recorded at Leptiminus, Misua, Ras Segala, Sullecthum, and Thapsus (see table 1).

of slaked lime would have been necessary to build the average North African jetty. To assemble these raw materials through production, purchase, and/or transport would have taken a major outlay.[169] But unlike baths or temples, ports may not have required marble, sculpture, or other decoration, all of which were expensive.[170]

We may now consider the costs of labor. Oleson et al. estimated that the 420 m^3 structure at Santa Liberata required 774 person-days of unskilled labor and 72 person-days of skilled labor.[171] Much of the time would have been spent filling and carrying baskets of material, mixing the mortar, and laying it in place. For the sake of comparison, if we apply the figures that Oleson et al. have suggested for Santa Liberata, the average African port of 10 x 241 m would have required nearly six times the effort. A larger structure such as that at Leptiminus, which consisted of a jetty measuring 10 x 370 m and a platform measuring 80 x 100 m, both of which appear to have been solid concrete with ashlar facing, would have been even more time-consuming to build. If we make the conservative assumption that the Leptiminus jetty and platform were each 1 m high on average, then these structures would have required nearly 30 times the effort.

Although Oleson et al. refrained from assessing the total costs of the Santa Liberata harbor, the raw materials and labor needs suggest that construction was costly. The labor needed for a larger project on the scale of most African ports would have been very expensive indeed.[172] While construction methods for artificial port structures in North Africa have been little examined, there is no question that substantial raw materials and labor inputs were required at all the North African artificial port structures. These issues lead us to consider issues of financing port construction.

Financing of Construction

Who was responsible for the construction of ports? To judge from comparative evidence elsewhere in the Mediterranean, those responsible could include the emperor (or similar dynastic ruler), wealthy elites, or cities. In North Africa, construction of a small number of ports may be attributed to the emperor. Connections between Septimius Severus and his hometown of Lepcis Magna are perhaps easiest to draw, because in the middle of his reign much of the city was expanded, including the harbor facilities. Three temples to deities closely associated with the emperor were built at the harbor. A dedicatory inscription to Jupiter Optimus Maximus Dolichenus on the altar at one of them indicated that it celebrated the victory and triumphal return of the emperor and his sons after the Parthian Wars. Nearby, a monumental three-story lighthouse was erected. This lighthouse may have been represented in relief on a frieze of the massive Arch of Septimius Severus at the intersection of the city's cardo and decumanus. Its appearance on the arch, in the background of a scene depicting the emperor and his sons during a triumphal procession, may arguably be construed as a statement about the importance of the harbor to the city, the triumph, and the emperor. There is therefore considerable evidence supporting the interpretation of the harbor as a monument integral to the Severan ideological program.[173]

Connections to emperors are evident at other cities as well. Commodus appears to have promoted Carthage as a harbor associated with the imperial grain fleet, the *Classis Africana Commodiana Herculea*. Additions to this harbor may have taken place during his reign.[174] At Iol Caesarea, port structures connected two offshore islands to the city. A sanctuary on one of the islands has been dated to the reign of the client king Juba II (25 B.C.E.–23 C.E.), who was a close associate of Augustus. Juba II may therefore have undertaken construction of the harbor with the knowledge, if not the support, of Augustus.[175] All the harbors associated with emperors contained religious buildings (temples or sanctuaries) and lighthouses. So, too, did the harbor at Apollonia. Although no evidence of imperial participation at Apollonia exists, it appears more likely here than elsewhere. Despite these examples, the involvement of the emperor in harbor construction was probably rare. The absence from most North

[169] Note also that my calculations exclude material used for platforms, quays, and breakwaters at North African harbors. I also do not include costs of lumber, on the grounds that at North African ports it may in part have been replaced by ashlars.

[170] On the costs of decorative materials, see DeLaine 1997, 217–18.

[171] Oleson et al. 2004, 219.

[172] Here I follow Duncan-Jones' (1962, 54) suggestion that prices in Africa should not have varied significantly from those in Italy in the Imperial period.

[173] Tuck (2008, 335–39) has argued that the temple to Jupiter was associated with Septimius Severus and that the other two temples were dedicated to Hercules and Dionysos—the first of which was associated with Caracalla, the second with Geta. He has also suggested that the lighthouse indicated the beginning of a triumphal procession at the harbor and that it occupied the position of a *porta triumphalis* found on earlier Roman monuments. For the dedicatory inscription, see Reynolds and Ward-Perkins 1952, no. 292.

[174] Hurst 2010, 55.

[175] Lassus (1959, 220) and Roller (2003, 124), among others, have suggested that the harbor was constructed during the reign of Juba II.

African harbors of temples, statues, or other ideological displays associated with the imperial family points to this conclusion.

Given the large amounts of raw material and labor required, how might harbors have been financed without imperial support? We may draw inferences about harbors from information about the costs and sponsors of buildings, statues, tombs, foundations, games, and other outlays preserved in dedicatory inscriptions from North Africa. Duncan-Jones, who has examined these inscriptions in a series of papers, found that construction projects in African cities were sponsored both by wealthy individuals and by cities themselves.[176] None of the more than 400 outlays whose costs survived, however, was for port structures. Two cities with plentiful evidence for other monuments show the range of variation, although neither was a port. At Thugga, more than 30 monuments between the reigns of Tiberius and Caracalla are known to have been commissioned by private individuals, while only two are known to have been built by the city during this time. At Thamugadi, inscriptions indicate that the city was responsible for 17 monuments from the Trajanic to Severan periods, and private individuals for only two. The evidence from a wide range of African cities has suggested that neither public nor private financing was more common but that there were important changes in civic munificence over time. Between the reigns of Trajan and Caracalla, public financing increased from 24 to 52%, and private financing decreased from 76 to 48%.[177]

As we have seen, the cost of a port structure would have been high, but it may not have been beyond the means of the wealthiest individuals. Donations of 200,000 sestertii or more by private individuals are recorded at Calama, Caput Amsaga, Lepcis Magna, Madauros, Oea, Sabratha, Sicca Veneria, Thagaste, and Theveste.[178] Even such large amounts may not have been sufficient for an artificial port structure, but we should be careful not to base our conclusions about cost on the limited evidence from a small number of surviving inscriptions. The extensive evidence for Africans of senatorial rank in the second and third centuries is well known, and many would have been far richer than Aemilia Pudentilla, whose estimated fortune of 4 million sestertii in 157 C.E. is the largest preserved.[179] There is good evidence that many of these families, including that of Septimius Severus, profited from trade in olive oil, wine, garum, and other products carried in amphoras.[180] It makes sense, therefore, to imagine that wealthy individuals may have been interested in erecting artificial port structures not only to gain prestige through euergetism but also to improve their own export opportunities. The very small number of known villa ports in North Africa (two definite, one possible), especially in comparison with the number known in Italy, may indicate that private individuals in North Africa were less likely to finance port structures themselves.

During the main period of port construction in North Africa, public financing of buildings was very common. Three main sources of revenue for port cities during this period can be identified: rents, contributions from members of the upper classes (*summae honorariae*), and local taxes. We have little means of estimating the amount that individual cities received in rents on public land, but it seems reasonable to assume that when opportunities for exporting surplus production existed, cities that owned large properties would have been able to rent land at a profit. We are slightly better informed about *summae honorariae*. There is limited but convincing evidence that these contributions were higher in ports than in inland cities. Sums survive at 27 municipalities: the average based on the five inscriptions from the three known cities with artificial port structures is 19,600 sestertii, while the average of 33 inscriptions at others is 7,073 sestertii.[181] Large port cities may therefore have gained considerable revenue from *summae honorariae*, although they would have had numerous expenses beyond port construction. The final source of revenue was local taxes, the largest of which appears to have been customs duties (*portoria*).[182] Studies of *portoria* have demonstrated that these were generally assessed at between 2 and 5% of the total cost of the goods subject to the toll, and, as has been argued concerning tax-laws at Palmyra,

[176] Duncan-Jones 1962; 1963; 1982, 63–119; 1990, 174–84. For the list of the costs, see Duncan-Jones 1982, 90–119. The only nonepigraphic source is Apul., *Apol.*

[177] Duncan-Jones 1990, 178–84.

[178] Calama: *CIL* 8 5365; Gsell 1922, 1:no. 250. Caput Amsaga: Carcopino 1914, 562. Lepcis Magna: Reynolds and Ward-Perkins 1952, nos. 300, 534, 707. Madauros: Gsell 1922, 1:no. 2120–21. Oea: Reynolds and Ward-Perkins 1952, no. 230. Sabratha: Reynolds and Ward-Perkins 1952, 117. Sicca Veneria: *CIL* 8 1641. Thagaste: Gsell 1922, 1:no. 877. Thamugadi: *ILS* 9362. Theveste: *CIL* 8 1858.

[179] Pudentilla: Apul., *Apol.* 77. African senators: Saller 1982, 145–204.

[180] Mattingly 1995, 153–55.

[181] Data derived from Duncan-Jones 1982, 108–10. I have excluded Duncan-Jones' (1982) inscription no. 348 (*CIL* 8 25468) on the grounds that the figure for the *summa honoraria* is uncertain.

[182] There is also evidence for taxes on individuals providing specific services (e.g., bakers, prostitutes), but these are unlikely to have produced more revenue than taxes on the movement of goods.

Zaraï, and elsewhere, at least some of the tolls may have been retained by local authorities.[183] From this evidence it seems reasonable to conclude that African port cities would have received revenues from taxes on the transit of goods. Since African harbors tended to export low-value goods, *portoria* would have accumulated substantial sums only on large volumes of exports—which the production and distribution of African amphoras imply. Attention has been paid to documenting imported goods only at a small number of ports, but we should not overlook these. Excavations at Euesperides have found that as early as the fourth and third centuries B.C.E. more than a third of the coarse wares at the site came from overseas sources (predominantly Corinth, Aegina, Carthage, and allied cities). Sabratha, too, has a large amount of imported pottery from the fourth to first centuries B.C.E., and Quinn has recently identified a higher volume of trade across the Syrtes than was previously thought to have taken place.[184] At Leptiminus, Roman-period imports consisted of metal ores, marble (statuary, columns, and *opus sectile*), millstones, wine, glass, fine pottery, cookwares, pumice, and brick.[185] Similar finds have been recorded on Jerba.[186] One may recognize many of these as prestige goods intended to create social distinctions, though the extent of exchange of utilitarian items such as cookwares indicates different patterns. In summary, the evidence from a few quantified studies suggests that port cities may have received revenues from a large volume of both import and export trade.

Surplus Production and Exports

The production of surpluses for export is the best explanation for investment in artificial port structures and subsequent economic growth. Detailed arguments for both exports and economic growth in the African provinces have to date focused on evidence for expanded cultivation of land, novel land-tenure and labor arrangements, increased trade and manufacturing, and innovations in grain, olive, and wine processing.[187] The construction of artificial port facilities must have formed one part of this overall picture.

At almost all the 29 harbors with artificial port structures, the export of fish, olive oil, and wine is attested (table 5). The evidence for wine and oil derives partly from physical remains of wine and olive presses either at the ports themselves or nearby. However, the liquids were more commonly produced in the interior regions, where the remains of press equipment are more abundant, and then transported in skins to the coast.[188] The evidence for fish, including tanks, fishponds, and shell deposits, is closely associated with harbors and the seashore. All these products were bottled in amphoras before export, since durable containers were necessary for shipment by sea.[189] The production of amphoras recognized as carriers of fish, oil, and wine has been located in the vicinity of many of the harbors with artificial port structures in Tunisia (fig. 9).[190] With the sole exception of the kilns at Oued el-Akarit, which lay 66 km from the nearest harbor with possible port structures (i.e., Macomades-Iunca), all the coastal amphora-production sites were located near a harbor with artificial port structures.[191]

Additional products for export, including grain, African Red Slip Wares, and African Cooking Wares at Carthage, timber and marble at Thabraca, silphium at Apollonia, and wool at Meninx, have been identified at many harbors (see table 5). Of these products, African Red Slip Wares, African Cooking Wares, and marble (the giallo antico of Simitthu) are well represented in archaeological deposits in Italy and elsewhere in the Mediterranean. Organic products, such as grain, timber, silphium, and wool, are more difficult to identify because of poor preservation. The prominence of Africa in the literary sources as a supplier of grain to Rome is no accident; grain must have been exported from several ports, particularly those between Iol Caesarea and Carthage.[192] Material traces of large-scale

[183] Palmyra: *CIS* 2(3) 3913; *IGRR* 3 1056; Matthews 1984. Zaraï: *CIL* 8 4508; Trousset 2002–2003. For other publications concerning *portoria*, see de Laet 1949; Cottier 2008.

[184] Evidence from Euesperides and Sabratha is analyzed in Quinn 2011. Wilson et al. (2012, 367–74) have provided the most recent discussion of trade across the Syrtes.

[185] Stone et al. 2011, 256–61.

[186] Fentress et al. 2009, 189–200.

[187] Cf. supra n. 7.

[188] For a summary of olive and wine production, see Brun 2004. On the use of skins, see Marlière and Torres Costa 2007.

[189] Peña (1998) has documented the process of measuring oil and filling amphoras as it is recorded on ostraca from the harbor at Carthage.

[190] See Bonifay (2004, 8–44) for amphora production in North Africa. Our knowledge of which amphora types carried which products derives from nine main sources of evidence about amphoras: products found within, painted labels (*dipinti*), distribution, location of kiln sites, methods of opening, methods of closing, suitability of shapes for contents, pitch linings, and archaeometric analysis of residues (Bonifay 2007a, 10–19).

[191] Amphoras were sometimes loaded on boats in natural harbors, of course, but it would not be surprising if future work detected port structures at Oued el-Akarit or in the vicinity, including at Tacapae (13 km away), which must at least have been an important natural harbor (Mattingly 1995, 127–28).

[192] Cic., *De imp. Cn. Pomp.* 34; Joseph, *BJ* 2.16.4.

Table 5. Evidence of Export Production at Harbors with Artificial Port Structures.

Harbor	Fish	Oil	Wine	Amph.	Officials	Other
Africa Proconsularis						
Acholla	x	x	x	x	–	–
Carpis	x	–	x	x	–	–
Carthage	x	x	x	x	x	grain, ARS, ACW
Cercina	x	–	–	–	–	–
Gigthis	x	x	?	–	–	–
Hadrumetum	x	x	?	x	x	–
Hippo Regius	x	x	x	–	x	marble, grain, timber, slaves
Homs	x	x	–	–	–	–
Lepcis Magna	x	x	–	x	x	slaves?
Leptiminus	x	x	x	x	x	ACW
Mahdia	x	x	–	x	–	–
Meninx	x	x	x	x	x	wool, slaves
Misua	x	–	–	–	–	–
Ruspina	x	x	–	–	–	–
Oea	x	x	–	x	–	ACW?
Ras Segala	x	x	x	x	–	–
Sabratha	x	x	–	x	–	–
Sullecthum	x	x	x	x	–	ACW
Thabraca	x	x	x	–	–	marble, timber
Thapsus	x	x	–	x	–	–
Mauretania Caesariensis						
Iol Caesarea	x	x	x	x	x	wild animals?
Ras el Meskouta	x	x	x	x	–	–
Thalefsa	–	x	–	x	–	–
Tipasa	x	x	x	x	–	–
Cyrenaica						
Apollonia	x	–	–	–	–	silphium, grain
Phycus	x	–	–	–	–	–
Ptolemais	x	–	–	–	–	–
Taucheira	–	–	–	–	–	–
Mauretania Tingitana						
Lixus	x	–	–	–	–	–

ACW = African Cooking Ware; Amph. = amphora; ARS = African Red Slip Ware

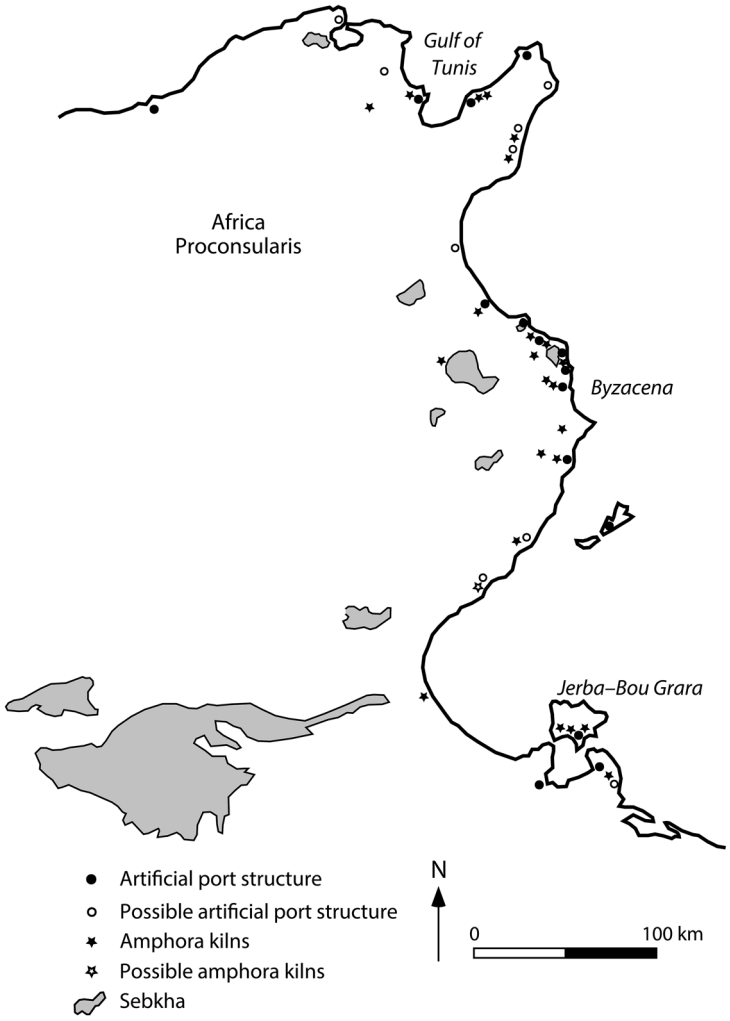

Fig. 9. Artificial port structures, amphora-production sites, and sebkhas in Tunisia (provinces are in roman; regional clusters of harbors are in italics).

grain production are rare, however. *Horrea* are known from inscriptions and material remains in North Africa, but those at ports are not definitively associated with the storage of grain.[193] In terms of shipwrecks, only three can be associated with cargoes of grain from North Africa, in comparison with more than 60 with cargoes of amphoras.[194]

Commodities such as slaves and wild animals are also difficult to detect in the archaeological record. They would have been among the most valuable items exported from North Africa, and therefore exchange even on a small scale may have been significant. There is substantial evidence for the provision of African slaves to Italy but only scarce evidence for the particular ports within Africa through which they traveled.[195] A structure known as the "chalcidicum" at Lepcis Magna has been interpreted as a marketplace for slaves. An ostracon found at Meninx mentioned a *mango* (slave

[193] E.g., an inscription (Gsell 1922, 2:no. 1) attests the construction of a *horreum* possibly but not certainly used for grain storage at Stora, the port of Rusicade, in 364–367 C.E. (Papi and Martorella 2007a, 183). The *horrea* at Meninx and Horrea Caelia were probably warehouses for amphoras (Bonifay and Trousset 2000; Drine 2007).

[194] The three wrecks are Saint Gervais 2, Les Laurons B, and Skerki Bank (Isis). Bonifay (2007b, 258) attributes the disparity to the greater visibility of wrecks carrying amphoras, which tend to form mounds on the seafloor.

[195] Fentress 2011; Schörle 2012. African slaves were also transported through Egypt.

trader). Augustine wrote of 120 slaves rescued at Hippo Regius before they could be transported by ship.[196] Wild animals exhibited in gladiatorial spectacles came from many regions of the Roman empire, but North Africa appears to have been one of the main sources. Various ancient texts refer to hunts in parts of Mauretania Tingitana, Mauretania Caesariensis, and Africa Proconsularis.[197] As with slaves, it is difficult to connect this evidence to particular ports; a mosaic depicting an elephant in the *statio* of Sabratha in the Piazza delle Corporazioni at Ostia may be as close as we can come. Other mosaics indicate that large animals would have boarded ships by walking across a gangplank.[198] The hard surface of a jetty would have been more suitable for this purpose than would a soft beach.

The Roman state enforced the collection of taxes and tribute in an organized and timely manner by placing officials (*procuratores*) in key provincial locations. It is reasonable to hypothesize that such officials were located in harbors where the largest and most valuable items were traded. The cities of Carthage, Hadrumetum, Hippo Regius, and Leptiminus are all known to have been the bases of *procuratores*. In addition, *procuratores* with responsibility for more than one city may have been headquartered at Iol Caesarea, Carthage, Lepcis Magna, and Meninx (see table 5).[199]

There are many connections between export production and each of the 16 harbors with possible artificial port structures (table 6). At some of these harbors, such as Neapolis and Thaenae, it is easy to imagine the loading of export cargoes from artificial port structures. At other locations on the list of possible structures, such as Clipea, Haniya, and Iomnium, less evidence of export is currently available, although this may be because of a lack of fieldwork.

The volume of export production by province is suggested by the number of harbors with artificial port structures where fish, olive oil, and wine exports are all known: eight in Africa Proconsularis, three in Mauretania Caesariensis, and none in either Cyrenaica or Mauretania Tingitana (see table 5).[200] The main export of Mauretania Tingitana was fish products; evidence for other exports is not known.[201] In Cyrenaica, the main export may have been the juices and extracts of the silphium plant. Previous research envisioned, in an admittedly cautious manner, only a minor role for the export of other products from Cyrenaican harbors.[202] Recent work has begun to adjust this picture. Since grain in Cyrenaica was harvested early in the year, it has been recognized that it could have been marketed in the neighboring Aegean before the harvest there and may have been especially desirable after a lean year.[203] The presence of fish-processing vats on a large scale at harbors in Cyrenaica has recently been documented by a survey between el-Agla and Noat.[204] Several other commodities, including olive oil, wine, saffron, and ostriches, are mentioned as exports by Synesius (*Ep.* 134, 148), but it is difficult to gauge the scale of these enterprises. Archaeological evidence for amphoras in which liquids were exported is beginning to be recognized.[205] We may expect future research to show that harbors in Cyrenaica had a larger role in the export of fish, olive oil, and wine than is currently known. Indeed, it seems unlikely that harbors with artificial port structures in Cyrenaica were developed solely for safe anchorages and the resupply of ships, since it would have been possible to facilitate travel along the southern coast of the Mediterranean without artificial harbors.

CONCLUSION

The extent of construction of artificial port structures in North Africa has not been widely recognized in the past. Not long ago, in a survey of western Mediterranean ports, de Souza wrote that in North Africa "several have been excavated but only a few have provided evidence of harbor installations." His discussion considered only five: Iol Caesarea, Carthage, Leptiminus, Sabratha, and Lepcis Magna.[206] Even when attention has been drawn to developments in African harbors, the focus has been on a small region.[207] This article has assembled, for the first time, evidence for artificial port structures at no fewer than 29, and possibly as many as 45, settlements in North Africa from Mauretania

[196] Lepcis Magna: Braconi 2005. Meninx: Fentress et al. 2009, 338. Hippo Regius: August., *Ep.* 10*.

[197] See Gsell (1913, 100–37) for a list of sources documenting wild animals in North Africa.

[198] *CIL* 14 4549, line 14: "Stat(io) Sabratensium"; Baratte 1970; Bertrandy 1987.

[199] Evidence for these officials may be found in Pflaum's (1960–1961) catalogue of equestrian *procuratores*.

[200] Ras el Meskouta in Mauretania Caesariensis is included, but since it was a villa port, its export production may not have been on the same scale as that of an urban center.

[201] On grain production in Mauretania Tingitana, see Papi and Martorella 2007b.

[202] Lloyd 1989, 84–5; Wilson 2004, 147–52.

[203] For this suggestion, see Horden and Purcell 2000, 71; Bresson 2011.

[204] See Hesein (forthcoming) for the results of this project. I thank M. Hesein for sharing his research with me in advance of publication.

[205] Wilson et al. 2012, 367–74.

[206] de Souza 2000, 243–47 (quotation from 243).

[207] E.g., Wilson 2011a, 47–50.

Table 6. Evidence of Export Production at Harbors with Possible Artificial Port Structures.

Harbor	Fish	Oil	Wine	Amph.	Officials	Other
Africa Proconsularis						
Rusicade/Stora	–	–	–	–	–	grain, marble
Hippo Diarrhytus	x	–	–	–	–	–
Utica	x	–	–	–	x	grain
Neapolis	x	x	x	x	–	–
Clipea	x	–	–	–	–	–
Curubis	x	–	–	–	–	–
Horrea Caelia	x	–	–	–	–	–
Thaenae	x	x	x	x	–	–
Macomades	x	x	–	x	–	–
Zarzis	x	x	x	x	–	–
Villa dell'Odeon Maritima	?	x	–	–	–	–
Mauretania Caesariensis						
Saldae	–	–	x	x	–	–
Musluvium	–	–	–	–	–	–
Iomnium	–	–	–	–	–	–
Cyrenaica						
Euesperides/ Berenice	–	–	–	–	–	silphium, wool?
Haniya	x	–	–	–	–	–

Amph. = amphora

Tingitana to Cyrenaica (modern Morocco to Libya). The result has enabled a study of the importance of specific harbors within regions, and of provinces within North Africa as a whole. It has enhanced the current picture of export from the African provinces by relating data for harbors to our understanding of major production and distribution centers of agricultural and nonagricultural goods. Greater emphasis has been placed on archaeological evidence for artificial harbor structures than on ancient textual sources or on harbors that were never endowed with permanent stone or concrete facilities. The texts of ancient authors may be useful in identifying, and in rare cases, describing, ancient ports, but they tend to present snapshots at a specific time rather than diachronic accounts of development over time. Harbors without artificial facilities, it has been argued, played a less important role in maritime commerce, though they would certainly have been important in aggregate and would have been especially significant on a local scale. Thus, this article has stressed the archaeological evidence for artificial port structures as the most reliable source of information about large-scale economic patterns. Despite lacunae in our current knowledge, such as precise dates of construction, this evidence has allowed us to compare the sizes, shapes, and mooring capacities of harbors to produce the sort of synthesis available for other better-known aspects of the African economy.

For what reasons were port structures built during the first to third centuries C.E.? Artificial port structures served several purposes connected with the ease of loading and unloading vessels. Boats docked alongside a jetty or quay could more rapidly discharge and take on cargo than those drawn up on the shoreline.[208] Wading through the water would have been more cumbersome than embarking and disembarking by ramp

[208] As Blackman (1988, 11) has argued, the most efficient method was to dock boats broadside and then extend a ramp between the boat and the dock.

onto a solid surface. And, if small craft were used to service large boats moored offshore, maneuvering heavy items would have been difficult, and at the very least extra time would have been required. From the perspective of keeping boats safe, enclosures, jetties, and breakwaters provided a haven against winds and waves and enhanced the security of a larger number of vessels in a port. But the primary explanation for the building of artificial port structures must be the strong correlation between these structures and the export of agricultural and maritime surpluses (see tables 5, 6; fig. 9).

It is difficult to say who built artificial port structures, because in most instances no information has been preserved. The exploration of how port construction was financed has suggested that imperial harbor projects like that at Lepcis Magna were probably rare in North Africa. Given the immense costs involved in harbor construction, the number of wealthy urban residents who chose to build them was probably also small (the limited number of villa ports in North Africa is certainly suggestive on this point, even if other evidence is lacking). Civic financing, through a combination of rents on public land, *summae honorariae*, and *portoria*, may offer the best explanation. The important point is that artificial port structures were mainly local initiatives. Municipal elites, though outright donations, *summae honorariae*, or the tolls they paid to import and export goods, must have been largely responsible for their financing, but in corporate rather than individual fashion.

Imperial tribute systems present complex dynamics that cannot always be simplified with neat diagrams. Nonetheless, there was probably some sort of "feedback loop" between the growth of grain, wine, fish, and olive oil production and that of harbor construction in North Africa. In the aftermath of the initial Roman conquest of North Africa, as the Roman army solidified and expanded its territorial control, as practices of tax collection became more regularized, as strategies for sharing power with local elites became more entrenched, and as the population increased and more marginal land came under cultivation, agricultural production increased, creating substantial surpluses for export. Artificial port structures were likely to have come after the development of some of the export trade but were also likely to have enabled further development of production, because they would have provided better facilities for ships to dock and increased the number of ships that could be handled in a harbor. The potential for cities to collect more tax revenues through *portoria* may also have been an incentive for port construction. The concentration of artificial port structures in regional clusters suggests this sort of expansion. As the agricultural and maritime production within an area gradually increased, permanent port facilities were constructed, and other small- and large-scale investments were made. The gradual growth of amphora production in the Gulf of Tunis, Byzacena, Jerba–Bou Grara, and Tripolitania is at present our best means of approximating the progression of these developments.[209]

Shaw emphasized the major shifts in agricultural production, economic orientation, and social relations during the first millennium B.C.E. in North Africa, when connectivity between the region and the rest of the Mediterranean increased. He also noted additional chapters in this story, which he likened to "recursive patterns that characterized the history of the pre-modern Maghreb in the Mediterranean."[210] I have suggested here that the first to third centuries C.E.—the main period of port construction in North Africa—constituted an important second phase of connectivity. The relationship between North Africa and Rome stimulated important developments in agricultural production, economic orientation, and social relations. In the cities and towns of the North African interior, many of these developments were directly related to the profits that could be acquired through manufacturing, quarrying, construction, and of course the production of agricultural surpluses and their transport. At ports, opportunities for profits may have been even greater, as they could be gained through these means as well as maritime industries: shipping and fish (garum, salsamenta, and murex dyes). We must not, however, overstate the distinction between ports and interior cities and towns. The imperial context in which all these cities were connected was the most important feature of the first to third centuries C.E. This phase of connectivity was characterized by the concentration of wealth in the hands of a small number of individuals and families in almost all African cities and towns, as well as by the extraction of profits by the imperial household and by the wealthiest members of the Roman empire, both of whom had invested in African land. It was this system that was not present earlier and that most distinguished this second phase of connectivity from the first.

DEPARTMENT OF CLASSICAL STUDIES AND
KELSEY MUSEUM OF ARCHAEOLOGY
UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48109–1003
DLSTONE@UMICH.EDU

[209] For an earlier attempt to discuss this process of growth, see Stone and Mattingly 2011, 52–6.

[210] Shaw 2003, 106.

Works Cited

al-Hamawi, Y. 1955. *Mu'jam al-buldane*. 5 vols. Beirut: Dar Sadir.

al-Maghribi, A. 1970. *Kitab al-djugrafiya*. Beirut: Manshurat al Maktab.

Aounallah, S. 2001. *Le Cap Bon, jardin de Carthage: Recherches d'épigraphie et d'histoire romano-africaines (146 a.C–235 p.C)*. Scripta Antiqua 4. Bordeaux: Ausonius.

Aranegui, C., and R. Mar. 2009. "Lixus (Morocco): From a Mauretanian Sanctuary to an Augustan Palace." *PBSR* 77:29–64.

Aubet, M.-E. 2001. *The Phoenicians and the West: Politics, Colonies, and Trade*. 2nd ed. Cambridge: Cambridge University Press.

Baratte, F. 1970. "Une mosaïque retrouvée: L'embarquement de l'éléphant, de Veii." *MÉFRA* 82:787–807.

Barker, G.W.W., D.D. Gilbertson, G.D.B. Jones, and D.J. Mattingly, eds. 1996. *Farming the Desert: The UNESCO Libyan Valleys Archaeological Survey*. 2 vols. Paris and London: UNESCO and Society for Libyan Studies.

Bartoccini, R. 1958. *Il porto romano di Leptis Magna*. Bollettino del Centro studi per la storia dell'architettura 13. Rome: Centro di Studi per la Storia dell'Architettura.

Becatti, G. 1961. *Mosaici e pavimenti marmorei*. 2 vols. Scavi di Ostia 4. Rome: Libreria dello Stato.

Beltrame, C. 2012. "New Evidence for the Submerged Ancient Harbour Structures at Tolmetha and Leptis Magna, Libya." *IJNA* 41:315–26.

Bertrandy, F. 1987. "Remarques sur le commerce des bêtes sauvage entre l'Afrique du nord et l'Italie." *MÉFRA* 99:211–41.

Blackman, D.J. 1982a. "Ancient Harbours in the Mediterranean: Part I." *IJNA* 11:79–104.

———. 1982b. "Ancient Harbours in the Mediterranean: Part II." *IJNA* 11:185–211.

———. 1988. "Bollards and Men." *Mediterranean Historical Review* 3:7–20.

Bonifay, M. 2004. *Études sur la ceramique romaine tardive d'Afrique. BAR-IS* 1301. Oxford: Archaeopress.

———. 2007a. "Que transportaient donc les amphores africanes?" In *Supplying Rome and the Empire: The Proceedings of an International Seminar Held at Siena-Certosa di Pontignano on May 2–4, 2004, on Rome, the Provinces, Production and Distribution*, edited by E. Papi, 8–31. *JRA* Suppl. 69. Portsmouth, R.I.: Journal of Roman Archaeology.

———. 2007b. "Cargaisons africaines: Reflet des entrepôts?" *AntAfr* 43:253–60.

Bonifay, M., and P. Trousset. 2000. "Hergla (Horrea Caelia)." *Encyclopedie Berbère* 22:3440–45.

Bouchenaki, M. 1971. "Algérie." In *L'Espansione fenicia nel Mediterraneo: Relazioni del colloquio in Roma, 4–5 maggio 1970*, edited by F. Barreca, 47–62. Pubblicazioni del Centro di studio per la civiltà fenicia e punica 8. Rome: Consiglio Nazionale delle Ricerche.

Braconi, P. 2005. "Il 'Calcidico' di Lepcis Magna era un mercato di schiavi?" *JRA* 18:213–19.

Bresson, A. 2011. "Grain from Cyrene." In *The Economies of Hellenistic Societies, Third to First Centuries BC*, edited by Z. Archibald, J.K. Davies, and V. Gabrielsen, 66–95. Oxford: Oxford University Press.

Briand-Ponsart, C., and Y. Modéran, eds. 2011. *Provinces et identités provinciales dans l'Afrique romaine*. Tables rondes du CRAHM 6. Caen: Presses Universitaires de Caen.

Brun, J.-P. 2004. *Archéologie du vin et de l'huile dans l'Empire romain*. Paris: Éditions Errance.

Bullo, S. 2002. *Provincia Africa: Le città e il territorio dalla caduta di Carthagine à Nerone*. Rovine circolari 4. Rome: L'Erma di Bretschneider.

Cagnat, R. 1912. *L'armée romaine d'Afrique et l'occupation militaire de l'Afrique sous les empereurs*. Paris: Imprimerie Nationale.

Carayon, N. 2005. "Le cothon ou port artificiel creusé: Essai de définition." *Méditerranée* 104:5–13.

———. 2008. "Les ports phéniciens et puniques: Géomorphologie et infrastructures." Ph.D. diss., Université Strasbourg II–Marc Bloch.

Carcopino, J. 1914. "Deux inscriptions du département de Constantine récemment publiées." *BAC*:561–70.

Carton, L. 1907. "Notes hadrumétines." *Bulletin de la societé archéologique de Sousse*:139–46.

Cat, É. 1891. *Essai sur la province romaine de Maurétanie césarienne*. Paris: Ernest Leroux.

Charles-Picard, G. 1966. "L'administration territoriale de Carthage." In *Melanges d'archéologie et d'histoire offerts à André Piganiol*, edited by R. Chevallier, 1257–65. Paris: Imprimerie Nationale.

Chelbi, F. 1995. "La Tunisie, carrefour du monde antique." In *L'histoire engloutie ou l'archéologie sous-marine*, edited by J.-Y. Blot, 132–33. Paris: Gallimard.

Chelbi, F., R. Paskoff, and P. Trousset. 1995. "La baie d'Utique et son évolution depuis l'antiquité: Une réévaluation géoarchéologique." *AntAfr* 31:7–51.

Cintas, P. 1949. "Fouilles puniques à Tipasa." *RAfr* 92: 263–330.

Conant, J. 2012. *Staying Roman: Conquest and Identity in Africa and the Mediterranean, 439–700*. Cambridge: Cambridge University Press.

Constans, L. 1916. "Gigthis, Étude d'histoire et d'archéologie sur un emporium de la petite Syrte." *NouvArch* 14:1–113.

Cottier, M., ed. 2008. *The Customs Law of Asia*. Oxford: Oxford University Press.

Daux, A. 1869. *Recherches sur l'origine et l'emplacement des emporia phéniciens dans le Zeugis et le Byzacium (Afrique septentrionale)*. Paris: Imprimerie Impériale.

Davidson, D.P. 1992. "Survey of Underwater Structures." In *Leptiminus (Lamta): A Roman Port City in Tunisia. Report No. 1*, edited by N. Ben Lazreg and D.J. Mattingly, 163–75. *JRA* Suppl. 4. Ann Arbor: University of Michigan.

Davidson, D.P., and R.A. Yorke. 2013. "The Enigma of the Great Thapsus Harbour Mole." *IJNA* 43:35–40.

Davis, D.K. 2007. *Resurrecting the Granary of Rome: Environmental History and French Colonial Expansion in North Africa*. Athens: Ohio University Press.

de Graauw, A. 2011–2014. "North Africa." *Ancient Ports/Ports Antiques*. www.ancientportsantiques.com/the-catalogue/north-africa/.

de Laet, S.J. 1949. *Portorium: Étude sur l'organisation douanière chez les romains, surtout à l'époque du haut-empire*. Bruges, Belgium: De Tempel.

DeLaine, J. 1997. *The Baths of Caracalla: A Study in the Design, Construction, and Economics of Large-Scale Building Projects in Imperial Rome. JRA* Suppl. 25. Portsmouth, R.I.: Journal of Roman Archaeology.

De Marcilly, M. 1853. "Notice sur les vestiges de l'occupation romaine dans le cercle de Phillipeville." *Annuaire de la Société archéologique de la province de Constantine* 1:20–38.

de Souza, P. 2000. "Western Mediterranean Ports in the Roman Empire, First Century B.C. to Sixth Century A.D." *Journal of Mediterranean Studies* 10:229–54.

De Vos, M., ed. 2000. *Rus Africum: Terra, acqua, olio nell'Africa Settentrionale. Scavo e ricognizione nei dintorni di Dougga (Alto Tell Tunisino)*. Labirinti 50. Trento: Università degli Studi di Trento.

Di Vita, A. 1974. "Un passo della Stadiasmos tes megales thalasses ed il porto ellenistico di Lepcis Magna." In *Mélanges de philosophie, de littérature et d'histoire ancienne offerts è Pierre Boyancé*, 229–50. *CÉFR* 22. Rome: École Française de Rome.

Dietz, S., L. Ladjimi Sebaï, and H. Ben Hassen, eds. 1995. *Africa Proconsularis: Regional Studies in the Segermes Valley of Northern Tunesia*. 2 vols. Copenhagen: National Museum of Denmark.

Drine, A. 2007. "Les entrepôts de Meninx." *AntAfr* 43: 239–52.

du Breil de Pontbriand, P. 1906. "Le port de l'antique *Gergis* ou la légende de la rivière de l'huile." *BAC*:251–52.

Dunbabin, K. 1978. *The Mosaics of Roman North Africa: Studies in Iconography and Patronage*. Oxford: Clarendon Press.

Duncan-Jones, R. 1962. "Cost, Outlays and *Summae Honorariae* from Roman Africa." *PBSR* 30:47–115.

———. 1963. "Wealth and Munificence in Roman Africa." *PBSR* 31:159–77.

———. 1982. *The Economy of the Roman Empire: Quantitative Studies*. 2nd ed. Cambridge: Cambridge University Press.

———. 1990. *Structure and Scale in the Roman Economy*. Cambridge: Cambridge University Press.

Erbati, E., and A. Trakadas. 2008. *The Morocco Maritime Survey: An Archaeological Contribution to the History of the Tangier Peninsula. BAR-IS* 1890. Oxford: Archaeopress.

Euzennat, M. 1955. "L'histoire municipale de Tigzirt: Rusuccuru colonia et municipium." *MÉFRA* 67:126–46.

Fantar, M. 1984. *Kerkouane: Cité punique de Cap Bon (Tunisie)*. Vol. 1. Tunis: Maison Tunisienne de l'Edition.

Fantar, M., I. Ben Jerbania, O. Ben Slimane, M. Mastouri, S. Trabelsi, I. Sfaxi, P. Bartoloni, P. Bernardini, P.G. Spanu, and R. Zucca. 2012. "Il Neapolitanus portus nel quadro della portualità antica del Capo Bon (Tunisia)." *AfrRom* 19:2267–87.

Fentress, E. 2011. "Slavers on Chariots." In *Money, Trade and Trade Routes in Pre-Islamic North Africa*, edited by A. Dowler and E. Galvin, 65–71. British Museum Research Publication 176. London: British Museum.

Fentress, E., and P. Perkins. 1988. "Counting African Red Slip Ware." *AfrRom* 5:205–14.

Fentress, E., A. Drine, and R. Holod, eds. 2009. *An Island Through Time: Jerba Studies*. Vol. 1, *The Punic and Roman Periods. JRA* Suppl. 71. Portsmouth, R.I.: Journal of Roman Archaeology.

Ferdi, S. 2004. "Recherches archéologiques subacquatiques effectuées sur la cote algérienne: À propos du port de Tipasa." In *Le strutture dei porti e degli approdi antichi: II seminario, Roma-Ostia antica, 16–17 aprile 2004*, edited by A. Gallina Zevi and R. Turchetti, 205–9. Soveria Mannelli, Italy: Rubbettino.

Ferrero, H. 1884. "La marine militaire de l'Afrique romaine." *BOran* 2:157–81.

Février, P.-A. 1966. "Inscriptions inédites relatives aux domaines de la région de Sétif." In *Melanges d'archéologie et d'histoire offerts à André Piganiol*, edited by R. Chevallier, 217–28. Paris: Imprimerie Nationale.

Flemming, N. 1965. "Apollonia." In *Marine Archaeology: Developments During Sixty Years in the Mediterranean*, edited by J. du Plat Taylor, 168–78. London: Hutchinson.

———. 1971. *Cities in the Sea*. Garden City, N.Y.: Doubleday.

Foucher, L. 1964. *Hadrumetum*. Archéologie, histoire 10. Tunis: Université de Tunis.

Fulford, M.G. 1989. "To East and West: The Mediterranean Trade of Cyrenaica and Tripolitania in Antiquity. *LibSt* 20:169–91.

Gascou, J. 1972. *La politique municipale de l'Empire romain en Afrique proconsulaire de Trajan à Septime-Sévère. CÉFR* 8. Rome: École Française de Rome.

———. 1983. "*Pagus et castellum* dans la confédération Cirthéenne." *AntAfr* 19:175–207.

Gavault, P. 1897. *Etude sur les ruines romaines de Tigzirt*. Paris: Ernest Leroux.

Giardina, B. 2010. *Navigare necesse est: Lighthouses from Antiquity to the Middle Ages. History, Architecture, Iconography and Archaeological Remains. BAR-IS* 2096. Oxford: Archaeopress.

Gibbins, D. 2001. "A Roman Shipwreck of ca. AD 200 at Plemmirio, Sicily: Evidence for North African Amphora Production During the Severan Period." *WorldArch* 32:311–34.

Gonzalbes Cravioto, E. 2005. "*Rusaddir, oppidum et portus*: Sobre el concepto de ciudad en el mundo antiguo." *Akros: La revista del museo* 4:19–26.

Gsell, S. 1913. *Histoire ancienne de l'Afrique du Nord*. Vol. 1, *Les conditions du dévelopment historique: Les temps primitifs, la colonisation phénicienne, et l'empire de Carthage*. Paris: Hachette.

———. 1920. *Histoire ancienne de l'Afrique du Nord*. Vol. 2, *L'état carthaginois*. Paris: Hachette.

———. 1922. *Inscriptions latines de l'Algérie*. 2 vols. Paris: É. Champion.

Guérin, V. 1862. *Voyage archéologique dans la Régence de Tunis*. 2 vols. Paris: Henri Plon.

Handley, M. 2011. *Dying on Foreign Shores: Travel and Mobility in the Late-Antique West. JRA* Suppl. 86. Portsmouth, R.I.: Journal of Roman Archaeology.

Hesein, M. Forthcoming. "Ancient Marine Resource Exploitation in the Coastal Strip of Cyrenaica: Some Evidence of Fish-Related Industry in Cyrenaica." In *Fish and Ships*, edited by V. Leitch and E. Botte.

Hitchner, R.B. 1993. "Olive Production and the Roman Economy: The Case for Intensive Growth in the Roman Empire." In *La production du vin et de l'huile en Méditerranée/Oil and Wine Production in the Mediterranaean Area*, edited by M.-C. Amouretti and J.-P. Brun, 499–508. *BCH* Suppl. 26. Athens: École Française d'Athènes.

———. 2005. "'The Advantages of Wealth and Luxury': The Case for Economic Growth in the Roman Empire." In *The Ancient Economy: Evidence and Models*, edited by J.G. Manning and I. Morris, 207–22. Stanford: Stanford University Press.

———. 2012. "Roads, Integration, Connectivity, and Economic Performance in the Roman Empire." In *Highways, Byways, and Road Systems in the Pre-modern World*, edited by S. Alcock, J. Bodel, and R. Talbert, 222–34. Chichester, England: Wiley-Blackwell.

Horden, P., and N. Purcell. 2000. *The Corrupting Sea: A Study of Mediterranean History*. London: Blackwell.

Houston, G. 1988. "Ports in Perspective: Some Comparative Materials on Roman Merchant Ships and Ports." *AJA* 92(4):553–64.

Hurst, H. 1994. *Excavations at Carthage: The British Mission*. Vol. 2, pt. 1, *The Circular Harbour, North Side: The Site and Finds Other than Pottery*. British Academy Monographs in Archaeology 4. Oxford: Oxford University Press.

———. 2010. "Understanding Carthage as a Roman Port."

Bollettino di Archeologia On Line 1, special volume B/B7:49–68.

Hurst, H., and L. Stager. 1978. "A Metropolitan Landscape: The Late Punic Port of Carthage." *WorldArch* 9:334–45.

Jones, G.D.B., and J.H. Little. 1971. "Coastal Settlement in Cyrenaica." *JRS* 61:64–79.

Kehoe, D.P. 1988. *The Economics of Agriculture on Roman Imperial Estates in North Africa*. Hypomnemata 89. Göttingen: Vandenhoeck and Ruprecht.

Lallemand, C. 1892. *La Tunisie: Pays de protectorat français*. Paris: Librairies-Imprimeries Réunies.

Lancel, S. 1992. *Carthage*. Paris: Librarie Arthème Fayard.

Laronde, A. 1988. "Le port de Lepcis Magna." *CRAI* 132: 337–53.

———. 1996. "Apollonia de Cyrénaïque: Archéologie et histoire." *JSav* 1:3–49.

Laronde, A., and C. Sintès. 1998. "Recherches recentes dans le port d'Apollonia." In *La Cirenaica in età antica: Atti del convegno internazionale di studi, Macerata, 18–20 maggio 1995*, edited by E. Catani and S. Marengo, 301–10. Ichnia 1. Pisa: Istituti Editoriali e Poligrafici Internazionali.

Lassère, J.-M. 1977. *Ubique populus: Peuplement et mouvements de population dans l'Afrique romaine de la chute de Carthage à la fin de la dynastie des Sévères (146 av.C.–235 p.C.)*. Paris: Editions du Centre Nationale de la Recherche Scientifique.

Lassus, J. 1959. "Les découvertes récentes de Cherchel." *CRAI* 103:215–25.

Le Bohec, Y. 2005. *Histoire de L'Afrique romaine: 146 avant J.-C.–439 après J.-C.* Antiquité-synthèses 9. Paris: Éditions Picard.

Leitch, V. 2011. "Location, Location, Location: Characterizing Coastal and Inland Production and Distribution of Roman African Cooking Wares." In *Maritime Archaeology and Ancient Trade in the Mediterranean*, edited by D. Robinson and A. Wilson, 169–95. Oxford Centre for Maritime Archaeology Monograph 6. Oxford: Oxford Centre for Maritime Archaeology.

Leonard, J. 1997. "Harbor Terminology in Roman *Periploi*." In *Res maritimae: Cyprus and the Eastern Mediterranean from Prehistory to Late Antiquity. Proceedings of the Second International Symposium "Cities on the Sea," Nicosia, Cyprus, October 18–22, 1994*, edited by S. Swiny, R. Hohlfelder, and H. Swiny, 163–200. Atlanta: Scholars Press.

Leveau, P. 1984. *Caesarea de Maurétanie: Une ville romaine et ses campagnes. CÉFR* 70. Rome: École Française de Rome.

Lézine, A. 1970. *Utique*. Tunis: Société Tunisienne de Diffusion.

Little, J.H. 1977. "Harbours and Settlement in Cyrenaica." *LibSt* 9:43–5.

Lloyd, J., ed. 1977. *Excavations at Sidi Khrebish Benghazi (Berenice)*. Vol. 1, *Buildings, Coins, Inscriptions, Architectural Decoration*. *LibAnt* Suppl. 5. Tripoli: Department of Antiquities.

———. 1989. "Urban Archaeology in Cyrenaica 1969–1989: The Hellenistic, Roman and Byzantine Periods." *LibSt* 20:77–90.

Longerstay, M. 1988. "Nouvelles fouilles à Tabarka, antique Thabraca." *Africa* 10:220–53.

Mackensen, M. 1993. *Die spätantiken Sigillata- und Lampentöpfereien von el Mahrine (Nordtunesien): Studien zur nordafrikanischen Feinkeramik des 4. bis 7. Jahrhunderts*. Münchner Beiträge zur Vor- und Frühgeschichte 50. Munich: C.H. Beck.

Mahmoudi, M. 1988. "Nouvelle proposition de subdivisions stratigraphiques des dépôts attribués au Tyrrhenien en Tunisie (région de Monastir)." *Bulletin de la Société Géologique de France*:432–38.

Marec, E. 1954. *Hippone la royale, antique Hippo Regius*. Alger: Direction de l'Intérieur et des Beaux-Arts, Service des Antiquités.

Marlière, E., and J. Torres Costa. 2007. "Transport et stockage des denrées dans l'Afrique romaine: Le rôle de l'outre et du tonneau." In *In Africa et in Hispania: Études sur l'huile africaine*, edited by A. Mrabet and J. Remesal Rodriguez, 85–106. Barcelona: Universitat de Barcelona.

Matthews, J.F. 1984. "The Tax Law of Palmyra: Evidence for Economic History in a City of the Roman East." *JRS* 74:157–80.

Mattingly, D.J. 1988. "Oil for Export? A Comparative Study of Olive-Oil Production in Libya, Spain, and Tunisia." *JRA* 1:33–56.

———. 1995. *Tripolitania*. London: B.T. Batsford.

Mattingly, D.J., and D.L Stone. 2011. "Leptiminus: Profile of a Town." In *Leptiminus (Lamta): The Field Survey. Report No. 3*, by D.L. Stone, D.J. Mattingly, and N. Ben Lazreg, 272–88. *JRA* Suppl. 87. Portsmouth, R.I.: Journal of Roman Archaeology.

Morley, N. 1996. *Metropolis and Hinterland: The City of Rome and the Italian Economy, 200 B.C.–A.D. 200*. Cambridge: Cambridge University Press.

Mrabet, A., and M. Ben Moussa. 2007. "Nouvelles données sur la production dans le territoire de l'antique Neapolis (Tunisie)." In *In Africa et in Hispania: Études sur l'huile africaine*, edited by A. Mrabet and J. Remesal Rodriguez, 13–40. Barcelona: Universitat de Barcelona.

Nasgowitz, D. 1981. *Ptolemais Cyrenaica*. Chicago: The University of Chicago Press.

Oleson, J.P. 1988. "The Technology of Roman Harbours." *IJNA* 17:147–57.

Oleson, J., C. Brandon, and R. Hohlfelder. 2011. "Technology, Innovation, and Trade: Research into the Engineering Characteristics of Roman Maritime Concrete." In *Maritime Archaeology and Ancient Trade in the Mediterranean*, edited by D. Robinson and A. Wilson, 107–19. Oxford Centre for Maritime Archaeology Monograph 6. Oxford: Oxford Centre for Maritime Archaeology.

Oleson, J., C. Brandon, S.M. Cramer, R. Cucitore, E. Gotti, and R.L. Hohlfelder. 2004. "The ROMACONS Project: A Contribution to the Historical and Engineering Analysis of Hydraulic Concrete in Roman Maritime Structures." *IJNA* 33:199–229.

Oleson, J., and G. Branton. 1992. "The Technology of King Herod's Harbour." In *Caesarea Papers: Straton's Tower, Herod's Harbour, and Roman and Byzantine Caesarea. Including the Papers Given at a Symposium Held at the University of Maryland, the Smithsonian Institution, and the Jewish Community Center of Greater Washington on 25–28 March, 1988*, edited by R.L. Vann, 49–67. *JRA* Suppl. 5. Portsmouth, R.I.: Journal of Roman Archaeology.

Oueslati, A. 1993. *Les côtes de la Tunisie: Géomorphologie et environnement et aptitudes à l'aménagement*. Publications de la Faculté des sciences humaines et sociales de Tunis Série 2, Géographie 34. Tunis: Université de Tunis.

Panella, C. 1973. "Anfore." In *Ostia III: Le Terme del Nuotatore. Scavo degli ambienti III, VI, VII, . . . V e di un saggio nell'area SO*. Vol. 1, edited by A. Carandini and C. Panella, 463–633. *StMisc* 21. Rome: De Luca.

Papi, E., and F. Martorella. 2007a. "I granai della Numidia." *AntAfr* 43:171–86.

———. 2007b. "Il grano della Tingitana." In *Supplying Rome and the Empire: The Proceedings of an International Seminar Held at Siena-Certosa di Pontignano on May 2–4, 2004, on Rome, the Provinces, Production and Distribution*, edited by E. Papi, 85–96. *JRA* Suppl. 69. Portsmouth, R.I.: Journal of Roman Archaeology.

Paskoff, R., and P. Sanlaville. 1983. *Les côtes de la Tunisie: Variations du niveau marin depuis le Tyrrhénien*. Collection de la Maison de l'Orient méditerranéen 14, Série géographique et préhistorique 2. Lyon: Maison de l'Orient.

Peña, J.T. 1998. "The Mobilization of State Olive Oil in Roman Africa: The Evidence of Late 4th-c. Ostraca from Carthage." In *Carthage Papers: The Early Colony's Economy, Water Supply, a Public Bath, and the Mobilization of State Olive Oil*, by J.T. Peña, J.J. Rossiter, A.I. Wilson, and C.M. Wells, 117–238. *JRA* Suppl. 28. Portsmouth, R.I.: Journal of Roman Archaeology.

Pflaum, H.-G. 1960–1961. *Les carrières procuratoriennes équestres sous le Haut-Empire romain*. 4 vols. Bibliothèque archéologique et historique 57. Paris: Paul Geuthner.

Ponsich, M. 1982. "Lixus: Informations archéologiques." *ANRW* 2.10.2:817–49.

Ponsich, M., and M. Tarradell. 1965. *Garum et industries de salaison dans la méditerranée occidentale*. Bibliothèque de l'École des hautes études hispaniques 36. Paris: Presses Universitaires de France.

Preece, C. 2000. "Marsa-el-Brega: A Fatal Port of Call. Evidence for Shipwreck, Anchorage, and Trade in Antiquity in the Gulf of Sirte." *LibSt* 31:129–47.

———. 2011. "Janzur: Anchorage, Trade, Industry and Development on the Tripolitanian Littoral." *LibSt* 42:47–58.

Quinn, J.C. 2009. "North Africa." In *A Companion to Ancient History*, edited by A. Erskine, 260–72. Chichester, England: Wiley-Blackwell.

———. 2011. "The Syrtes Between East and West." In *Money, Trade and Trade Routes in Pre-Islamic North Africa*, edited by A. Dowler and E. Galvin, 11–20. British Museum Research Publication 176. London: British Museum.

Ravoisié, A. 1846. *Exploration scientifique de l'Algérie pendant les années 1840, 1841, 1842, publiés par ordre du gouvernement et avec le concours d'une commission acadèmique: Beaux-arts, architecture et sculpture*. Paris: Didot Frères.

Rebora, L. 1884. "Tabarca (Thabraca): Ruines, mosaiques, inscriptions inédites." *BOran* 2:122–34.

Reynolds, J.M., and J.B. Ward-Perkins. 1952. *The Inscriptions of Roman Tripolitania*. Rome: British School at Rome.

Reynolds, P. 2010. *Hispania and the Roman Mediterranean, AD 100–700: Ceramics and Trade*. London: Duckworth.

Roller, D. 2003. *The World of Juba II and Kleopatra Selene: Royal Scholarship on Rome's African Frontier*. New York: Routledge.

Romer, F., trans. 1998. *Description of the World*, by Pomponius Mela. Ann Arbor: University of Michigan Press.

Rougé, J. 1966. *Recherches sur l'organisation du commerce maritime en Méditerranée sous l'Empire romain*. Paris: Imprimerie Nationale.

Salama, P. 1951. *Les voies romaines de l'Afrique du Nord*. Algiers: Imprimerie Officielle.

———. 1980. "Les voies romaines de Sitifis à Igilgili: Un example de politique routière approfondie." *AntAfr* 16:101–33.

Saller, R. 1982. *Personal Patronage Under the Early Empire*. Cambridge: Cambridge University Press.

Salza Prina Ricotti, E. 1971. "Le ville maritime di Silin (Leptis Magna)." *RendPontAcc* 43:135–63.

———. 1973. "I porti della zona di Leptis Magna." *RendPontAcc* 45:75–103.

Schörle, K. 2011. "Constructing Port Hierarchies: Harbours of the Central Tyrrhenian Coast." In *Maritime Archaeology and Ancient Trade in the Mediterranean*, edited by D. Robinson and A. Wilson, 93–106. Oxford Centre for Maritime Archaeology Monograph 6. Oxford: Oxford Centre for Maritime Archaeology.

———. 2012. "Saharan Trade in Classical Antiquity." In *Saharan Frontiers: Space and Mobility in Northwest Africa*, edited by J. McDougall and J. Scheele, 58–72. Bloomington: Indiana University Press.

Schörle, K., and V. Leitch. 2012. "Report on the Preliminary Season of the Lepcis Magna Coastal Survey." *LibSt* 43:149–54.

Shaw, B. 2003. "A Peculiar Island: Maghrib and Mediterranean." *Mediterranean Historical Review* 18:93–125.

Shipley, G. 2011. *Pseudo-Skylax's Periplous: The Circumnavigation of the Inhabited World. Text, Translation and Commentary*. Exeter: Bristol Phoenix Press.

Sintès, C. 2010. "Les *neosoikoi* d'Apollonia de Cyrénaïque." In *Ricoveri per navi militari nei porti del Mediterraneo antico e medievale: Atti del Workshop, Ravello, 4–5 novembre 2005*, edited by D.J. Blackman and M.C. Lentini, 83–96. Archeologia, storia, cultura 5. Bari: Edipuglia.

Slim, H., P. Trousset, R. Paskoff, A. Oueslati. 2004. *Le littoral de la Tunisie: Étude géoarchéologique et historique*. Paris: Editions du Centre Nationale de la Recherche Scientifique.

Slim, L., M. Bonifay, and P. Trousset. 1999. "L'usine de salaison de Neapolis (Nabeul): Premiers résultats des fouilles 1995–1998." *Africa* 17:153–97.

Stone, D.L. 2008. "Coloni and the Imperial Cult in the Countryside of Sitifis." *AfrRom* 17:2165–78.

———. Forthcoming. "The Jetty with Platform: A Type of Port Structure from North Africa." In *Debating Port and Harbour Archaeology in the Roman World*, edited by A. Rogers and C. Rummel.

Stone, D.L., and D.J. Mattingly. 2011. "Moderate Economic Growth in a Port City: Investment and Growth at Leptiminus." *FACTA* 5:31–63.

Stone, D.L., D.J. Mattingly, and N. Ben Lazreg. 2011. *Leptiminus (Lamta): The Field Survey. Report No. 3. JRA* Suppl. 87. Portsmouth, R.I.: Journal of Roman Archaeology.

Tissot, C.J. 1878. *Recherches sur la géographie comparée de la Maurétanie tingitane*. Mémoires de l'Académie des inscriptions et belles-lettres 9. Paris: Imprimerie Nationale.

Toutain, J. 1892. "Fouilles et explorations à Tabarca et aux environs." *BAC*:175–209.

Trakadas, A. 2005. "The Archaeological Evidence for Fish Processing in the Western Mediterranean." In *Ancient Fishing and Fish Processing in the Black Sea Region*, edited by T. Bekker-Nielsen, 47–82. Black Sea Studies 2. Aarhus: Aarhus University Press.

Trousset, P. 1994. "Curubis." *Encyclopédie berbère* 14:2157.

———. 2002–2003. "Le tarif de Zaraï: Essai sur les circuits commerciaux dans la zone présaharienne." *AntAfr* 38–39:355–73.

———. 2003. "Iunci (Macomades)." *Encyclopédie berbère* 25:3806–12.

———. 2005. "Kerkena/Kerkennah." *Encyclopédie berbère* 27:4159–66.

Tuck, S.L. 2008. "The Expansion of Triumphal Imagery Beyond Rome: Imperial Monuments at the Harbors of Ostia and Lepcis Magna." In *The Maritime World of Ancient*

Rome: Proceedings of "The Maritime World of Ancient Rome" Conference Held at the American Academy in Rome, 27–29 March 2003, edited by R.L. Hohlfelder, 325–41. *MAAR* Suppl. 6. Ann Arbor: University of Michigan Press.

Tusa, S. 2010. "Rapporto preliminare della missione italiana per lo studio dell'archeologia costiera e subacquea in Cirenaica (2003–2008)." *LibAnt* 5:211–36.

Uggeri, G. 1996. "*Stadiasmus Maris Magni*: Un contributo per la datazione." *AfrRom* 11:277–85.

Vaglieri, D. 1912. "Ostia—scoperta di un altra 'schola' di corporazione." *NSc*:203–13.

———. 1913. "Ostia—scavi e richerche nel Decumano, in via delle Corporazioni, nel portico dietro il Teatro, nel Teatro, ad ovest di questo, nel piazzale innanzi ai Quattro tempietti, nella via ad ovest del Piccolo Mercato." *NSc*:120–41.

Valérian, D. 2006. *Bougie: Port maghrébin, 1067–1510. BÉFAR* 328. Rome: École Française de Rome.

Vars, L. 1896. *Rusicade et Stora , ou Philippeville dans l'antiquité.* Constantine: Imprimerie Emile Marle.

Villaverde Vega, N. 2001. *Tingitana en la antigüedad tardía (siglos III–VII): Autoctonía y romanidad en el extremo occidente mediterráneo.* Bibliotheca archaeologica hispana 11. Madrid: Real Academia de la Historia.

Virlouvet, C. 2007. "Entrepôts de stockage, entrepôts et marchés: Pour une typologie des horrea dans l'Afrique du Nord antique." *AntAfr* 43:165–69.

Wilson, A. 2004. "Cyrenaica and the Late Antique Economy." *Ancient West and East* 1:143–54.

———. 2011a. "Developments in Mediterranean Shipping and Maritime Trade from the Hellenistic Period to AD 1000." In *Maritime Archaeology and Ancient Trade in the Mediterranean*, edited by D. Robinson and A. Wilson, 33–60. Oxford Centre for Maritime Archaeology Monograph 6. Oxford: Oxford Centre for Maritime Archaeology.

———. 2011b. "City Sizes and Urbanization in the Roman Empire." In *Settlement, Urbanization, and Population*, edited by A. Bowman and A. Wilson, 161–95. Oxford: Oxford University Press.

Wilson, A., P. Bennett, A.M. Buzaian, T. Buttrey, K. Görensson, C. Hall, A. Kattenberg, R. Scott, K. Swift, and E. Zimi. 2001. "Euesperides (Benghazi): Preliminary Report on the Spring 2001 Season." *LibSt* 32:155–77.

Wilson, A., K. Schörle, and C. Rice. 2012. "Roman Ports and Mediterranean Connectivity." In *Rome, Portus and the Mediterranean*, edited by S. Keay, 367–91. Archaeological Monographs of the British School at Rome 21. London: British School at Rome.

Yorke, R.A. 1966. "Cambridge Expedition to Sabratha 1966 Report." *Underwater Association Report* 1966:1–31. www.societies.cam.ac.uk/cuueg/Archives/Sabratha_1966.pdf.

———. 1967. "Les ports engloutis de Tripolitaine et de Tunisie." *Archeologia* 17:18–24.

———. 1973. "A Survey of Ancient Harbours in Cyrenaica." *IJNA* 2:200–1.

———. 1986. "The Harbour." In *Excavations at Sabratha 1948–1951*, by P. Kenrick, 243–45. London: Society for the Promotion of Roman Studies.

Yorke, R.A., and D.P. Davidson. 1969. "Roman Harbours of Algeria." *Underwater Association Report* 1969:8–21.

———. 1985. "Survey of Building Techniques at the Roman Harbours of Carthage and Some Other North African Ports. In *Harbour Archaeology: Proceedings of the First International Workshop of Ancient Mediterranean Harbours, Caesarea Maritima, 24–28.6.83*, edited by A. Raban, 157–64. *BAR-IS* 257. Oxford: British Archaeological Reports.

Yorke, R.A., and J.H. Little. 1975. "Offshore Survey at Carthage, Tunisia, 1973." *IJNA* 4:85–101.

Younes, A. 1999. *Recherches sur la ville portuaire de Thapsus et son territoire en Byzacène dans l'antiquité.* 2 vols. Cahiers du CERES 10. Tunis: Tunis Centre d'Études et de Recherche Économiques et Sociales.