Ancient marine resource exploitation in the Western Mediterranean: the contribution of the fish-salting industry of Mauretania Tingitana *(Morocco)*

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1. Introduction

In Morocco, systematic documentation of marine resource exploitation is a fairly recent phenomenon. Records of the numbers and types of fish caught generally do not exist prior to 1930, and are only periodic by the late 1940s;[1] more official catch records for the country do emerge with some regularity by the late 1960s.[2] Prior to the records of the twentieth century, the information regarding marine resources in the region is sporadic, and mostly qualitative in nature. However, from the first century BC to the fifth century AD, when northern Morocco was controlled and then administered as a province of the Roman Empire, there is available for study a body of evidence related to fishing and marine resource exploitation. The evidence from this period can be divided into qualitative and quantitative sources.

The qualitative data includes a limited corpus of iconography, in which fishing and fish are treated as subject matter. Many of the images of marine life in the province are depicted in several floor mosaics from the private homes or public buildings in cities such as Volubilis and Banasa.[3] In these floor canvases, a variety of marine species are depicted, but are sometimes also made part of more fanciful scenes with nereids and tritons. Fish, thought to be tunny, also are shown as the columns of a temple on the reverse of coins struck at Lixus, which was the only African city to depict fish in this way.[4]

Additionally, there are small number of contemporary, textual references to local fishing methods and fish found in the region. For example, the first-century AD writer Strabo states that just outside the Straits of Gibraltar, the sea is very rich in tunny (*Geography* 3.2.7), and that large conger eels and cuttle fish could be found. Pliny, writing in the later first century AD, states that flying fish and swordfish were present at Cotta near Cap Spartel in Morocco (*Natural History* 32.15).

To examine more fully the marine resources exploited in antiquity in Morocco, however, the most quantitative and descriptive information available is found in the archaeological record. During the Roman period, this record consists largely of sites where salted fish and fish sauces were processed for later consumption, the various ceramic containers (amphorae) used to transport these fish-salting products, and ichthyo-archaeological finds from processing and habitation sites.

There are certainly constraints on using both the qualitative and quantitative information available from the Roman provincial period in Morocco. Nevertheless, it is possible to derive from these data, and particularly the archaeological remains of the fish-salting industry, information useful in answering some of the four posed research questions asked by the HMAP-Mediterranean project.[5] The data represents the earliest period for which wider marine resource exploitation in the region can be documented.

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[1] Some sporadic catch information is contained within the monthly *Le Maroc Maritime* (started in 1930 under the French Protectorate to record shipping information), and fish and fishing techniques are published in Rouch 1934.

[2] Pers. com., Abdelatif Orbi, Institut National de Recherche Halieutique (INRH), Casablanca

[3] Thouvenot & Luquet 1951: 31-32, pl. II; Neira Jiménez 1994: pls. IVb, VII

[4] Ripoll López 1988: 483-485

[5] Posed at the beginning of this workshop by P. Holm: 1) What are the diversity, distribution, and abundance of marine resources? 2) What factors have influenced/forced a change in these resources? 3) What has been the anthropogenic and biological significance in these changes? 4) By what processes have marine ecosystems interacted with human societies?

2. Marine resources

Morocco occupies a unique geographical position, as the northwestern-most country in Africa and the land closest to the European continent. The country's 3,500 km-long coastline borders two major marine ecosystems, the western Mediterranean Sea and the eastern Atlantic Ocean. It is crucial to consider both these marine systems because of their interactive nature, connected by the hydrographically-active Sea of Alboran and Straits of Gibraltar (Fig. 1).

The hydrographical conditions of the waters that border Morocco provide an ideal environment for pelagics and migratory species, which take advantage of the upwelling and seasonal and dominant currents in the region. Approximately 240 marine species are presently caught in Moroccan waters, the overwhelming majority in the Atlantic Ocean. The largest stock today is sardine, representing two-thirds of the country's overall catch.[6]

Upwelling along the Atlantic coast of North Africa creates a rich biological system that brings in pelagics of the Moroccan Atlantic continental plateau. The primary Atlantic catches for Morocco today consist of:[7] Atlantic horse mackerel (*Trachurus trachurus*), sardine *(Sardina pilchardus)*, Cunene horse mackerel (*Trachurus trecae*), European hake *(Merluccius merluccius)*, red shrimp *(Plesiopenaeus edwardsianus)*, blackmouth catshark *(Galeus melastomus)*, Mediterranean slimehead *(Hoplosthetus mediterraneus)*, greater forkbeard *(Phycis blennoides)*, softhead grenadier *(Melacocephalus laevis),* black belly rose fish *(Heliocolenus dactylopterus*), and cephalopods (squid, octopus, and cuttlefish).

In the Mediterranean, fisheries are concentrated in the coastal zone, and in increasing amount of catch, out of the ports of M'diq, Tanger, Al Hoceima, and Nador. Minor tunny constitute a large percentage of the catches of these ports. The primary Mediterranean catches for Morocco today consist of:[8] red mullet *(Mullus barbatus)*, sardine *(Sardina pilchardus)*, Atlantic bonito (*Sarda sarda)*, frigate tuna *(Auxis thazard)*, skipjack tuna *(Katsuwonus pelamis)*, little tunny *(Euthynnus alletteratus)*, plain bonito *(Orcynopsis unicolor)*, swordfish *(Xiphias gladius)*, and sea bream (*Pagellus acarne*).

Particularly important to Moroccan fisheries in the past and present are the tunny migrations through the Straits of Gibraltar.[9] Ancient fisheries in the region undoubtedly understood and capitalized on these migrations, and writers like Oppian and Athenaeus, in the third

Fig. 1. The coastline of Morocco and occupied Western Sahara extend 3,500 km, reaching from the Mediterranean to the Atlantic. Map: S. Claesson

century AD, clearly state that tunny species migrated from the Atlantic to the Mediterranean (Oppian, *Haleutica* 3.620; Athenaeus 7.315). The migration for most of the tunny species still begins in the Atlantic, where they pass through the Straits into the Mediterranean in early summer, returning in the late summer. Tunny were and are fished by line or net, and also by fixed nets such as the *Al-madraba*.[10]

3. The Roman period

The indigenous populations of the coastal regions of north-western Africa undoubtedly practised fishing as a means of sustenance during prehistory, reaping the harvest of this marine-rich zone.[11] In the region of North Africa that constitutes present-day Morocco, archaeological excavations to date have identified quantities of fish and marine mammal bones, as well as shell-fish remains in the habitation layers of coastal Neolithic sites dating from 3,000 – 2,000 BC. These sites are all located on the Atlantic coast of Morocco: the island of Essaouira, coastal sites between Casablanca and Rabat (notably at Dar-es-Soltan), and several sea-front caves near Cap Spartel, in the Achakar region.[12] No pre-historic sites have been located on the Mediterranean coast of Morocco, but this area remains largely unstudied.

Definitive evidence for the exploitation of the region's marine resources emerges quite clearly during the first century BC. At this time, under the cultural and economic influence of the Roman Empire, installations that manufactured salted-fish products were built along the coasts of northern Morocco. At the same time, numerous, similar sites were also established in southern Iberia.[13] Over the next five centuries, as northern Morocco was administered as the Roman province of *Mauretania Tingitana*, the local marine resources were fished to supply these sites. The products of the industry constituted one of the important commodities of the region, consumed locally but mainly exported throughout the Mediterranean.[14]

3.1 Fish salting

In the Roman world, fish could be processed in two basic ways: the flesh could be cut up and salted, forming *salsamenta* with its liquid by-product *muria,* or the leftovers and/or small fry could be macerated with salt and fermented, forming various fish sauces such as *garum, liquamen,* and *allec*.[15] These types of fish products served as an essential food item in antiquity, mainly as a source of protein but also as a salt substitute and for medicinal use. Processing with salt was an innovative method for preserving a necessary food item in a world without any means of refrigeration, and made possible the trans-shipment of preserved fish and fish sauces to distant locations.

The method for making *salsamenta* is preserved by only two first-century AD Latin sources, Manilius (*Astronomica* 5.656-81) and Columella (*De Re Rustica* 12.55.4). The descriptions of the process given by these ancient authors suggest that it was quite simple and required pieces of fish to be covered with salt and stacked alternately in a large vat or ceramic container. To ensure the salt's absorption, a weight was placed on the top-most layer of fish parts. Some fish were packed with more salt than others, and for some products, the scales were left on the meat. The liquid derived from the *salsamenta*-making process, *muria*, was also consumed.[16]

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[6] Naji 2000: 328-332; INRH 2002: 33
[7] INRH 2002: 40-51, 62-75
[8] INRH 2002: 14-31, 130-146
[9] Trousset 1998: 13-16
[10] INRH 2002: 130-135, 142-144; Trousset 1998: 23-27; The nets called *Al-madraba* in Morocco and Spain are also referred to as *madrague* (France), *tonnara* (Italy), and *armaçao* (Portugal). These are anchored or fixed nets, and are for trap-net fishing purposes, with one or more channels leading up to the main trap.
[11] Ponsich 1970: 28-66; Souville 1958-59: 315
[12] Souville 1958-59: 315, 320; Gilman 1975: 111-112; Koehler 1931: 8, 11-12
[13] Ponsich & Taradell 1965; Curtis 1991: 47-71
[14] Gozalbes Cravioto 1997: 176-213; Callegarin 2000: 1333-1334
[15] Curtis 1991: 6-9
[16] Curtis 1991: 7-8, n. 8

Of the various fish sauces produced during the early Roman Empire, *garum,* or *liquamen,* as it was also called, seems to have been the most common. The methods for the sauces' manufacture are preserved in some ancient recipes as early as the first century BC; the most complete description is given in the *Geoponica*, a tenth-century AD Byzantine agricultural manual based on a sixth-century AD Latin treatise.

The most basic recipe required pieces of eviscerated fish, including the meat, bones, guts, scales, eggs, and fins, to be set in a ceramic container or vat with salt. On occasion, shellfish were added. The mixture could then be artificially heated, reducing the liquid by two-thirds, or left to ferment in the sun for 27 days to 3 months (*Geoponica* 20.46.1-6). Afterwards, a semi-transparent liquid was strained off the top of the mixture; this was *garum*. *Allec*, the remaining fish debris from the *garum/liquamen*-making process, was also consumed.

3.2 Fish-salting sites

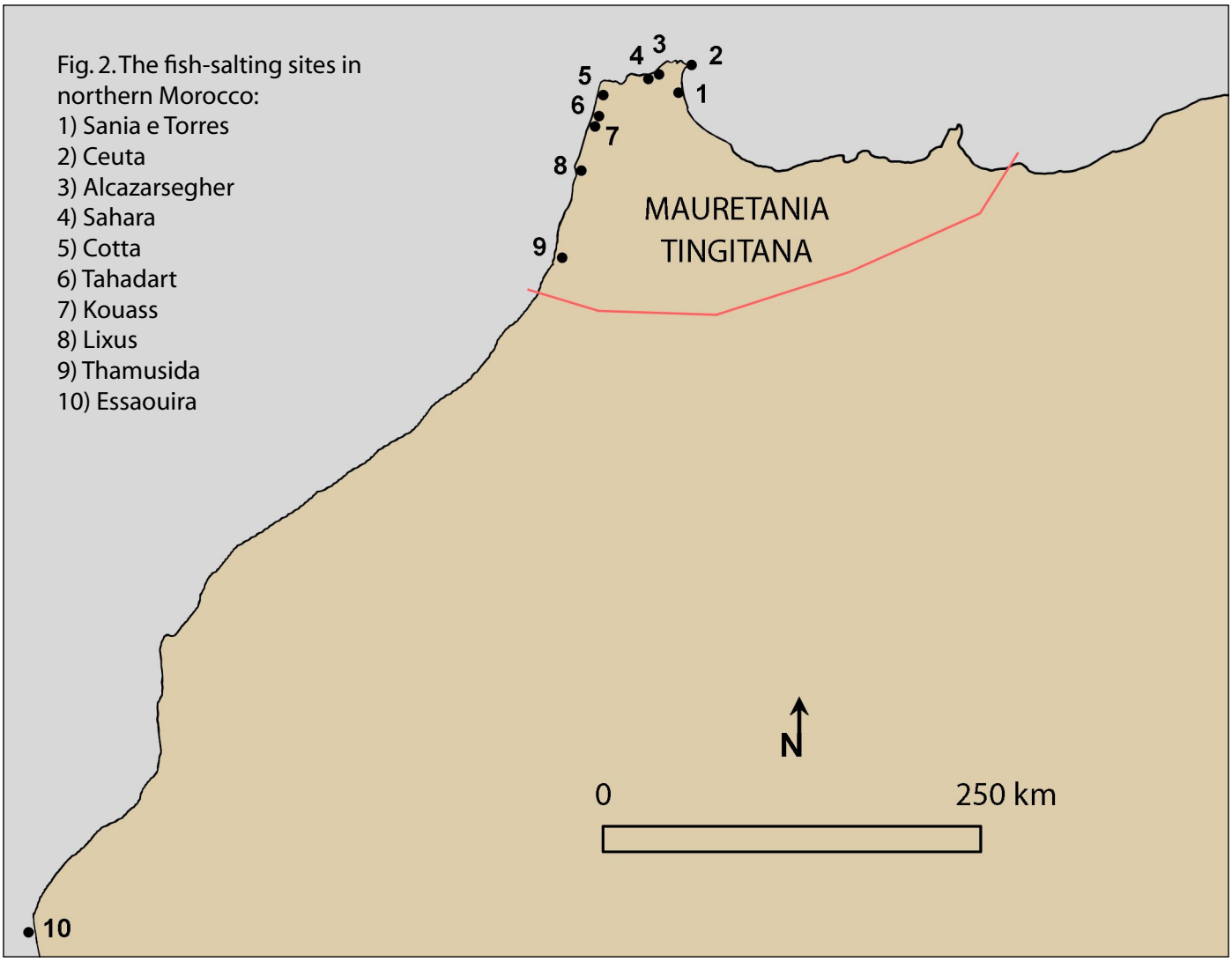
Ten sites that manufactured the various salted-fish products operated in the province of *Mauretania Tingitana* (Fig. 2). Two of the sites, Sania e Torres and Ceuta, are located on the Mediterranean coast; Sahara and Alcazarsegher are located on the southern coast of the Straits of Gibraltar; and the remaining six sites, Cotta, Tahadart, Kouass, Lixus, Thamusida, and Essaouira, extend down the north Atlantic coast.[17]

Fish processing at Lixus, Kouass, Tahadart, Cotta and Essaouira began to occur in the late first century BC, during the early period of Roman political and cultural influence in the region. When northern Morocco was officially annexed as *Mauretania Tingitana* in 42/43 AD, the Roman province extended south to the Bouregreg River on the Atlantic coast (at Rabat), but included the distant Îles Purpuraires at Essaouira. It is also during this century that installations or processing vats were built at Ceuta, Sahara, Alcazarsegher, Sania e Torres and Thamusida. The installations at Cotta, Sahara, Alcazarsegher, Thamusida, and Essaouira ceased operation in the third century AD; the remainder fell out of use by the late fourth and early fifth centuries AD.[18]

The fish-salting sites throughout the province vary in size and plan, but their excavated remains reveal a surprising degree of constructional homogeneity. In particular, the vats used for processing fish, called *cetariae* (Pliny, *NH* 9.92), are remarkably similar in their design throughout the province. Rectangular or square in shape, but varying in size and depth, the *cetariae* were built of bricks and/or rubble construction. The walls were then faced with a sealing mortar mixture of lime and small fragments of tiles or ceramics, forming *opus signinum*.[19]

The 10 known installations in the province vary considerably in size. A small number of vats, groups of two to five, are present at Sania e Torres, Sahara, Kouass, Thamusida, and Essaouira.[20] The installation at Cotta is certainly the most complete fish-salting site remaining in Morocco and the most thoroughly excavated; within the main building are 16 vats arranged around a cistern.[21] At Tahadart, six separate factory buildings are sited along a tidal river bank, and at least 41 extant vats were identified at the installation.[22] At Lixus are 10 excavated industrial complexes, although there were undoubtedly more in antiquity; a modern road cuts through the centre of the factory area. Extant however, are at least 142 square and rectangular vats. The excava-

[17] Ponsich & Taradell 1965: 9-77; Rebuffat 1977: 284-285; Jodin 1967: 68-71, 256-262; Bravo Perez 1980; Bernal Casasola & Pérez Rivera 1999: 28-32, 46
[18] Ponsich 1988: 103-136
[19] Edmondson 1987: 122
[20] Ponsich & Taradell 1965: 38-40, 68-70, 75-77; Rebuffat 1977: 284-285; Jodin 1967: 68-71, 256-262
[21] Ponsich & Taradell 1965: 55-68, fig. 36
[22] Ponsich & Taradell 1965: 40-55
[23] Ponsich & Taradell 1965: 9-37
[24] Bernal Casasola & Pérez Rivera 1999: 40; Bravo Pérez, *et al*. 1995; Villaverde Vega & López Pardo 1995



tors believe that 10 more factories existed in antiquity; therefore, Lixus was likely the largest consortium of fish-salting processors in the western Mediterranean.[23]

Comparatively, at Ceuta, it is difficult to establish the full extent of the site, due to the fact that the modern city, now a Spanish enclave, covers the entire peninsula. However, five different sites of two to four vats each have been excavated during the construction of new buildings. These sites could represent separate factory installations, but also could constitute several larger installations or one installation of considerable size, extending over 200 meters in length.[24]

4. Sources assessment

4.1 Quantitative data

The archaeological data from the fish-salting industry during the Roman period in Morocco can provide a detailed level of quantitative information. For example, an examination of the distribution of the fish-salting sites of *Mauretania Tingitana* provides basic information regarding areas that were fished during the Roman period. Over half the installations, including the large site of Lixus, were sited along the Atlantic coast, near salt and fresh water resources (see Fig. 2). The distribution of the sites possibly reflects that like today, the Atlantic was of primary importance to the ancient fisheries. (This statement should be made cautiously, however, as the Mediterranean coast of Morocco has been little investigated, and the contemporary situation in Mediterranean Spain is quite the opposite.) Lixus, Kouass, Thamusida and Tahadart might also provide information on estuarine fishing in the Roman period, as these installations were all sited slightly inland on tidal rivers.

An examination of the capacity of the vats from the 10 fish-salting sites also could provide relevant data regarding production levels. Although the level of

preservation of some of these sites has deteriorated drastically since their excavation in the late 1950s and early 1960s, it might be possible to estimate conservatively each installation's processing capacity. Although excavation reports do not generally describe the vat dimensions in any great detail, measurements from three installations are obtainable from site plans.[25] At Lixus, there are 142 excavated vats, providing a processing capacity of 1,013 m^3 (Fig. 3). From Cotta's 16 vats, the processing capacity totals 258 m^3; from Sania e Torres' five vats, the processing capacity is 80 m^3.

These capacities are certainly low estimates, taking into consideration, for example, that sites like Lixus have not been fully excavated, or that the extant remains at other sites, like Alcazasegher, are extremely deteriorated. Establishing these numbers, however, might provide a general understanding of supply and resource exploitation in the region. Further analysis could combine this production data with the chronology of each site, to understand production over time. Additionally, as some factories functioned for longer periods than others, it might be possible to examine broader resource distribution and availability over time. Annual production might also vary; for example, some sites, like Sahara and Alcazasegher in the Straits of Gibraltar, could have only been used seasonally during migration periods, while Cotta or the installations at Lixus were certainly used year-round. An allowance also has to made for the production of other products, as some sites also manufactured purple dye from murex shells.[26]

An examination of the particular amphorae that were used to trans-ship the products of these factories in Morocco and throughout the Mediterranean can also provide relevant quantitative data (Fig. 4). The inscriptions and graffiti present on some of these amphorae can, in some instances, provide additional information on types of products and the types of fish used, as well as origin, destination, and transhipment details.[27] Although these ceramic finds from *Mauretania Tingitana* are documented, a large amount is not published; of those that are, they usually are not done in any synthetic manner. My current research involves cataloguing these amphorae types found within the borders of the Roman province, in present-day Morocco and Spanish Ceuta. This cataloguing involves looking at find sites as well as places of manufacture. This compilation will hopefully contribute to quantifying a certain amount of the production, local distribution and consumption, trade, and perhaps even the regional organization and domestic extent of the industry. Further analysis would include looking at the Moroccan fish-salting amphorae found at other sites throughout the Mediterranean, particularly on the Italic Peninsula.[28]

Analysis of the ichthyo-archaeological remains from sites and from amphorae, if present, can also provide invaluable quantitative data. In Morocco, fish bones

Fig. 3. The vats of 'Factory 1' at Lixus. The modern road that cuts through the site can be seen at the top of the picture. Photo: ALT

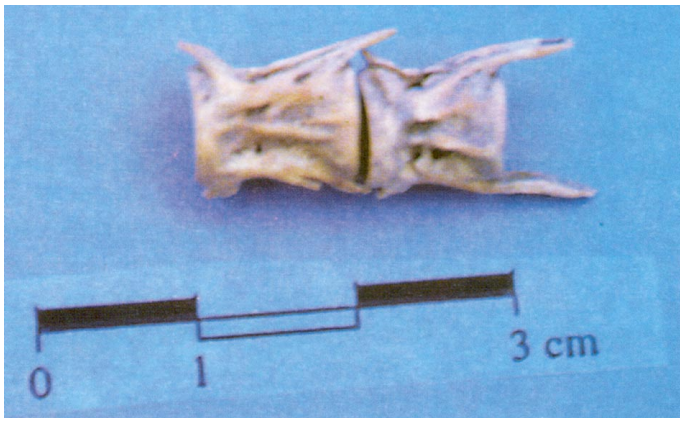
and fish scales were found during the excavations of three of the sites in the 1950s, but no detailed analyses were conducted.[29] However, ichthyo-archaeological studies have been conducted on some material from the Neolithic Atlantic coastal sites, and a thorough study was done with materials excavated in 1999 from Lixus.[30] At the latter site, fish types and distribution in the Pre-Roman, that is, Phoenician and Punico-Mauretanian occupation layers are described (Fig. 5). Estimates of the fish sizes are not discussed, but the fish types and their amounts provide information on local fishing grounds and consumption habits.

Only at the now-Spanish enclave of Ceuta have ichthyo-archaeological remains from Roman-period fish-salting vats and amphorae been analyzed. Mackerel *(Scomber japonicus)* is the most common type found at the sites, but also present are the remains of John Dory *(Zeus faber)*, tunny *(Thunnus thynnus)*, Atlantic bonito (*Sarda sarda)*, grouper *(Epinephelus)*, Spanish mackerel *(Scomber japonicus)*, Atlantic horse mackerel *(Trachurus trachurus)*, and sea bream (*Pagellus acarne*). The diversity of these faunal remains could suggest diversity in the types of fish sauces and salted-fish products.[31]

If further analyses of ichthyo-faunal remains from these sites were conducted, the data could assist not only in identifying local fishing grounds and consumption preferences, but also provide a base for comparing fish size from the Roman period to that of today. *Salsamenta* remnants preserved inside southern Spanish amphorae have been analyzed in this manner: in the amphorae of the cargo of the first-century AD shipwreck *Sud Perduto II*, in the Straits of Bonifacio, were the skeletons of one species, *Scomber japonicus*. In one amphorae were 25 large mackerel, each ca. 40 cm long, and weighing an estimated 650 g.[32] *Scomber japonicus* is also present inside amphorae

Fig. 4. One of the amphorae produced in *Mauretania Tingitana* to transport salted-fish products. Type Dressel 18/Mañá C2b at the Tetuan Archaeological Museum, Morocco. Photo: ALT

Fig. 5. Vertebrae of *Scomber japonicus* recovered from Phoenician layers at Lixus in 1999. After Grau Almero, *et al.* 2001: 219, fig. 16.



[25] Ponsich & Taradell 1965: 9-37; 57, 76-77
[26] Hita Ruiz & Villada Paredes 1994: 49-50; Ponsich & Taradell 1965: 39, 102
[27] Liou 1987: 68-69; Curtis 1991: 65, n. 94
[28] Carandini & Panella 1981
[29] Jodin 1966: 12; Curtis 1991: 69
[30] Grau Almero, *et al.* 2001: 204-220
[31] Villaverde Vega & López Pardo 1995: 463; Hita Ruiz & Villada Paredes 1994: 49-62
[32] Desse-Berset & Desse 2000: 75-77

from another southern Spanish shipwreck of the same period at Port Vendres *(Cap Béar III)*. These mackerel are each ca. 33 cm long, and weighed an estimated 320-350 g.[33] Such measurements can certainly be compared to present-day catch sizes in the region.

4.2 Qualitative data

Contemporary qualitative data, such as the limited iconographic evidence from the province and textual references that discuss the region's marine life, can be cautiously applied to supplement the available archaeological data from the fish-salting industry in Morocco. Some texts do note types of fish present in the local waters, as mentioned earlier; moreover, the descriptions of locations of fishing effort and fishing technology might also be better understood within the context of archaeological evidence.

For example, at the site of Cotta, the south-western corner of the building houses a square addition, thought by the excavators to have been a watchtower, or more specifically, a tunny watchtower (*thunnoskopeion*).[34] Such towers, mentioned by Strabo (5.2.6; 5.2.8; 17.3.16), were utilized by lookouts who could spot the migration of the fish by observing changes in the colour or surface pattern of the ocean caused by the dense schools. The practice of observing tunny in this manner is also mentioned by Pliny (*NH* 9.44, 9.47). Such purpose-built towers are present elsewhere in the Roman world, but were also used during later historical periods in southern Spain.[35] The fixed nets used to capture these schools, referred to as *Al-madraba* nets, were described by Oppian in the third century AD (*Hal*. 3.597, 641) and again in fourteenth to late eighteenth-century Spanish treatises.[36] Presently, five to six *Al-madrabas* are established in Moroccan Mediterranean waters near the Straits. Four to five *Al-madraba* nets are set in Atlantic waters, all of which are established just south of the site of Cotta.[37]

5. Conclusions

The fish-salting industry that flourished during the Roman provincial period in northern Morocco provides some of the earliest, detailed evidence for marine resource exploitation in the region. Ranging in date from the first century BC to the fifth century AD, the archaeological remains of this industry provide primary evidence of early fishing efforts in the region. I believe that from the various preserved remnants of the industry, it is possible to provide pertinent, quantitative data to assess an early state of marine resources in the south-western Mediterranean. Qualitative data, which is very limited for Morocco, can possibly supplement the interpretation of this information. Although there are some constraints on using both data types, I hope that the information presented here will be seen as useful towards the aims of the HMAP-Mediterranean project. A long-range view over five centuries of human interaction with the marine environment would help to understand ecosystem dynamics and change in the little-studied south-western Mediterranean/North African region.

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[33] Desse-Berset & Desse 2000: 79-80

[34] Ponsich & Taradell 1965: 60-61

[35] Cf., the 16th-century engraving by Georgius Houfnaglius of tunny fishing in Cadiz

[36] Hita Ruiz & Villada Paredes 1994: 51-53; see also references in article by D. Florido del Corral circulated at the HMAP-Mediterranean workshop

[37] INRH 2002: 130-135

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