Université de Montréal

Lighting the Wine Dark Sea,
A Typology of Ancient Lighthouses
Based on Archaeological Evidences

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Mémoire présenté à la Faculté des études supérieures
en vue de l'obtention du grade de maîtrise
en études classiques
option archéologie classique

avril 2007

Université de Montréal
Faculté des etudes supérieures

Ce mémoire intitulé:

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Mémoire accepté le 30 avril 2007

Résumé en français du mémoire: Lighting the Wine Dark Sea: A Typology of Ancient Lighthouses Based on Archaeological Evidences.

En effectuant une étude comparative de vestiges archéologiques de certains phares dans l'antiquité, ce mémoire tente d'établir une typologie des phares anciens.

Le travail comporte 2 volets :

Le chapitre 1 procède à des études individuelles sur chaque phares sélectionnés abordant certains aspects prédéterminés tel: la localisation géographique et physique, le contexte, l'histoire, le plan, les dimensions, les matériaux de construction, la présence de statuaire ou inscriptions religieuses ainsi que les combustibles. Les phares représentés sont : Boulogne-sur-Mer, Féjus (la Lanterne d'Auguste et le phare de la Butte Saint-Antoine), Dover (Eastern Pharos et Western Pharos), Ostie, La Coruña, Cherchel, Leptis Magna et Pharos.

Le chapitre 2 conduit des études comparatives analysant entre eux les différents aspects abordés dans le chapitre 1. Il offre ensuite une typologie qui, d'après les résultats obtenus dans ce chapitre, se base sur la morphologie et la localisation physique des phares dans l'antiquité.

Des illustrations pertinentes au travail viennent compléter ce mémoire.

Les résultats engendrés par cette étude nous démontrent, que dans la plupart des cas, la forme et le plan des phares semblent être influencés non pas par l'environnement géographique mais par l'environnement physique.

Mots clés : archéologie, études classiques, phares, typologie, histoire.

Résumé en anglais du mémoire: Lighting the Wine Dark Sea, A Typology of Ancient Lighthouses Based on Archaeological Evidences.

This memoir proposes to conduct a comparative study based on archaeological evidence of some ancient lighthouses erected between the 3rd century BC and 2nd century AD in order to establish a typology.

In chapter 1, a study of specific lighthouses examines details such as location, context, history, shape, dimensions, construction material, statuary and religious inscription, fuel as well as function. The lighthouses investigated are: Boulogne-sur-Mer, Frejus (2) (Lanterne d'Auguste and Butte Saint-Antoine), Dover (2) (Western Pharos and Eastern Pharos), Ostia, La Coruña, Cherchel, Leptis Magna and Pharos. They were selected on the basis of their archaeological evidence.

Chapter 2 consist of a comparative analysis, topic by topic, of the above-mentioned lighthouses in order to propose a tentative typology based on the morphology of lighthouses and their physical environment.

Illustrations and geographic maps complete this work.

The results yielded by this study show that the morphology of lighthouses are more likely to be dictated by the physical environment than their geographic locations.

Mots clés: archaeology, classics, lighthouse, typology, history.

Contents

LIGHTING THE WINE DARK SEA: A TYPOLOGY OF ANCIENT LIGHTHOUSE BASED ON ARCHAEOLOGICAL EVIDENCE

INTRODUCTION:

According to the *Concise Oxford Dictionary* (1982, 582), a lighthouse is a: "tower or other structure containing beacon light to warn or guide ships at sea". For the purposes of this study, these are the elements which will determine what lighthouses will be reviewed in this thesis: an architectural entity with a beacon used to guide ships.

Ancient lighthouses are constructed out of stone and brick. They take the form of a tower, but can be of different shapes: octagonal, square, round, and rectangular. The beacon is located at the top, sometimes in a cupola. Inscriptions were embedded in the walls of some lighthouses and frequently name the builder and/or a dedication to a deity. Images of lighthouses on Greek and Roman coins, glass vessels, and mosaics show that they often included statuary decoration of emperors and/or deities. Lighthouses are located variously at the entrances of harbours, usually at the end of breakwaters, or on isolated cliffs above the coast, approximately a few kilometers from the harbour installations.

The first evidence for lighthouses in the Ancient Mediterranean comes in Homer's *Iliad* and tells of beacons lit on the beaches or upon rocky cliffs to guide ships:

"Then he took up the great thick shield, which flashed in the distance like the moon, or like the gleam that sailors catch at sea from a fire on a lonely upland... " (Homer, *Iliad* XIX-375). This is not strictly a lighthouse but acts as an aid to navigation and fulfills the same function.

Archaeological evidence for lighthouses begins in the 6th cent. BC with a structure at Thasos in Greece (Empereur, Archontidou-Argyri, Simossi 1989, 51-59). This small tower, made out of stones, measures approximately 1.50m. The beacon, located on the top, is accessed by a ladder (Fig. 23). Very few of these early aids to navigation survive, but it is also probable that major harbours like Piraeus featured lighthouses.

The lighthouse built at Pharos marked a turning point in lighthouse technology. The solid structure made of granite and measured approximately 130m in height. A concession to aerodynamics can be observed: the lower level was square but the upper receding levels were octagonal and cylindrical. At high altitudes, were wind is prevalent, these shapes offered less resistance. Pharos seems to have established some guidelines which were going to be observed from then on: the receding levels and the aerodynamic shape.

The Roman world saw the inclusion of many lighthouses as a common feature of harbours. These lighthouses occur in numerous configurations, building materials, sizes, and often display decorative features. Despite these differences, they all serve the same purposes, and at least some of the Roman examples show a consistency of construction as well.

The visibility of these beacons is difficult to gauge, although Josephus claims that the Pharos at Alexandria could be seen at 60 kilometers away or "three hundred furlongs away" (Josephus, *Jewish Wars* IV-612). These obviously would have required huge amounts of fuel.

Precise details are unavailable but options would have included olive oil, pitch, coal, and petroleum by-products (Greek fire).

Despite the importance of lighthouses in ancient seafaring, few physical remains are available for study. The location of lighthouses, often at the edge of cliffs, and their great height make them fragile and prone to disasters, such as tsunamis, earthquakes and erosion. Their primary use can also be altered and their shapes distorted over time, making their identification and also study particularly difficult.

Also lacking is the ancient testimonia, which tends to be of a very general nature, even when a specific lighthouse, like the Pharos, is mentioned; nonetheless, these do not always provide detailed data permitting a reconstruction. Authors like Pliny the Elder (XXXIV-83), Josephus (*Jewish Wars* IV-612), and Suetonius (*Caligula* 46 and *Claudius* 20) refer to lighthouses in this general manner.

Secondary scholarship on specific lighthouse sites is frequently vague and seldom conclusive. Several publications, however, are noteworthy and useful. In the 19th century, Jean Allard, a lighthouse engineer appears to have been the first to address the subject (Allard 1898). In 1909, a German archaeologist, Hermann Thiersch (Thiersch 1909), wrote a monumental opus on the lighthouse of Pharos. This lighthouse is today under excavation by Jean-Yves Empereur and an underwater team (Empereur 1998). Michel Reddé established a "typology" of ancient lighthouse from representations on in the pictorial arts (Reddé 1979).

The material addressed in this thesis ranges from the 3rd century BC into the 2nd century AD. All classes of evidence are considered, where available. Not every extant lighthouse has been included, and the ten examples were selected on the basis of availability of primary and

secondary evidence; this study is ongoing and further lighthouses will be added in future research.

The first chapter presents the archaeological evidence. This includes a brief catalogue entry for each lighthouse that contains data such as chronology, location, material, and shape. Following each entry is a discussion of the lighthouse, with focus upon its particular issues. These are presented by continent (Europe, North Africa), and then by country, moving from the northern most Roman province to the south (Britain to Egypt).

Chapter 2 contains comparative analyses of the data in Chapter 1and proposes a tentative morphological typology based on the results of these analyses.

Illustrations and bibliography are collected at the end.

Chapter 1: Archaeological Evidence

Within each catalogue entry, the following information is offered: country, specific location at the site, patron's name (if known), shape of the lighthouse, building materials, date (if known), dimensions (if known), statuary decoration and epigraphical evidence. Also included are the primary and secondary sources pertinent to each example as well as the illustration included in the Appendix of this thesis.

Europe

England: Dover (Ancient Dubris)

Dover preserves remains of two ancient lighthouses: the Eastern or Castle Pharos, and the Western Pharos. Both lighthouses once dominated the cliffs of Dover

1. Eastern or Castle Pharos

Location:	Cliff, ca. 1.3km east of Roman harbour; 23m from cliff edge; 116m above sea level.
Patron:	Unknown
Shape:	Octagonal
Materials:	Mortar and bricks with imported green stone facing
State of Preservation:	Lower 13m (Roman); later incorporated into church of St. Mary in Castro.
Fuel:	Unknown
Date:	1st century AD (?Claudian)
Dimensions:	Ht: 19m (including 5.8m Mediaeval); W. of each side: 4.60m
Sculpture:	None
Epigraphy:	None
Primary Sources:	None
Secondary Sources:	Wheeler 1929.
Illustration:	Figs. 9-12

The history of the Eastern Pharos is vague and lacks sufficient sources. Its construction may have been prompted by the Roman invasion of Britain by Claudius 43 AD (Suetonius, *Claudius*, 17). This resulted in increased crossing of the English Channel, which features high cliffs and few safe anchorages. A lighthouse was required and probably built

at this time. The point at which it ceased to function is unknown, but ca. 1000 AD, it was incorporated into the church of St. Mary in Castro, which was built around it. In 1247, Henry III ordered repairs and alterations to be at this church, and by 1252, three bells cast in Canterbury were sent to the church and hung in the tower; by this date, the Eastern Pharos had been converted into the church's bell tower (Wheeler 1929, 34). By 1690, no public worship was occurring in the church, and in 1808 it collapsed and was used as coal storage. In 1888, the church and Eastern Pharos were restored 1888[1]. No formal excavations have been conducted on this structure, but in-depth studies have been undertaken by the Office of the Works (Wheeler 1929, 29).

The Roman Eastern Pharos is octagonal, but its interior layout is square. Its exterior elevation is formed of receding levels, five of which are extant. Each of these levels is separated by a plinth, which recedes 0.3m on each storey, except between the base and the first storey where the plinth is 0.46m. The plinths between the levels recede 0, 30 m each story, except between the base and the first story where the plinth measures 0, 46 m. It is estimated that the complete lighthouse would have contained eight such levels with a parapet on the ninth level, to a height of approximately 25m. Each level had a floor of wooden planking resting on two main beams. These were held in square sockets in the south and north walls. Sockets have also been found in the south-east and north-east corners, where it is believed that they supported angle beams connected to staircases.

The ground floor was accessed from the south side through an arched door 3 meters high. This doorway is 4m deep, with a ceiling 5.40 in height. The northern wall is pierced by an

[1] www.dover.gov.uk/musuem/history/stmary.asp November 16th 2006. Article written by Thomas Hastings

arcuated recess 3,40m high with a small arched window on the top. There seem to have been other openings along the ground-floor walls, but these were altered medieval renovations.

The second, third and fourth levels are between 2,30m to 2,50m in height. These preserve traces of original openings or windows that measure 1.9m to 2m in height. The thickness of the walls is reduced with each successive level, with thicknesses at the lower levels of 2.44m to 1.90m at the upper level.

The beacon was probably located within the parapet on the top of the lighthouse. The Medieval re-use of the structure has eliminated any traces of this area, and the nature of the fuel used for the flame is unknown.

The core of the walls is *opus quadratum* made of rubble in white mortar and faced in green sandstone and tufa held together with pink brick dust mortar. It is leveled externally at a rate of seven courses of masonry with two courses of bricks. The bricks are 0,04m thick, with an area of ca. $0.7m^2$. Their surfaces are scored for adhesion to the mortar. The bricks exhibit four knobs at each corner. The mortar joints measure 0,04m in width. The arched windows are formed by alternating pairs of tiles and blocks of tufa that produce a polychrome effect. Bricks stamped with CL.BR (*Classis Britannica*) (Fig. 13) were found in the area of the lighthouse in 1899, but their relationship to the structure is unclear (Wheeler 1929, 39).

The Eastern Pharos is at the northern part of the site of Dover. Immediately to the south-west lies the Roman fort, and further south is the Roman harbour. The lighthouse is isolated from both of these features, constructed on a high cliff, ca. 610m from the harbour. The existence of the Fort and the location of the site suggest that this lighthouse was military in nature. Its isolated

location suggests that it was used to warn ships of coastal dangers rather than illuminating the harbour's location.

2. Western Pharos

Location:	Cliff; 300m from Roman harbour; 1.2km from Eastern Pharos.
Patron:	Unknown
Shape:	Hexagonal/octagonal.
Materials:	Mortar and bricks with local stones
State of Preservation:	Several masonry levels, built into the casemate of the Kent military camp (1861)
Fuel:	Unknown
Date:	Unknown (later than Eastern Pharos)
Dimensions:	W. preserved side: 3.60m
Sculpture:	None
Epigraphy:	None
Primary Sources:	None
Secondary Sources:	Wheeler 1929.
Illustration:	Figs. 9, 14-15.

The date for the construction of the Western Pharos is unknown. The earliest documentation for this lighthouse dates to 1701, when antiquarians referred to the structure as a tower or pharos. This material, including drawings from the 18th century, shows a rapid deterioration, and by 1760, it was reduced to a large shapeless form of masonry and was no longer referred to as pharos by the locals but rather by names like the Bredenstone or the Devil's Drop (Wheeler 1929, 44). In 1805-6, threats of invasion led to the swift building of fortifications in the vicinity of the Western Pharos. Part of its masonry was reused in the building of these, while the rest of the lighthouse structure was buried under a mountain of masonry left over from this construction (Wheeler 1929, 43), and the lighthouse completely disappeared from view. In 1861, excavations were undertaken by the army to alter the fortifications and build new barracks. This led to the rediscovery of some the walls of the Western Pharos. These can now be seen as part of the barracks redoubt known as Fort George (Wheeler 1929, 43).

Information regarding the Roman lighthouse is available in journals kept by Knocker during the construction of the new barracks in 1861.[2] It seems to have been built on a platform set upon a flint level, both ca. 38.1cm thick; the flint foundation extends ca. 1.90m beyond the platform. The entire platform was not excavated, and it seems that Knocker revealed only part of this structure. He suggested that it was hexagonal, and notes the width of one outer side to be "twelve or fourteen feet" (3.60m or 4.30m) (Wheeler 1929, 43). If this is accurate, the Western Pharos would be somewhat smaller than the Eastern Pharos, since 8 sides of 4.60m are larger than 6 sides of 4.30m. It seems unlikely that a second lighthouse of smaller dimensions would serve this harbour site adequately, since it would not significantly augment existing illumination. Knocker's interpretation of a hexagonal lighthouse is also refuted by Wheeler, who notes that these dimensions for the outer side are the same as for the sides of the Eastern Pharos, an octagonal lighthouse (Wheeler 1929, 44). This implies that the two Dover lighthouses were the same shape.

The location and nature of the beacon for this lighthouse is unknown due to the paucity of preserved remains and their accessibility.

The platform is solid, fashioned from very hard, reddish concrete with flint mixed with Kentish rag-stones and longitudinally placed tiles. There appeared to be only one layer of tiles of various sizes and thicknesses. Unlike the Eastern Pharos, which was built entirely of imported material, the Western Pharos is made of local stone and tile, which Wheeler considers recycled; this combination is frequently observed in later Roman constructions in Britain (Wheeler 1929, 45). It is logical to assume that the initial Roman lighthouse on the site was built of stone brought

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[2] Knocker 1862, 47; cited by Wheeler 1929, 43.

in by the Romans during their early visits to Britain, but that local stone was later discovered to be satisfactory.

A singular feature of this lighthouse is a thick layer (0.30m) of charcoal from burnt wood and animal bones that was excavated on top of the lighthouse masonry platform (Wheeler 1929, 44). It is unlikely that this is the remains of Roman ritual sacrifice, although a medal of Commodus represents a bull sacrificed in front of the lighthouse at Boulogne-sur-Mer (Fig. 3). The full height of the Western Pharos is not known, and the 19th century digging located the platform only 3.40m below modern ground level. This cannot be the ancient top surface with the beacon, since it is implausible to conceive of at least 20m below this platform, and the burnt remains are probably post-antique.

The Western Pharos lies due south-west of the Roman Fort and north-west of the harbour; the fort is located approximately mid-way between the two lighthouses. Its beacon would have illuminated the harbour more than the Eastern Pharos, but was far enough away that it does not seem to have constituted part of the harbour installations. The necessity of a second lighthouse may be due to the placement of the first: the Eastern Pharos indicated coastal dangers but did not identify the harbour's location.

3. France: Boulogne-sur-Mer (Ancient Gésoriacum) / La Tour D'Ordre

Location:	Cliff, away from harbour, ca. 0.5km from entrance to harbour canal; 2km from Roman harbour
Patron:	Unknown
Shape:	Octagonal.
Materials:	Local yellow and grey stone, brick
State of Preservation:	None
Fuel:	Unknown
Date:	1st century AD (Claudian)
Dimensions:	Ht: 66m; Diam: 19.40m; W. of side: 8m
Sculpture:	None preserved
Epigraphy:	None preserved
Primary Sources:	Suetonius, IV-45-46
Secondary Sources:	D'Erce 1966
Illustration:	Figs. 1-4

Boulogne-sur-Mer is the point in northern France that represents one side of the narrowest passage across the English Channel; it faces Dover. It is also the harbour from which Caesar and Claudius launched their invasions of Britain in 55-54 BC and 43 AD (Suetonius, *Claudius*,17; Will 1980, 92). The construction of a lighthouse here may have been connected with Caligula's aborted invasion of Britain in 39 AD (Suetonius, *Caligula*, 46): "...commemorating this victory by the erection of a tall lighthouse, not unlike the one at Pharos, in which fires were to be kept going all night as a guide to ships" (Suetonius, *Caligula* 46).[3] Boulogne-sur-Mer is located at the nexus of the Germania and Gaul-Britannia routes, and also offers an enclosed harbour near the sea. If

this lighthouse can be connected with Caligula, it may have been still unfinished at the time of his death in 41 AD and perhaps completed under his successor Claudius, after his own successful invasion of Britain; it would have been built by soldiers. Claudius is known to have raised the

[3] "...et in indicium victoriae altissimam turrem excitavit, ex qua ut Pharo noctibus ad regendos navium cursus ignes emicarent..." (Suetonius, *Caligula*, 46.)

Classis Britannica for the invasion (Cleere 1977, 16), and after he established Roman supremacy over parts of Britain, he might have needed to establish a naval route between Britain and France to ensure the transport of troops and supplies. Boulogne-sur-Mer also preserves evidence of the *castrum* of the *Classis Britannica* (Will 1980, 89)

With the fading of the Roman Empire in Britain during the 5th century AD, the lighthouse at Boulogne-sur-Mer ceased to be used and no further maintenance was undertaken on it until the 9th century AD, when the Emperor Charlemagne repaired the upper part of the lighthouse and used it for navigation during his expedition against the Normans (D'Erce 1966, 91). This marked the lighthouse's reentry into service. In 1544, Henry VIII, while occupying Boulogne-sur-Mer, took over the lighthouse as a watchtower, since it provided a strategic view over the surrounding area. He had ramparts erected around the lighthouse and filled it with artillery. A garrison of about 600 to 1000 men occupied the lighthouse until 1559 when the French reclaimed the tower (D'Erce 1966, 93). Since the 14th century, the cliff underneath the lighthouse had been subject to illegal quarrying. The city of Boulogne-sur-Mer tried to restrain this activity, but it continued, and, in 1644, half the lighthouse collapsed. In 1687, what remained was repaired and the beacon re-lit. By 1693, the beacon was fueled by straw and coal (D'Erce 1966, 94). Eventually the lighthouse collapsed into the sea due to the continued erosion of the cliffs. All archaeological remains are now submerged (D'Erce 1966, 94-95), and the area is today very unstable; the "Chapelle des Marins" built near the site collapsed into the sea in 1990.[4]

There are no accessible physical remains of this lighthouse, but 16th century prints and medieval texts aid in reconstruction (D'Erce 1966, 93). It seems to have been octagonal and made

[4] Personal comments from Madame Angelique Demon, Chef de Service, service Archéologie de la Ville de Boulogne-sur-Mer, April 13th, 2005.

of twelve successive levels, each one narrower than the last from the base, at the Eastern Pharos at Dover (Cat. 1). An early scholar, Egger, claims that the lighthouse was 66m high and that each side was about 8m wide.[5] Each level measured 5.0m to 5.50m in height and was offset by ca. 0.45m. The circumference of the base was equal to its height, and the diameter was ca. 19.40m. Each level contained eight apertures each, either doors or windows (Allard 1898, 32; D'Erce 1966, 91).

The levels of the lighthouse consist of alternating courses of yellow stone, grey stone, and red brick, all set in mortar (D'Erce 1966, 91). A. Demon, the Chef de Service, for Boulogne-sur-Mer (See footnote 4), states that these stones come from the nearby quarry of Bainthun and Marquise. The red bricks and mortar might have been manufactured locally; there is no evidence of brick manufacture in the area, and these might have been imported from Italy.

A 17th century Dominican monk, Lequien, provides a description of the masonry, from bottom to top:[6]

1- Three courses of gray stones from the coast
2- Two layers of yellow stones
3- Two rows of red bricks
4- Three layers of gray stones
5- Two or three rows of red bricks
6- Three rows of yellow stones
7- Two rows of gray stones
8- Two rows of red bricks
9- Two rows of yellow stones
10- Three courses of gray stones

[5] Allard 1898, 31, mentions Egger but provides no other reference information.
[6] Lequien, cited in Allard 1898, 32.

It has been suggested that nine of these courses represent one architectural level, with the tenth course beginning the next. The bricks were 3.70m thick, but the dimensions of the stones are not known (Allard 1898, 32).

The Boulogne-sur-Mer lighthouse is believed to be represented on one ancient monument, a medal minted under Commodus (Fig. 3) to commemorate an excursion to Britain. This medal represents a man, possibly Comodus, and a woman standing in front of the lighthouse at Boulogne-sur-Mer. Also shown are ships sailing and a sacrificed bull floating in the water. The inscription on the medal states *votis felicibus.*

There is no ancient evidence for the type of fuel used at this lighthouse. An account dating to 1691, however, lists amounts of straw and coal for lighting the beacon (D'Erce 1966, 94) in its later phase.

The Roman harbour at Boulogne-sur-Mer is located inland, connected to the sea by a narrow canal. The lighthouse stands on a 50m cliff about half a kilometer from the entrance of this canal and about two kilometers from the Roman harbour, the Portus Itus (D'Erce 1966, 91; Will 1980, 92). The lighthouse is therefore not part of the harbour installations and probably identified the entrance to the canal. It was not, however, placed directly at the mouth of the canal but rather 0.5km from it, which suggests that it was used as a warning signal (Fig. 4). It may have alerted ships to unfavourable tides, thus signaling them to proceed no further until there were suitable sailing conditions; this also seems to have been the case at Alexandria (Josephus, *Jewish Wars* IV-612). This is confirmed by a 1643 text by Fournier, the *Hydrographie*, wherein the

author notes that the beacon at Boulogne-sur-Mer was only lit when the tide was high enough to let the ships into the canal[7].

The deliberate use of polychrome building enhances the structure's visibility and identification; it may have been used as a daylight signal. There is also a degree of display inherent in the relative wealth required to build such a lighthouse. A building commissioned by imperial degree and probably built by the Roman army would make a powerful statement regarding power and domination in a Roman province.

[7] Citation in D'Erce 1958, 95, without further information.

4. Frejus-Lanterne d'Auguste-(*Forum Julii*)

Location:	South West along the Canal leading to the Roman harbour, 400 meters from the second lighthouse at Butte saint-Antoine.
Patron:	Unknown
Shape:	Hexagonal
Materials:	Mortar and stones
State of Preservation:	Rebuilt in the 19th century.
Fuel:	Unknown
Date:	Unknown
Dimensions:	H. 11.19m, Sides 1.50m
Sculpture:	None
Epigraphy:	None
Primary Sources:	None
Secondary Sources:	Gébara, Béraud, Rivet 1998.
Illustration:	Figs. 6-7.

Frejus is a coastal town located near the Côte D'Azur in the Var department of Provence. Its ancient harbour, now completely silted (Fig. 6), was not located by the ?modern seafront, and access to it was gained by a waterway reminiscent of the ancient harbour at Boulogne-sur-Mer. The harbour is believed to have been built prior to the second *triumvir* and was made famous by Octavian, who brought to Fréjus the ships captured from the defeated Mark-Anthony at Actium (Reddé 1986, 171). Recent excavations of the site revealed that the harbour was used as a military base during the reign of Augustus, between 45-25 BC. (Reddé 1986, 171-173, 177) Two structures have been identified as lighthouses: the Lanterne d'Auguste, and the main tower on the Butte Saint-Antoine. There are no references to these lighthouses among the ancient sources.

According to Reddé (1986, 173), the construction of the Lanterne d'Auguste appears to have post-dated that of the harbour. The structure, which was rebuilt during the 19th century (Gébara, Béraud, Rivet 1998, 55), is a hexagonal tower topped by an equally hexagonal pyramidal top (Fig. 7). Each side is 1.50m wide with a height of 2.86m to the base of the

pyramidal's apex, where there is a narrow decorative cornice of about 0.38m. The pyramidal apex measures 3.21m. The Lanterne d'Auguste was erected on a 4.64m concentric semi-circular double platform. The lower part of the platform measures from its base 1.80m high, while the upper section of the platform is 2.84m high. This gives the whole structure a height of 11.19m[8]. It is made of *opus quadratum* and lacks some of the elements required to function as lighthouse. First, there is no identifiable beacon area. The pyramidal roof offers no apertures for lighting a beacon, and its shape would not offer a place for lighting a signal (Reddé 1986, 176). Second, the tower displays no openings for the light to shine through, a feature common to all ancient and modern lighthouses. Windows are usually pierced through the walls of lighthouses, especially along the inner staircase, to facilitate indoor lighting during the day. This enables the light keepers to carry out their daily duties without the constant use of lamps or torches. The only other possible alternative is an outdoor staircase that might have run along the sides of the lighthouse to the top, but there is no evidence for this feature. There are also no artistic representations of the original lighthouse and it may well have been altered during its reconstruction in the 19th c. On the other hand, the Lanterne d'Auguste may have functioned as a sea-mark: in daylight, sailors would have been able to stay their course by aligning their ships with it.

The Lanterne d'Auguste is not part of the harbour installations, but it is nonetheless located along quays south west of the entrance of the harbour and 400m south of the tower at Butte Saint-Antoine. These quays follow a canal of about 460 m long leading from the sea to the harbour (Reddé 1986, 176). The location of the lighthouse half-way along the canal suggests that it could not have been used to indicate its entrance. Its position closer to the harbour might have

[8] The dimensions for the Lanterne d'Auguste have been taken from the web site: http://trajanus.rediris.es/textos/portaug_fr.htm#_ftn1, author Vito Valenti (2002). April 18, 2007

indicated a maneuver to the ship's pilot who would have needed to prepare to veer starboard to reach the harbour. It might also have indicated the presence of shoals. The fact that the harbour is now silted suggests a problem shoals.

5. Frejus-Butte Saint-Antoine-(*Forum Julii*)

Location:	Along the rampart of Butte Saint-Antoine, west of harbour.
Patron:	Unknown
Shape:	cylindrical
Materials:	Mortar and stones
State of Preservation:	Lower part of the structure remains
Fuel:	Unknown
Date:	Unknown
Dimensions:	H. unknown, Diameter 7.20m
Sculpture:	None
Epigraphy:	None
Primary Sources:	None
Secondary Sources:	Gébara, Béraud, Rivet 1998.
Illustration:	Figs. 6-8.

Located on the south-west side of the harbour, the Butte Saint-Antoine protects the eastern side of the site with ramparts, along which were erected three circular towers (Fevrier 1962, 208). One of these towers is located on the waterfront is thus believed to have been a lighthouse. The remains of this structure show a cylindrical tower with a diameter of 7.20m (Fig. 8) (Fevrier 1962, 208). There are also traces of the second floor. This structure has four doors: one leading to the citadel, one to the quays, and two leading to the interior of the ramparts. The main floor of the lighthouse therefore appears to have served as a passageway to the interior of the fortress.

The masonry used for the construction is *opus incertum*, a thick agglomeration of rubble in mortar faced with irregular stones. The dimensions of the stones vary between 0.15 to 0.20 m and the joints between the dressed stones are calibrated between 1 and 2 cm (Février 1962, 14).

There is no evidence for the kind of fuel used as the illumination at this lighthouse. Since the upper part of the structure is inexistent coupled with the lack of pictorial representation it is also not possible to determine the structure of its beacon. From its position on the south-west

side of the harbour, this lighthouse likely indicated the entrance to the harbour. It might also have been used as a warning signal to indicate the ramparts to the ships and let the mariners know that they had to veer port in order to reach the harbour. The lighthouse therefore may have played a duel role of acting as a coastal warning as well as indicating the way to the harbour.

6. Italy: Ostia

Location:	At the end of the west mole (mount Arena) in the harbour of Claudius.
Patron:	Emperor Claudius
Shape:	Square
Materials:	Unknown, mortar
State of Preservation:	Base of the lighthouse made from a sunken ship filled with mortar.
Fuel:	Unknown
Date:	1st century AD (between 41 and 54 AD)
Dimensions:	Unknown
Sculpture:	None preserved, but might have had statue of Claudius on top.
Epigraphy:	None preserved
Primary Sources:	Suetonius, Claudius 20.
Secondary Sources:	Testaguzzo 1970.
Illustration:	Figs. 16-19

The city of Ostia is located west of Rome; its sea front harbour lies to faces north. The harbour is divided into two sections: the Claudian harbour, and the Trajanic harbour. Claudius commissioned the construction of a harbour that included a lighthouse in 42 AD (Suetonius, *Claudius*, 20). From Ostia goods could be conveyed by barge up the Tiber to the ever-growing population of Rome. Despite the constant silting problems of the Tiber, which made it difficult to transport the merchandise to Rome, the harbour remained active throughout the 1st century AD. The harbour also did not offer good protection against the elements to the berthing ships. Tacitus recalls an incident in 62 AD where a violent storm left more than 2000 ships in a state of disrepair (Tacitus *Annals* XV, 18, 2). This problem, coupled with the silting of the Tiber, prompted Trajan to launch the construction in 100 AD of a second harbour within the Claudian port. He also had a passage dug, the *fossa trajana*, to enable the barges to reach the Tiber more easily (Chevalier 1986, 123). The port remained active until the 6th c (Chevalier 1986, 20). After that date, it fell into ruin and constant silting eventually buried it. After the 6th c., written

evidence is scarce and notes regarding the decaying harbour of Ostia reappear only in 18th c. travelers' accounts (Chevalier 1986, 20). In the early 1960s, Italy's need for an international airport near Rome prompted salvage excavation under the direction of archaeologist Otello Testaguzzo. This led to the discovery of both harbours and the base of the Ostia lighthouse (Testaguzzo 1964).

The only extant archaeological evidence for the lighthouse is the base upon which it was erected. According to scholars as well as ancient texts, the base was constructed by the sinking of Caligula's *mirabilis naves* and filling it with cement (Testaguzzo 1964, 176, Suetonius *Claudius*, 20). The base measures approximately 95m long by 21m wide (Testaguzzo 1964, 176).

The positioning or structure of the lighthouse upon this base is unknown, as are its dimensions. Reconstructions therefore rely on artistic representations (Figs. 18-19). The lighthouse is depicted with a square floor plan and three square receding upper levels. A cupola at the top covers the beacon. There appears to be a large entrance on the main floor. A mosaic from *l'Isola Sacra* shows windows on the three levels, while the mosaic from *The Place of the Corporation* shows what is believed to be entrances on all levels. A consistent element of both representations is the statue on top of the cupola, which might have been a representation of the Emperor Claudius.

The base of the lighthouse was made of *opus caementicium* (Testaguzzo 1964, 177-8). It is not possible, however, to determine what other kinds of building materials were used for the structure itself.

There is also no evidence for the type of fuel used at this lighthouse. The *Torlonia relief* (Chevalier 1986, 1) shows what could be identified as flames or curling smoke coming out of the top of the lighthouse.

A plan of the harbour (Fig. 16) shows that Claudius' harbour was circular and enclosed by two moles. To the south-east is the octagonal Trajanic harbour, which could be accessed from Claudius' harbour by a canal. The lighthouse was located on the west mole of Claudius' harbour now known as mount Arena. The lighthouse was therefore part of the harbour installations. For a long time, scholars were unable to tell whether the lighthouse stood alone on an artificial island, as is shown on the Peuthinger Map (Fig. 5 top), or if it was part of the north mole. Archaeological evidence appears to confirm that the lighthouse was part of the mole. The lighthouse may have been originally set on an island but, as time passed and the tides became treacherous, the attachment of the base of the lighthouse to the northern mole might have provided extra security for the ships by helping to keep out the dangerous currents. Therefore, the lighthouse probably once stood alone on a man-made island, with later constructions provided to attach the base of the lighthouse to the mainland. The lighthouse thus would have been used to indicate the entrance to the harbour, but the silting problems of the area might have engendered shoals; the lighthouse might also have served as a warning to sailors of these dangers.

7. Spain: La Corùna

Location:	On a peninsula near an isolated cliff, 2, 40 km from the harbour.
Patron:	Gaius Sevius Lupus
Shape:	Square
Materials:	Unknown
State of Preservation:	Lighthouse still in service, Roman construction obliterated with new building materials
Fuel:	Unknown
Date:	2nd century AD (Trajanic)
Dimensions:	H.40m, W. 9m
Sculpture:	None preserved.
Epigraphy:	Dedication by Gaius Sevius Lupus
Primary Sources:	Strabo (III)
Secondary Sources:	Hauschild 1976.
Illustration:	Figs. 20-23

Part of the province of Galicia, the town of La Coruña is located in the north-west of the Iberian Peninsula. It is longitudinally aligned with Ireland. The town possesses a sheltered harbour protected by two moles (Fig.20). According to Allard (1898, 26), the site of Brigantium was originally a Phoenician site, from which they left to travel to Ireland where they traded. A lighthouse might have stood there to guide the Phoenician ships. When the Romans established themselves on the Iberian Peninsula, trade was initiated between England, France and Portugal (Allard 1898, 26). By the 2nd c. AD, a Roman lighthouse was erected by Gaius Sevius Lupus, according to a dedicatory inscription found at the base of the lighthouse (Allard 1898, 26, Hauschild 1976, 239).

During the Medieval period, the lighthouse ceased to be used and was transformed into a fortress for the Bishop of Compostella (Allard 1898, 26). Written evidence in the form of an official international document dating to 1685 reveals that a contingent of representatives from England, Holland and France offered to help pay for the repairs of the lighthouse and to render it

back to its original purpose (Hauschild 1976, 239); it is unknown whether these repairs occurred. Another document dating to 1791 reveals that under Carlos V the lighthouse was completely renovated and modernized to resume its original function (Hauschild 1976, 241). At this time, a new shell of granite was built around the original Roman work and a cupola was added to the top. The lighting system was also completely modernized. The lighting apparatus must have been subsequently modernized so that it confirmed to the code of aids to navigation[9]. This is the oldest lighthouse in the world still in service

The lighthouse at La Corùna is square. The Roman section of the lighthouse is thought to have measured approximately 40m high by 9m wide (Hauschild 1976, 240). It was composed of three levels, but these do not recede, unlike the Western Pharos at Dover (Cat. 1) and the lighthouse at Boulogne-sur-Mer (Cat. 3). Instead, they are maintained by three sets of solid double arches inside each successive level (Fig. 21). These arches have now been filled with masonry, but their outlines are still visible. The first level measured approximately 8.89m, the second 8.78m, and the third 12.68m (Hauschild 1976, 239-240). There are many apertures along the walls of the lighthouse for access to its inner rooms.

An interesting feature is the external staircase, which led to the top of the lighthouse (Fig. 22). The staircase was very much part of the structure and was hewn in the rock of the lighthouse. It measured between 1.20m and 1.50m wide (Hauschild 1976, 242). It is thought to have been not so much a staircase but a ramp to allow fuel to be brought to the top by animals. This staircase runs alongside the apertures on the exterior walls of the lighthouse; these apertures might have been used to admit light to the tower as well as to allow access to the different floors of the

[9] A fresnel lens was eventually fitted and its signal can now be seen from 23 marine miles. Information from: http://www.lhdepot.com/database/uniquelighthouse.cfm?value=1185, no author mentioned. April 18th, 2007.

structure (Hauschild 1976, 242). Apart from La Coruña (Cat. 7), the only other lighthouse with a similar feature is a small lighthouse excavated at Thasos (Fig. 23) (Empereur, Archontidou-Argyri, Simossi 1989, 58). The top of the Thasos structure, however, is accessed by a ladder propped against its structure. This also dates to the 6th century BC, (Empereur 1998, 15), while the lighthouse at La Coruña is believed to have been built during the 2nd century AD (Hauschild 1976, 239). Access ramps in ancient lighthouses are not a novelty: the Alexandrian Pharos seems to have been equipped with an indoor ramp (Empereur 1998, 26-7). In 1791, when the lighthouse was restored, a new staircase was installed inside the structure, and the outdoor ramp/staircase, now obsolete, was covered by a large band of stone (Allard 1898, 29). Its outline is still visible today.

There is no extant evidence of the original Roman building materials, just as there is nothing to indicate the type of fuel or lighting apparatus used in the Roman phase of this structure.

Epigraphic evidence was found carved on a stone at the base of the lighthouse of La Coruña. It is a dedicatory inscription by the builder of the lighthouse which reads:

" Lupus dedicated the lighthouse to Mars."[10]

This lighthouse was not dedicated to a god or gods of the sea but to Mars, often associated with war. Mars was a very important god to the Romans who believed that, having fathered Romulus and Remus with Rhea Silvia, he was their ancestor (Livy I-1). One of the animals sacred to Mars was the wolf (Howatson 1989, 611-2), which might allude to the builder's name. Mars association with Spain is seen in the conflation of the god Mars and the Iberian God

[10] "Marti Aug Sacr C Sevius Lupus Architectus Aeminiensis Lusitanus Ex Vo." in Hauschild 1976, 255.

Capriociegus, indicated in two inscriptions found in the northwest of Spain, at Pontevedra, not far from La Coruña (Green 1992, 140). The dedication to Mars may also have been thought to protect warships.[11]

The lighthouse at La Corùna is located ca. 2, 40 km from the harbour, on a peninsula near an isolated cliff. It faces the sea and is set diametrically opposite the harbour by way of land (Fig. 20). The lighthouse is not part of the harbour installations. Like the lighthouses of Boulogne-sur-Mer (Cat. 3) and at Dover (Cats. 1 & 2), it was constructed on a cliff, a location implying that ships would have had to make a large detour around the cliffs and coast, sailing to south east, in order to reach it. We have no evidence for any other lighthouse located near the entrance of the harbour at the end of the moles.

From its location, the lighthouse appears to have been established as a warning signal for a dangerous coast. With sailing charts, such as the Antonine itinerary, pilots would have known that the harbour was situated east of the lighthouse. The lighthouse's primary function, however, appears to have been as a warning signal.

[11] Personnal comment from Dr.Jane Francis.

Africa

8. Algeria: Cherchel (*Iol-Caesarea*)

Location:	Cliff, north on the îlôt Joinville.
Patron:	Unknown
Shape:	Octagonal
Materials:	Angles made of blocks of masonry, walls made of mortar and stone (*Opus africanum*)
State of Preservation:	Foundations and a height of 1.40m of the remaining walls.
Fuel:	Unknown
Date:	1st century AD (?Claudian)
Dimensions:	Diameter 18m, W. of each side: 2.32m, angles 2.51m.
Sculpture:	None
Epigraphy:	None
Primary Sources:	None
Secondary Sources:	Lassus 1958.
Illustration:	Figs. 24-26.

The harbour of Cherchel is situated in North Africa, 75 kilometers from the city of Algiers. The lighthouse is located on a cliff north of a small island called the îlot Joinville (Fig. 25). The lighthouse was excavated in 1958-1959 when the Direction des Phares et Balises responsible for the modern lighthouse erected on the îlot Joinville wanted to install a new antenna (Lassus 1959, 218). Excavations were conducted, and the base of a Roman lighthouse was unearthed.

Little is known of the history of the lighthouse. The Emperor Claudius gave Mauretania Caesarea, where Cherchel is located, the status of *Provincia* (Lassus 1959, 219) in 40 AD, and inscriptions from the necropolis near the harbour state the presence of an *imperial classis* (Reddé 1986, 246). The construction of the lighthouse might be dated to the 1st century AD (Lassus

1959, 219). According to Reddé, the ancient harbour works at Cherchel might have been this military one established by Claudius (Reddé 1986, 246).

The lighthouse seems to have been octagonal (Fig. 26). The northern part is well preserved, while its southern part is largely damaged. The angles at the sides of the lighthouse walls measure 2,5m, exterior, on each side, and 1,85m on the interior, (Lassus 1959, 221). The wall thickness is 1,62m. The height of the walls above is 1,40m (Lassus 1959, 221). The walls of the octagon, between the angles, have a length of 2,32m and a thickness of 1,23m which means that they recede 20cm from the inside. The diameter of the base of the lighthouse is 18m (Lassus 1959, 221).

The base of the lighthouse rests on a shield of rocks produced by a foundation trench in the bedrock. In this were laid courses or large blocks of masonry in an east-west direction (Fig. 27). The masonry is so accurate that the joints between each stone are almost obliterated. Above these, two courses of large dressed stones form the angles of the octagon. Above these eight angles were placed masonry blocks carved out of a single piece of stone. The walls between the angle stones were erected in rubble and mortar. This type of construction is known as *opus africanum*. The northern wall shows imprints of vertical and horizontal wood planks, part of the original coffering used when the mortar was poured (Lassus 1958, 221-2)[12].

There is no available evidence for the kind of fuel and the lighting system used for this lighthouse.

Several statues have been found in the area of the lighthouse: one believed to represent Juno-Caelestis (Lassus 1958, 224); and a statue of Minerva with snakes (Lassus 1958, 224).

[12] Lassus, the director of the excavation, does not offer information as to what kind of stones were used for the construction of the lighthouse.

Neither of these can be securely associated with the lighthouse. No epigraphic evidence was found.

As at the lighthouse at Boulogne-sur-mer (Cat.3), the lighthouse at Cherchel is not located within the harbour installations but rather is isolated. It stands with its back to the harbour on the northern tip near a cliff on the îlot Joinville (Reddé 1986, 245). The cliff is constantly buffeted by strong winds and waves and appears to have eroded over time; some of the other buildings near the lighthouse have collapsed into the sea. The base of the lighthouse is still *in situ*. In front of it are the ruins of an apsidal building, which survives only in its base and part of a semi-circular wall of 4.40 m in diameter (Lassus 1959, 219). According to Lassus, this structure might have been part of a sanctuary (1959, 219). The remains of the lighthouse show that it was constructed to take into account the walls of this apsidal building. The base of the lighthouse is cut in its middle by another much larger polygonal structure, which scholars believe to have been Turkish fortifications (Lassus 1959, 219). The southern part of the ancient lighthouse base was damaged by the erection of the modern lighthouse.

From its location on a rocky cliff, the lighthouse might have served as a warning signal.

9. Libya: Leptis (*Lepcis*) Magna

Location:	On a mole at the entrance of the harbour.
Patron:	Septimus Severus
Shape:	Square
Materials:	Mortar and rubble with brown limestone facing.
State of Preservation:	Platform, southern vaults and parts of northern vaults and part of a cornice belonging to 3rd level.
Fuel:	Unknown
Date:	3rd century AD (Severan)
Dimensions:	W 21.2m, Sides 9m.
Sculpture:	None
Epigraphy:	None
Primary Sources:	None
Secondary Sources:	Bartoccini, Zanelli 1960.
Illustration:	Figs. 24-26.

The town of Leptis Magna is situated on the Libyan coast 120 kilometer east of Tripoli (Stillwell, *Princeton Encyclopedia of Classical Sites* 1976, 499), and takes its name from the three main cities (*treis poleis*). The harbour is located north east of the city, and the lighthouse is erected on the northernmost tip of the harbour on the west mole, at the mouth of the Wadi Lebda (Floriani 1966, 1).

The harbour, Punic in origin, is believed to have been reconstructed by the Emperor Septimius Severus during the third century AD as part of his building program (Ward- Perkins 1948, 59). Septimius Severus was born in Leptis Magna from a good provincial family: his grand-father had been part of one of the first pair of *duoviri*, and his uncles had both been consuls (Ward-Perkins 1948, 59-60). He therefore provided the city with many favours, among which was the building of a lavish harbour with a lighthouse. It is believed that the massive building program was too much for the city's financial resources and that this led to the decline of Leptis-Magna (Ward-Perkins, 1948, 59-60). There is no evidence for the chronology of this lighthouse.

The lighthouse at Leptis Magna was erected on a square platform and displayed two receding levels above. According to a reconstruction by Bartoccini (Hauschild 1976, 248), the platform was accessed by a stairway and entered a large room separated by two long vaults. Two diametrically opposed staircases led to the upper levels; the second and third levels were crowned with large cornices (Hauschild 1976, 248).

The excavated platform measured 21.2m (Hauschild 1976, 248). The northern vaults were damaged, but the southern vaults are preserved and spanned 2.43m with a height of 6.20m (Hauschild 1976, 248). The inner core of the first level measured 9 m (Hauschild 1976, 248). Part of the cornice originally located on the third level has been excavated, and the height of the lighthouse can be estimated to have been between 30 to 35m (Hauschild 1976, 248).

The inner core of the first level was made of *opus quadratum* and measured 9m. (Hauschild 1976, 248) The masonry of the lighthouse seems to have been made of the brown limestone indigenous to the region and quarried nearby at Ras-el-Hammam (Ward-Perkins 1948, 59).

No statues or inscriptions have been connected to this lighthouse. There are no evidence as to the kind of fuel or lighting apparatus used for the lighthouse at Leptis Magna.

Its location, at the very end of the northern mole, suggests that this lighthouse was used to indicate the entrance to the harbour. The coast here is quite flat and there are no references to inhospitable geological formations, such as cliffs. The area also does not appear prone to silting and therefore the formation of shoals. The type of lighthouse appears to be a guide to the mouth of the harbour.

10. Egypt: Pharos

Location:	On a mole at the entrance of the harbour.
Patron:	Ptolemy II (Philadelphus)
Shape:	Square
Materials:	White granit and pink quartz.
State of Preservation:	None
Fuel:	Unknown
Date:	297-293 BC
Dimensions:	W 30m, Sides 12m.
Sculpture:	Statues of Ptolemy I & II with their consorts and various other statues.
Epigraphy:	Dedicatory inscription by builder, Sostratos of Cnidos.
Primary Sources:	Josephus, Pliny the Elder.
Secondary Sources:	Thiersh 1909 and Empereur 1998.
Illustration:	Figs. 29-35.

The island of Pharos is located to the east of Alexandria in the Nile Delta. The mainland forms a bay with two elevated cliffs at each end. The island of Pharos is placed between these two cliffs and therefore offers the possibility of a harbour with two entrances. When the harbour was established, one of these entrances was blocked by a man-made passage, called the *Heptastadio*, that connected the island to the mainland (Fig. 29). Moles were set up to the east of the island, and the lighthouse was erected upon the north-east mole where the fort of Qaitbay is located today (Empereur 1996, 12) (Fig. 30).

Scholars agree that the construction of the lighthouse might have started around 297 BC under king Ptolemy I Soter and ended in 283 BC during the reign of Ptolemy II Philadelphus (Empereur 1998, 16). A lighthouse was much needed in this area due to the rocky coast and it also became part of the building programs of both Ptolemy I and Ptolemy II. The lighthouse proved to be impressive and size and beauty and displayed multiple statues of the kings Ptolemy I and II with their wives, Berenice and Arsinoë, who would have confirmed the glory of the

Hellenistic monarchs to all who sailed into port. The project cost 800 talents (Pliny the Elder XXXVI-18) and the job was given to Sostratos of Cnidos, who is believed to have been a friend of King Ptolemy I (Empereur 1996, 16). The lighthouse remained in use for nearly 16 centuries Empereur 1998, 44-45). Its slow decline started in the 12th century when it was transformed into a mosque (Empereur 1998, 45). It stood until the 13th century when, according to an Arab traveler called Edrisi, it was destroyed by an earthquake (Empereur 1998, 88-89).

There is sufficient iconographic evidence as well as written sources to aid in the reconstruction of the lighthouse at Pharos. According to the texts by Edrisi, the lighthouse was erected on a square base (Fig. 31). It was built in three levels and was accessed by an entrance measuring 11.50m by 4.90m; it had a depth of 2.1. The first of these levels was square with a slightly pyramidal shape and had a height of approximately 71m by a width at the base of 30m (Empereur 1998, 26). Approximately fifty rooms were set within the first level for storage of fuel as well as staff quarters (Empereur 1998, 26-27). Daylight came into the tower by several windows (Empereur 1998, 26). Large ramps provided a means of ascension into the tower, which, according to Edrisi, (Thiersch 1909, 44) were wide enough for two horses since animals, mostly donkeys and mules, were used to carry the fuel to the top. On the top of this first level was a cornice 2, 30 m high displaying statues of Tritons blowing into conch shells (Fig. 32). These Tritons were located on each of the tower's four corners.

The second level was octagonal and measured 34m in height. The top of this level was reached by an interior stairway of thirty-two steps (Fig. 32). The third level was circular and measured 9m in height; it had had an eighteen-step indoor stairway. A cupola at the top of the

lighthouse held the beacon. The total height of the lighthouse is estimated to have been 130 m (Empereur 1998, 24).

Numismatic (Fig. 34) and archaeological evidence (Empereur 1998, 102) suggests that statues also decorated the monumental entrance (Fig. 35). This large entrance consisted of lintel and jambs made of pink quartz closed by enormous doors. The lintel and jambs have been excavated but the doors are still missing (Empereur 1998, 102-103). There seems to have been a group of nine statues (Fig. 35) placed on either side of the door of the monumental entrance. The largest probably represented Ptolemy I and Bernice (Empereur 1998, 102).

Archaeological evidence confirms that the lighthouse at Pharos was built with the white granite stone indigenous to the region (Empereur 1998, 22-23) and quarried on the north coast of Egypt. The blocks were joined together with metal clamps. The solid parts of the structure, such as lintels, were fashioned from Assouan granite, while some the architectural features were of pink quartz.

Ancient texts do not help to understand the lighting and fuel of this lighthouse, but the text by Edrisi is more illuminating (Empereur 1996, 124-127, Thiersch 1909, 44). He states that the fuel was carried upstairs along a ramp by means of animals; this implies a large amount of fuel, although the stairs at the top of the second floor are hardly fit for a work animal. It may be that fuel was carried and stored near the second floor throughout the day for the night beacon and that necessary quantities were hauled by hand as needed to stoke the fire.

An inscription made of attached letters of lead was placed on one of the outward face of the lighthouse (its exact location still unclear) and provided the name of the

builder: "*Sostratos son of Dexiphanes of Cnidos dedicates this monument to the savior gods for the protection of sailors*"(Empereur 1998, 16, Thiersch 1909, 44).The lighthouse is thus dedicated to the Savior Gods, who, until recently, were thought to be Castor and Pollux, the Dioscuri who helped protect sailors (Howatson 1989, 322-323). Recent evidence, however, has changed this hypothesis: according to Empereur (1998, 16), Ptolemy I and his wife Berenice are referred to as the Savior Gods and the lighthouse may have been dedicated to those who commissioned it.

Iconographic and archaeological evidence has proven that many statues were erected on top and around the lighthouse. Coins representing the lighthouse at Pharos show a solitary statue on top of the cupola (Fig. 34), probably Poseidon, along with the tritons on each corner of the first level. The Begram Vase, an ancient glass vessel, found in 1937, also depicts the lighthouse of Pharos. (Fig. 33) This vase, made of carved glass, shows the upper levels of the Pharos lighthouse with its masonry and windows. Parts of the second level are also visible on the left of the vase and show the tritons on either side below the top level. On top is the cupola, where a youthful statue holding a paddle stands in heroic nudity. The iconography of this statue is inconsistent with most representations of Poseidon, as the latter is most often shown as an older man with a beard. Goodchild argues convincingly that the statue might represent Zeus Soter, the savior (Goodchild 1961, 218-223). Consensus now appears to point to the fact that the statue on top of the lighthouse might have represented Ptolemy I Soter in Heroic nudity.

A text of 670 AD by Aroulfe (Empereur 1998, 35) mentions that torches were used to light piles of wood in the Pharos. Torches were often dipped in a petroliferous substance. In Mesopotamia, bitumen and other fossil fuel were harvested from swamps and used on torches

(Mayor 1997, 56), and the torches and wood used to light the lighthouse of Pharos could have been treated with a petroleum by-product. Pliny the Elder also mentions that the light of the beacon could be seen from very far and shone like a star (Pliny the Elder, XXXVI.18). A simple wood fire does not maintain a steady-enough light for this description, even when constantly stoked.

The earthquake of the 13th c. completely submerged the remains of the Pharos. It is believed that the violence of the earthquake spread the blocks, statues, and other structural elements over a surface of 1.3 hectares (Empereur 1998, 96-103). Artistic renderings confirm that the lighthouse was located at the entrance of the harbour, and it would therefore have indicated the entrance of the harbour, but this may not have been its sole function. Epigraphic evidence suggests that the coast surrounding Pharos was inhospitable (Pliny the Elder, XXXVI.18), and it may be that the lighthouse also served also as a warning signal. This hypothesis is further strengthened by Josephus (*Jewish Wars*, IV, 612), who mentions that ships seeing the light of Pharos at night would drop anchor and wait until daylight to resume sailing, as the coast was so dangerous.

The lighthouse of Pharos is without a doubt the best documented ancient lighthouses. Its construction during the Hellenistic era set the new standard for future lighthouses such as the lighthouse at Ostia (Cat. 6), which seems to follow some of its guidelines by using decreasing levels or the lighthouses of Boulogne-sur-Mer (Cat. 3) and Dover's Eastern Pharos (Cat. 1) which uses the aerodynamic octagonal shape, to name but a few.

CHAPTER II

This chapter brings together some of the different aspects of lighthouses that were discussed individually in the previous chapter. Through comparative study, a tentative morphological typology/classification of lighthouse will be proposed.

Distribution

Chart I: Distribution

Country	Number of Lighthouses		Cylindrical/Round	Square	Hexagonal	Octagonal
Africa	3			Cats. 9-10		Cat.8
Europe	6		Cat.5	Cats. 6-7	Cats. 2-4	Cats.1-3

The distribution of lighthouses' archaeological remains indicates that Europe possessed almost twice as many lighthouses as Africa. Many factors influence the state of preservation of these remains. The length of time that a lighthouse was kept in service could affect its preservation. For instance, the lighthouse at Boulogne-sur-Mer (Cat. 3) was in use until the 17th c.; the lighthouse at La Coruña (Cat. 7) is still in service; and Pharos was used as a mosque till its destruction in the 13th c. This suggests that Europe kept more of its lighthouses in service than Africa.

Tsunamis and earthquakes might also be responsible for the disappearance of lighthouses along the African coast. One example, cited above, is Pharos (Cat. 10), which was destroyed by such an earthquake.

The need for these lighthouses may vary from one continent to another. Dangerous coasts might require lighthouses, such as Dover (Cats.1- 2), Boulogne-sur-Mer (Cat. 3), Ostia (Cat. 6), Cherchel (Cat. 8) and Pharos (Cat. 10). This suggests that the number of dangerous coasts were

perceived to be greater in Europe than Africa, and this belief might have influenced the decision to erect a lighthouse.

Small beacons, such as the 6th c. lighthouse at Thasos (Fig. 23; Empereur, Archontidou-Argyri,Simossi 1989, 51-59), might have dotted the coast lines, thus rendering obsolete the need for larger lighthouses. The limited archaeological evidence for these small structures might be due to the re-use of their building materials once they were no longer in service (Empereur, Archontidou-Argyri,Simossi 1989, 51-59). Their location, often on top of cliffs could render them vulnerable to earthquakes or tsunamis.

The number of inland harbours might also be a reason to erect a lighthouse. Harbours such as Frejus contained two lighthouses: Lanterne d'Auguste (Cat. 4) and Butte Saint-Antoine (Cat. 5). The harbour of Boulogne-sur-Mer, also inland, shows one lighthouse: Boulogne-sur-Mer (Cat. 3). None of the lighthouses in Africa offers protection to an inland harbour.

The patterns displayed in *Chart I* suggest that geographic dispersion does not affect the architectural shape of lighthouses. Square and octagonal lighthouse plans are found in Europe, at Dover (Cats. 1-2), Boulogne-sur Mer (Cat. 3), Ostia (Cat. 6), and La Coruña (Cat. 7), as well as in Africa, at Cherchel (Cat. 8), Leptis Magna (Cat. 9), and Pharos (Cat. 10). The determinant factor for the plan of a lighthouse was not its geographic location.

Distribution within Site

CHART II – Distribution Within Site.

Plan	Cliffs	Harbour installations	Canals
Square	1	3	
Octagonal	3		
Hexagonal	1		1
Cylindrical/Round		1	

Chart II shows that the location of lighthouses within each site seems to affects the architectural shape of its plan. Patterns can be seen with the square and octagonal examples. Square lighthouses predominate when located within harbour installations. This may be due to many factors: these lighthouses are often erected at the end of breakwaters on man made-moles. Man-made moles are usually built using the Roman technique of sinking a square caisson and filling it with *opus caementicium* (Hohlfelder 1985, 81). A square platform is the easiest base for these structures, as at Leptis Magna (Cat. 9), Pharos (Cat 10), and at Ostia (Cat. 6) This would leave only one side of the lighthouse, the side facing the sea, exposed to inclement elements. For instance, the excavations at Leptis Magna (Cat. 9) show that the southern side of the lighthouse, which was facing the entrance of the harbour, had been much better protected than the northern side, which was exposed to the elements.

The lighthouses found within harbour constructions are often part of an Emperor's building program such as the Emperor Claudius at Ostia (Cat. 6), and Septimus Severus at Leptis Magna (Cat. 9). Both these lighthouses appear to have been built following the prototype of the lighthouse at Pharos (Cat. 10), which served propagandistic as well as practical purposes for

Ptolemy I and II. The Pharos might have set a certain standard among aids to navigations that emperors might have been eager to emulate.

The other lighthouse that is part of harbour installation is the lighthouse of Frejus at Butte Saint-Antoine (Cat. 5). This lighthouse is problematic because, while part of harbour installations, it is not located at the end of a mole but belongs to a fortress wall; its circular form is similar to that of the other towers erected along the same wall. This might have originally been constructed as a towers and then transformed into a lighthouse as a need for one in this location grew.

While lighthouses erected at the end of moles within harbour installations offer one side to the elements, those located upon isolated cliffs are more likely to be buffeted by winds on all sides. There is a phenomenon called *drag*, which refers to "the interaction or contact of a solid body with a fluid (liquid or gas)" (www.grc.nasa.gouv. 2006-03-14, Glen Research Center, April 17th, 2007). The wind moving around a lighthouse creates drag. This is less likely to occur in lighthouse located at the end of a breakwater where one or more of its sides are sheltered by the quiet sanctum of the harbour. The lighthouse on a cliff does not benefit from the same protection, but damage might be minimized by its shape. Altitude also plays a role in wind velocity: the higher the altitude, the higher the speed of the winds. The height of cliff would also contribute to this problem of drag, and engineers would have had to develop an appropriate shape for a lighthouse, as square towers might create more drag. Sostratos of Cnidos, the engineer who built the lighthouse of Pharos (Cat. 10), appears to have countered the effects of wind versus height by making the upper levels of the structure smaller and more aerodynamic: the section of second level is octagonal and the third one round. However in order to achieve this form, he had to

decrease the width of each successive level. The engineers who constructed the lighthouses located on cliffs thus had to find a way of erecting structures that were able to withstand the constant sea winds. Three of the lighthouses located upon cliffs share the octagonal shape: Dover (Cat. 1), Boulogne-sur-Mer (Cat. 3), and Cherchel (Cat. 8) .The octagonal lighthouse, with its receding levels, proved to have been a good choice for such a location. The winds would have had less of a surface to create drag since the walls are smaller and the shape almost circular.

Not all cliff-side lighthouses are round, however. The square lighthouse at La Coruña (Cat.7) is also located on a cliff, and this is somewhat surprising. However, the lighthouse still solidly stands. This could be due to two factors. First, the lighthouse is constructed in three levels with large covered arches to sustain them. Second, the staircase located on the outside of the structure might also have added extra strength, as it is believed that a guard would have been installed to prevent the workers or animals from falling.

In conclusion, it seems that the geographic location of lighthouses does not affect their shape, while their location within a site does.

Building Materials

Chart III – Building Materials

Lighthouse	Brick	Rocks	Mortar	Unknown
Eastern Pharos (Cat.1)	*	*	*	
Western Pharos (Cat. 2)	*	*	*	
Boulogne-sur-Mer (Cat. 3)	*	*	*	
Lanterne d'Auguste (Cat. 4)		*	*	
Butte Saint-Antoine (Cat.5)		*	*	
La Coruña (Cat. 7)				*
Ostia (Cat. 6)			*	
Cherchel (Cat. 8)		*	*	
Leptis-Magna (Cat. 9)		*	*	
Pharos (Cat. 10)		*		

The original building materials used for most lighthouses are not always known due to their re-use in other structures and damage or loss. For many, only the base remains like the lighthouse at Cherchel (Cat. 8); for others, such as La Coruña (Cat. 7), the original materials have been obliterated by renovations.

Most lighthouses use mortar and stone. For some of the lighthouses (Cats. 9, 10), which were part of an emperor/king's building programs, the materials were local. It is not known, however, whether there is a correlation between an imperial lighthouse and the choice of local stone as building material.

Three the lighthouses; Eastern Pharos (Cat. 1), Western Pharos (Cat. 2) and Boulogne-sur-Mer (Cat. 3), use bricks in addition to stone and mortar. Two of these appear to have been built during the Julio-Claudian Era. From the1st c. AD brick had become a popular building material and was used in conjunction with veneer facings. The Eastern Pharos (Cat. 1) was built in such a way, the facings being made of green stone.

Some of the bricks found in the vicinity of the Eastern Pharos (Cat. 1) bear the stamp CL.BR (*Classis Britannica*) (Fig. 13). These bricks, no doubt manufactured by the army, were probably used in the building of the lighthouse. This strengthens the hypothesis that the army built the Eastern Pharos (Cat. 1) at Dover and probably erected the lighthouse at Boulogne-sur-Mer (Cat. 3) as well, since evidence of the *Classis Britannica*'s *castrum* have been uncovered in the vicinity of the lighthouse (Will 1956, 17).

Wheeler (1929, 30) maintains that the building materials used in the construction Eastern Pharos (Cat. 1) at Dover were imported. This is probably true: the bricks could have been manufactured by the army at Boulogne-sur-Mer and sent across the Channel to Britain. There is no evidence for the source of the stones used in the Eastern Pharos' construction; the materials used in the construction of the lighthouse at Boulogne-sur-Mer (Cat. 3) were local (note 4). The Western Pharos (Cat. 2) is believed to have been built at a later date (Wheeler 1929, 44) with re-used materials from other local structures: Kentish rag-stones and flint (Wheeler 1929, 43).

Chart III confirms a preference for local building materials in the construction of lighthouses. Stones and mortar are present in most examples, while bricks appear to have been used by the army for the construction of the lighthouses located in the north-west of the Empire.

Statues and Epigraphy

Some lighthouses in this study are known to have been dedicated to specific deities (Cats. 7, 10) and some were decorated with statuary (Cats. 6, 10). Pictorial evidence, such as mosaics (Figs. 18-19) and coins (Fig. 34), confirm the use of statues on lighthouses. Octagonal lighthouses, like the Eastern Pharos (Cat. 1), the Western Pharos (Cat. 2) Boulogne-sur Mer (Cat. 3), and Cherchel (Cat. 8), do not appear to have had any statuary, while many of the square examples such as Ostia (Cat. 6), La Coruña (Cat. 7), and Pharos (Cat. 10), included some sort of religious dedication and/or statues.

Only two of the square lighthouses with evidence of statuary and/or dedications can be associated with the building program of an Emperor or king: Ostia, (Cat. 6), and Pharos, (Cat. 10).

Chronology

This section is based on the historical data gathered for each lighthouse, which is frequently sparse and imprecise. It is therefore difficult to determine whether there was an evolution in the construction and shape of lighthouses. Pharos (Cat. 10) is the only lighthouse for which there are specific details about its date of construction. For this reason, the time periods in the chart and referred to in this section will be given by the name of the era, Emperor or imperial family that was in power at the time of construction.

CHART IV - Chronology

Lighthouse	Era
Eastern Pharos(Cat. 1)	Julio-Claudian
Western Pharos(Cat. 2)	no precise date but later than Eastern Pharos
Boulogne-sur-Mer (Cat. 3)	Julio-Claudian
Lanterne d'August (Cat. 4)	No precise date
Butte Saint-Antoine (Cat. 5)	No precise date
Ostia (Cat. 6)	Julio-Claudian
La Coruña (Cat. 7)	Trajanic
Cherchel (Cat. 8)	Julio-Claudian
Leptis-Magna (Cat. 9)	Severan
Pharos (Cat. 10)	Hellenistic

General conclusions indicate that square lighthouses appear to have been built during all eras, but octagonal examples only occur during the Julio-Claudian era. It may be that technological advances were made during the Julio-Claudian era solely for lighthouses located upon cliffs, (the lighthouse at Ostia (Cat. 6) built under Claudius shows no real technological advancement). It may thus be possible to narrow their chronology to 41 – 54 AD, near the end of Caligula's, to the end of Claudius' reign.

Patrons and Builders

For many lighthouses, we have some idea of who commissioned them and who the engineers where. This section will consider whether differences in lighthouses construction could be due to the different engineers/builders who designed the lighthouse or the patron who commissioned them.

Chart V – Patrons and Builders

Lighthouse	**Patrons**	**Engineers/builder**
Eastern Pharos (Cat. 1)	Unknown	Classis Britannica
Western Pharos (Cat. 2)	Unknown	Unknown
Boulogne-sur-Mer (Cat. 3)	Caligula?Claudius	Classis Britannia
Lanterne d'Auguste (Cat. 4)	Unknown	Unknown
Butte Saint-Antoine (Cat. 5)	Unknown	Unknown
Ostia (Cat. 6)	Claudius	Unknown
La Coruña (Cat. 7)	Unknown	Gaius Sevius Lupus
Cherchel (Cat. 8)	Unknown	Unknown
Leptis-Magna (Cat. 9)	Septimus Severus	Unknown
Pharos (Cat. 10)	Ptolemy I/II	Sostratos of Cnidos

Many of the square lighthouses, Ostia (Cat. 6), Leptis-Magna (Cat. 9) and Pharos (Cat. 10), associated with harbour entrances, were commissioned as part of an Emperor's building program.

Two of the octagonal lighthouses, Eastern Pharos (Cat. 1) and Boulogne-sur-Mer (Cat. 3) have the same builder the *Classis Britannia*. Besides their similarities in shape, their locations, on

an isolated cliff near military harbours, bear a distinct resemblance. It is probable that octagonal lighthouses were army built and are therefore military lighthouses. In this category we should also include the lighthouse at Cherchel (Cat. 8). This is because of the military harbour established at Cherchel during the Julio-Claudian era. This lighthouse might have been also erected by the army.

Emperor Claudius commissioned the lighthouse at Ostia (Cat. 6) and is believed to have commissioned the lighthouse at Boulogne-sur-Mer (Cat. 3). Both lighthouses bear marked differences and yet were commissioned by the same person. This suggests that there might have been some sort of established lighthouse patterns during the Julio-Claudian era. These dictated the lighthouse shape regardless of patronage: Square lighthouses were usually erected at the entrance of harbours and octagonal lighthouses were built upon cliffs usually by the army.

Lighting and Fuel

There is minimal information for the kinds of fuel and lighting apparatus for ancient lighthouses, and this makes it difficult to establish what was used to keep a beacon lit. Some scholars believe that a wood pyre was lit on the top (Empereur 1998, Thiersch 1909). The lighthouse of Pharos is said by Pliny the Elder (XXXVI-18) to have shone like a star and visible miles away. This seems to indicate that there was no wavering or waning of the beacon even as the fuel burned. It would be difficult with a wood pyre to stoke such a beacon directly, as the heat of the inferno would reach intolerable temperatures. Moreover, a wood fire does keep a constant flame, and a steady beacon would not be obtained (Allard 1898, 30). The amount of wood needed would be very great, and Egypt is not known for its abundant forests; the cost of importing such large amounts of wood to keep the beacon burning would also be considerable. A related issue is

the storage of such a fuel supply. The lighthouse at Pharos, despite a roomy interior, was also used for staff and animals as well as the storage for the fuel. Even given that some lighthouses might not have been lit during the winter off-sailing season, the amount of fuel needed for one season would still be considerable.

Alternative fuels, such as petroleum by-product (Greek fire), should be considered. When applied to wood, a petroleum by-product might maintain a steady, shining light.

Documentation from the 15th century mentions an annual amount of money set for the purchase of coal and straw for the beacon of the Boulogne-sur-Mer lighthouse (Cat. 3). Despite the later date at which coal was used for the beacon, research on the mining of coal in the Roman world should be further pursued to see if the product was used in ancient lighthouses. This topic will be addressed in future research.

Functions

Chart VI– Functions

Lighthouse	Harbour Marker	Warning Signal	Watch Tower
Eastern Pharos(Cat.1)	*	*	
Western Pharos (Cat. 2)	*	*	
Boulogne-sur-Mer (Cat. 3)	*	*	*
Lanterne d'Auguste (Cat. 4)	*	*	
Butte Saint- Antoine (Cat. 5)	*	*	*
Ostia (Cat. 6)	*	*	
La Coruña (Cat. 7)	*	*	
Cherchel (Cat. 8)	*	*	
Leptis-Magna (Cat. 9)	*		
Pharos (Cat. 10)	*	*	*

This chart indicates that most lighthouses had more than one function. The old consensus that lighthouses were simply built to indicate the entrance of a harbour needs to be re-evaluated. Lighthouses are expensive to build, and their up-keep is onerous due to the maintenance of the building as well as the constant need for fuel. Even if they are built to indicate the entrance of a harbour, most lighthouses also served other functions, such as the warning of danger along a coast.

Conclusion

A comparative analysis of the preserved lighthouses addressed in this thesis shows patterns emerging. This suggests that the shapes of lighthouses are not dictated by overall distribution but rather by the distribution within sites. Most lighthouses built at the entrance of harbours, on moles are square: Ostia (Cat. 6), Leptis Magna (Cat. 9), and Pharos (Cat. 10). Lighthouses erected on cliffs tend to be octagonal in shape: Eastern Pharos (Cat. 1), Boulogne-sur-Mer (Cat. 3) and Cherchel (Cat. 8).

This study also suggests that local building material was used when available. Stones and mortar are found in most lighthouses, but brick appearsin the octagonal lighthouses in the north-west of the Empire: Eastern Pharos (Cat. 1), and Boulogne-sur-Mer (Cat. 3).

Pictorial evidence shows that sculptural decorations are mostly included in lighthouses that were part of an emperor/king's building program. These are usually located at the entrance of harbours. Among these are the lighthouse at Ostia (Cat. 3) and the lighthouse at Pharos (Cat. 10).

Epigraphic evidences in the form of dedications have been found in two lighthouses: La Coruña (Cat. 7) and Pharos (Cat. 10).

The chronology suggests a large time-line for the construction of lighthouses; however, octagonal lighthouses seem to have been built only during the Julio-Claudian era.

Patronage for the commission of a lighthouse does not seem to have affected its shape. Guidelines may have been established wherein lighthouses located at the entrances of harbours were square and many of the lighthouses constructed upon isolated cliffs were octagonal.

On the other hand, engineers might have influenced the shapes of lighthouses. Of the four lighthouses built upon cliffs, three octagonal (Eastern Pharos (Cat. 1); Boulogne-sur-Mer (Cat.

3); and Cherchel (Cat. 8)). are believed to have been built by the army. The lighthouse of La Coruña (Cat. 7), also built upon a cliff, is square, and, from the dedicatory stone found at the base of the lighthouse, might have been built by a civil engineer.

There is very little or no evidence concerning the kind of lighting apparatus used in lighthouses, nor about their fuel.

Finally several of the lighthouses are multi-functional. They not only indicate the entrance to a harbour but also serve as warning signals for dangerous coasts.

Based on these result, a tentative morphological typology/classification may be proposed. The lighthouses can be divided into two groups, each identified by a Roman numeral: those located upon cliffs (I) and those built within harbour installations (II). In each of these two categories, the lighthouses can be placed into sub-categories according to shape and denoted by Arabic numerals: cylindrical/round (1); hexagonal (2); octagonal (3); and square (4).

Morphological typology/classification:

Main categories:

I- Lighthouses built upon cliffs
II- Lighthouses built within harbour installations.

Sub-categories:

1-Cylindrical/round
2- Hexagonal
3- Octagonal
4- Square

I-1 No lighthouses

I-2 Western Pharos (Cat. 2)

I-3 Eastern Pharos (Cat. 1), Boulogne-sur-Mer (Cat. 3), Cherchel (Cat. 8)

I-4 La Coruña (Cat. 7)

II-1 Butte Saint-Antoine (Cat. 5)

II-2 Lanterne d'Auguste (Cat. 4)

II-3 No lighthouses

II-4 Ostia (Cat. 5), Leptis Magna (Cat. 9), Pharos (Cat. 10)

The above parameters were established on the basis that each lighthouse could be included in this morphological system.

CONCLUSION

The assemblage of data comprised within this work has reviewed ancient lighthouses in a new way. The material addressed within this thesis ranged from the 3rd century BC to the 2nd century AD. The lighthouses: Dover's Eastern Pharos (Cat. 1) and Western Pharos (Cat. 2) France's Boulogne-sur-Mer (Cat. 3), Lanterne d'Auguste (Cat. 4) and Butte Saint-Antoine (Cat. 5), Italy's Ostia (Cat. 6), Spain's La Coruña (Cat. 7), Algeria's Cherchel (Cat. 8), Libya's Leptis Magna (Cat. 9) and Alexandria's Pharos (Cat. 10), were selected on the basis of the availability of evidence: primary or secondary.

This seems to be the first time that data on various ancient lighthouses has been gathered and studied comprehensively. The results are very interesting.

The purpose of Chapter 1 is to introduce the archaeological evidence. It includes a brief catalogue entry for each lighthouse followed by discussions its particular.

Chapter 2 offers a comparative study of the data from Chapter 1. From this comparative analysis, patterns have emerged and a tentative typology/classification based on morphology and distribution was established.

The study suggests that the shape of lighthouses is not dictated by their general distribution but rather by their distribution within site. Lighthouses built within harbour installations, often at the end of breakwaters, are square in shape: Ostia (Cat. 6), Leptis Magna (Cat. 9) and Pharos (Cat. 10). The octagonal shaped lighthouses are more often located on isolated cliffs: Eastern Pharos (Cat. 1), Western Pharos (Cat. 2) and Boulogne-sur-Mer (Cat. 3).

The chronology suggests a large time-line for square lighthouses. The octagonal lighthouses, however, seem to have been built during the Julio-Claudian era.

Patronage for the commission of ancient lighthouses does not appear to have influenced their shape. Engineers, however, might have had an influenced on their overall design. This, especially when referring to octagonal lighthouses (Eastern Pharos (Cat. 1), Western Pharos (Cat. 2) and Boulogne-sur-Mer (Cat. 3)) which are believed to have been built by the army.

Evidence regarding fuel and lighting apparatus is almost inexistent and the problem needs to be re-addressed.

Finally, regarding the function of ancient lighthouses, studies from chapter 2 suggest that lighthouses were not only used to indicate the entrance of harbours but also to warn sailors of coastal dangers.

Hopefully, the results obtained in this work will be particularly useful to scholars of trade, harbour installations and ancient seafaring.

ILLUSTRATIONS

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Fig. 20 *Harbour at La Coruña*, from: Hauschild, T., "Der Römische Leuchtturme von La Coruña (Torres de Hercule), Madrider Mitteilungen, 17, 1976, p.240.

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Fig. 22 *A 1685 representation of the lighthouse of La Coruña*, from: Hauschild, T., "Der Römische Leuchtturme von La Coruña (Torres de Hercule), Madrider Mitteilungen, 17, 1976, p.240.

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Fig. 25 *Floor plan of the lighthouse at Cherchel*, from: Lassus, Jean, « Les découvertes récentes de Cherchel », Compte-rendus des Scéances – Académie des Inscriptions et des Belles-Lettres,1959, p. 221.

Fig. 26 *Archaeological evidence from the lighthouse at Cherchel.* From: Lassus, Jean, « Les découvertes récentes de Cherchel », Compte-rendus des Scéances – Académie des Inscriptions et des Belles-Lettres,1959, p. 217.

Fig. 27 *Plan of the harbour of Leptis Magna*, from: Floriani, Squarciapino, M., Leptis Magna, Raggi Verlag Basel, Switzerland, 1966, p.1.

Fig. 28 *Reconstruction of the lighthouse at Leptis Magna from R. Bartoccini*, from: Hauschild, T., "Der Römische Leuchtturme von La Coruña (Torres de Hercule), Madrider Mitteilungen, 17, 1976, p.248.

Fig. 29 *Harbour at Alexandria,* from: White K.D. Greek and Roman Technology, Cornell university press New York, 1984, p.105.

Fig. 30 *Modern Fort Qaitbay*, from: Thiersch, Hermann, Pharos Antike Islam und Occident, ein Betrag zur Architekturgeschichte, Leipzig und Berlin, 1909, p.84.

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Fig. 33 *The Begram Vase*, from:p. Picard, CH., "Sur Quelques Représentations Nouvelles du Phare d'Alexandrie et sur l'Origine Alexandrine des Paysages Portuaires.", Bulletin de Correspondance Hellenique, vol. LXXVI, 1952, p. 67.

Fig. 34 *Two coins from Pharos*, from: Empereur. Jean-Yves, Le Phare d'Alexandrie, La Merveille Retrouvée, Découvertes Gallimard, France, 1998, p.27.

Fig. 35 *Reconstruction of Monumental Entrance at the lighthouse at Pharos*, from: Empereur. Jean-Yves, Le Phare d'Alexandrie, La Merveille Retrouvée, Découvertes Gallimard, France, 1998, p.72.

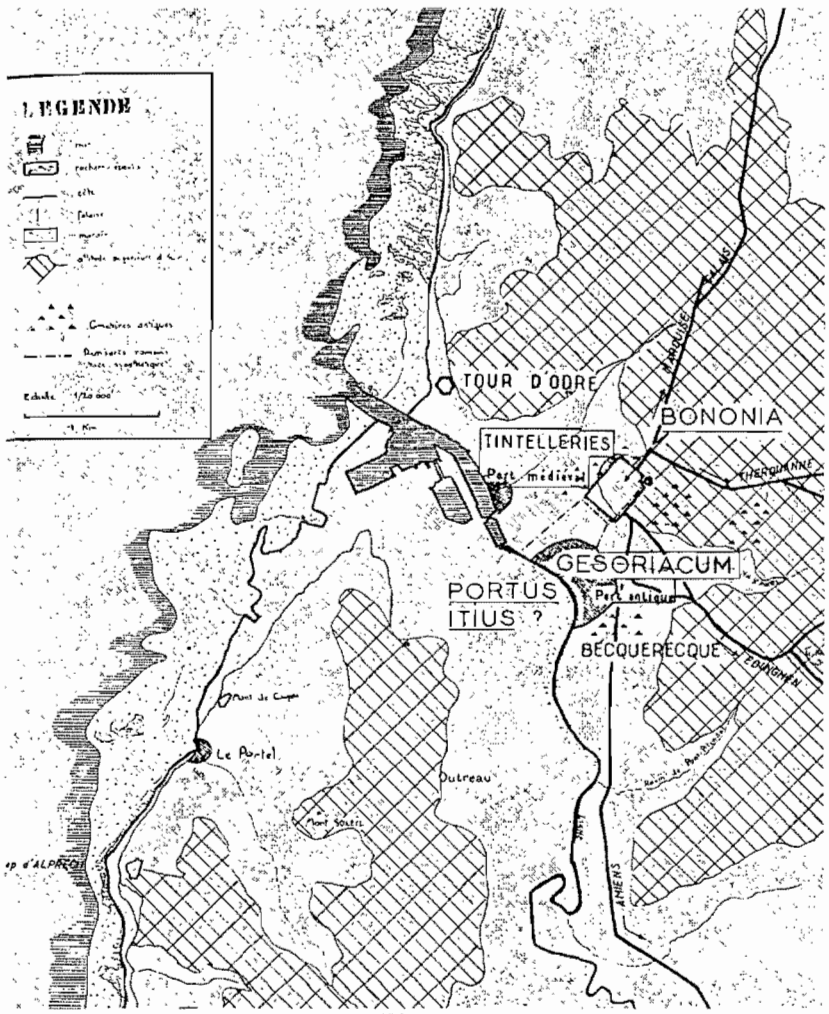

Fig. 1

Plan of Boulogne-sur-Mer.

On this plan the lighthouse is referred to as « Tour D'Ordre »

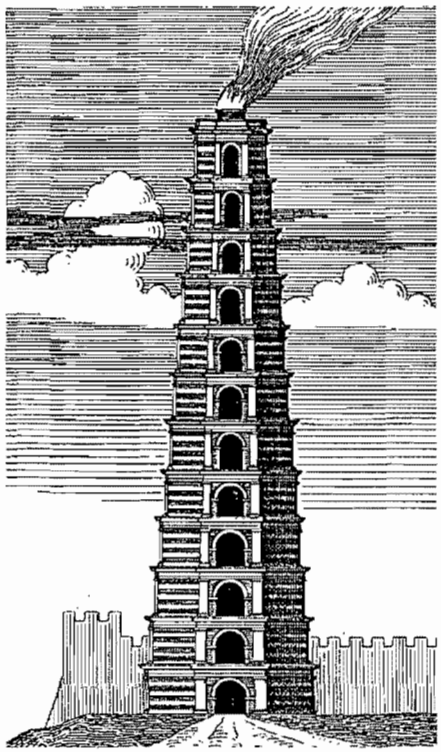

Fig. 2

Reproduction of the lighthouse at Boulogne-sur-Mer based on 16th century sketch by geographer Beaurain.

Fig. 3

Commodus Medal Representing lighthouse at Boulogne-sur-Mer.

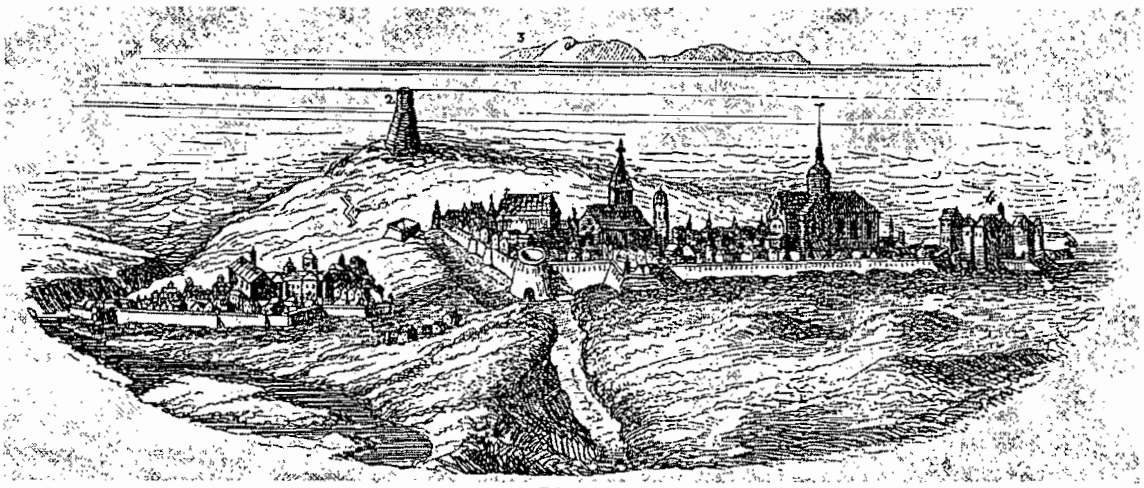

Fig. 4

Later engraving of the lighthouse at Boulogne-sur-Mer and area showing the surroundings and the coast of Britain.

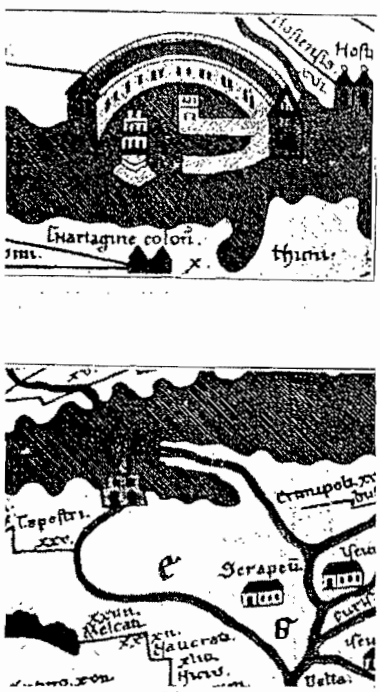

Fig. 5

Peutinger Map showing the lighthouses of Ostia (above) and Pharos (below).
We note the effort in representing the architectural differences of the lighthouses.

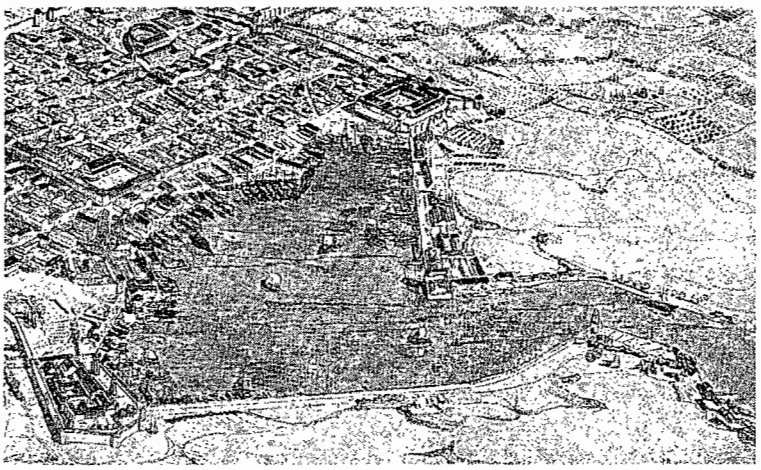

Fig. 6
Harbour at Frejus recreated by artist Jean-Claude Golvin.

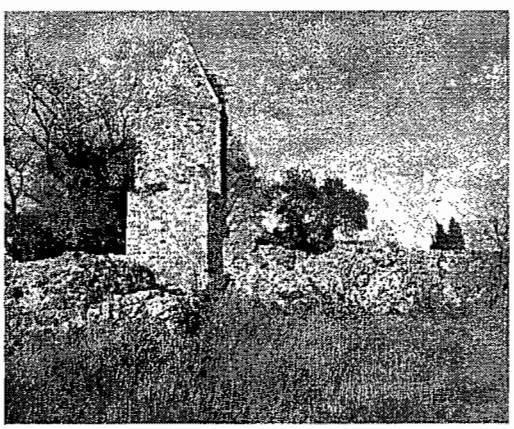

Fig. 7
Lanterne d'Auguste.

Fig. 8
Archaeological drawing of Butte Saint Antoine.
The highest tower supposedly the lighthouse.

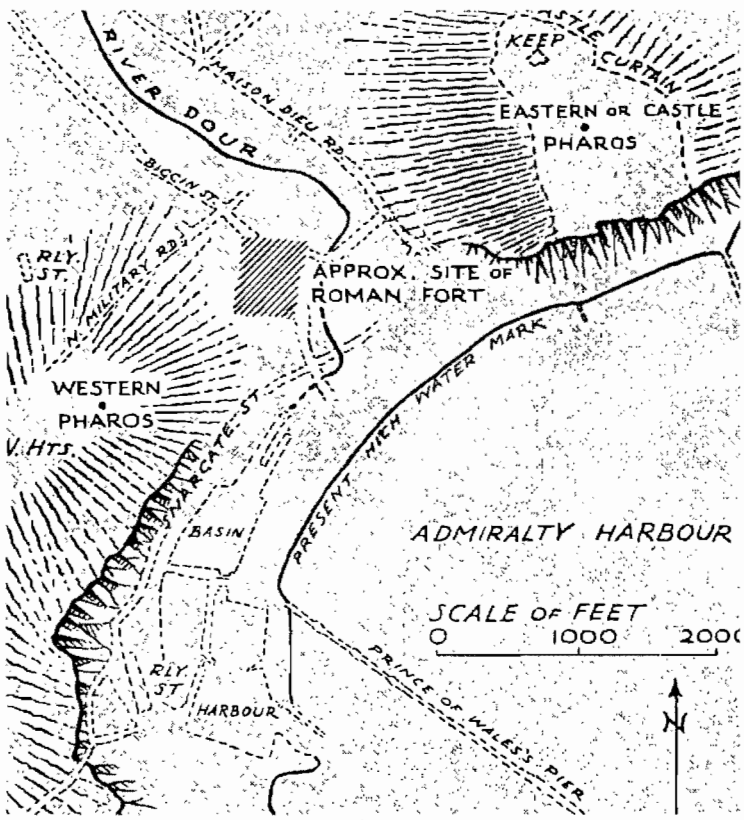

Fig. 9
Plan of Dove.r
From the "Office of the Works".

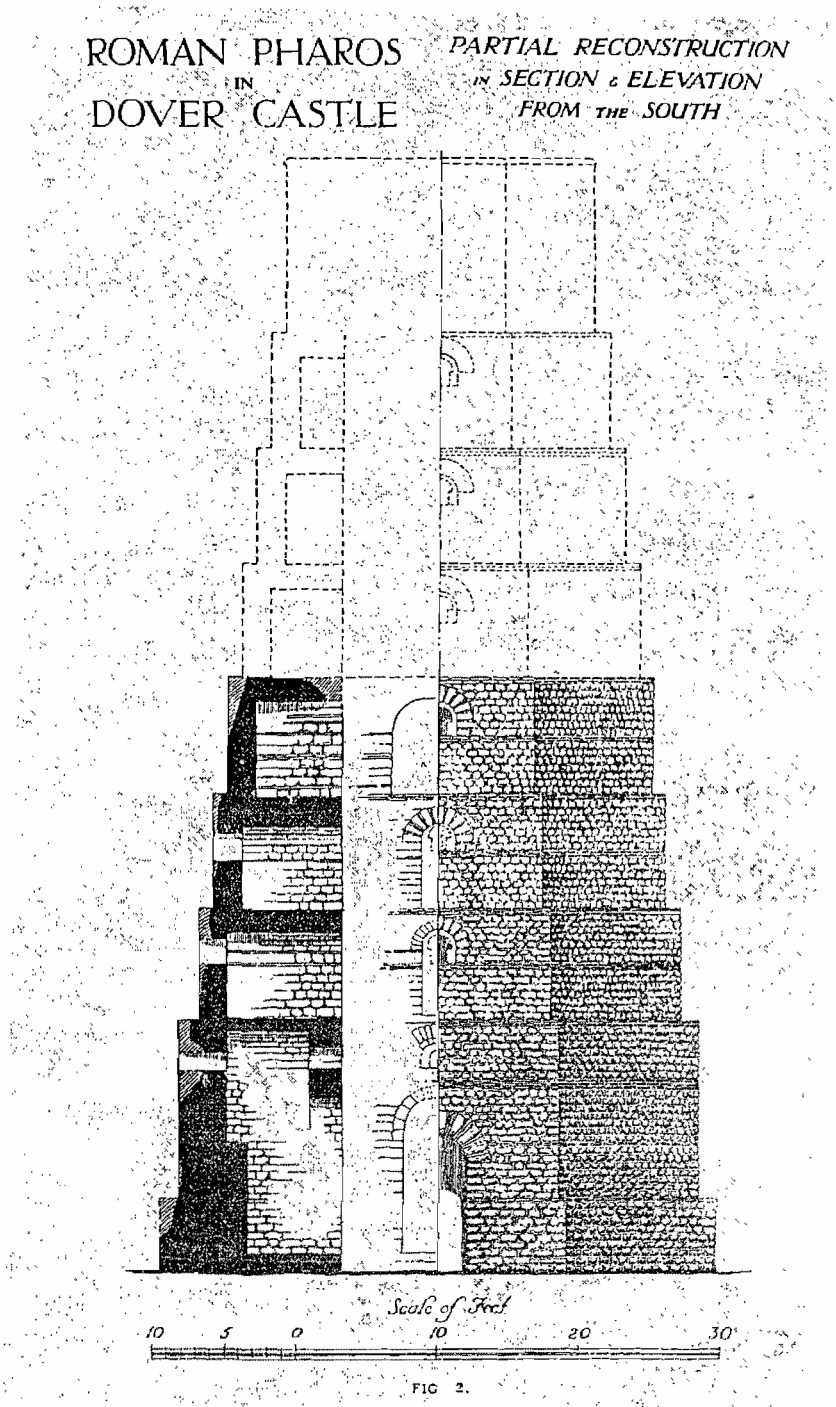

Fig. 10
Eastern Pharos.

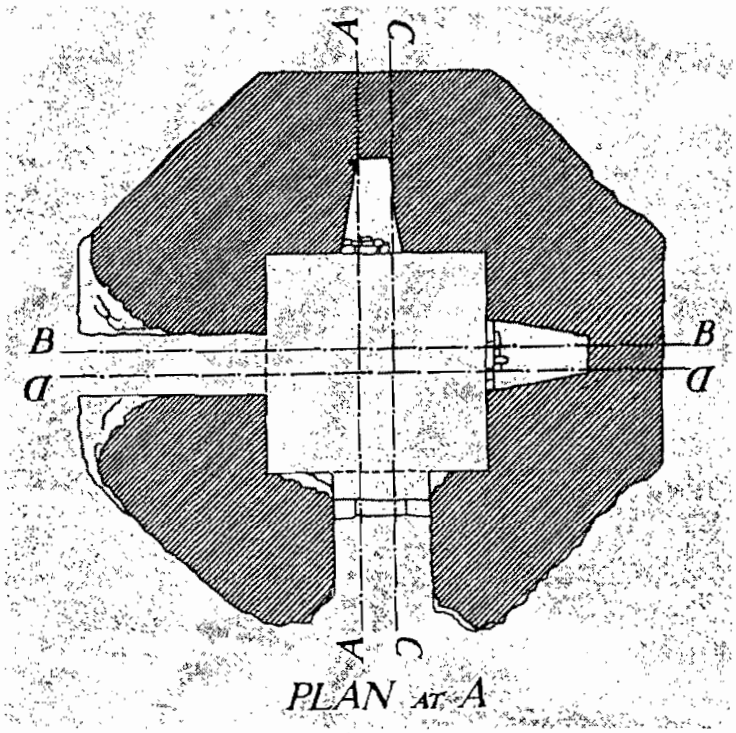

Fig. 11
Floor plan of Eastern Pharos.

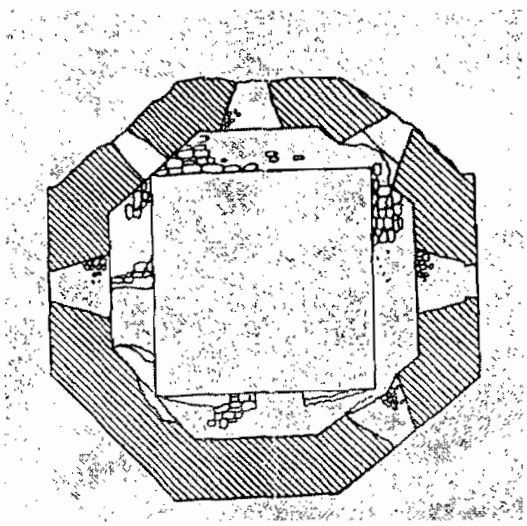

Fig. 12
Plan of upper level altered during medieval times.
The outward cross-hatch represent the medieval construction over the Roman structure.

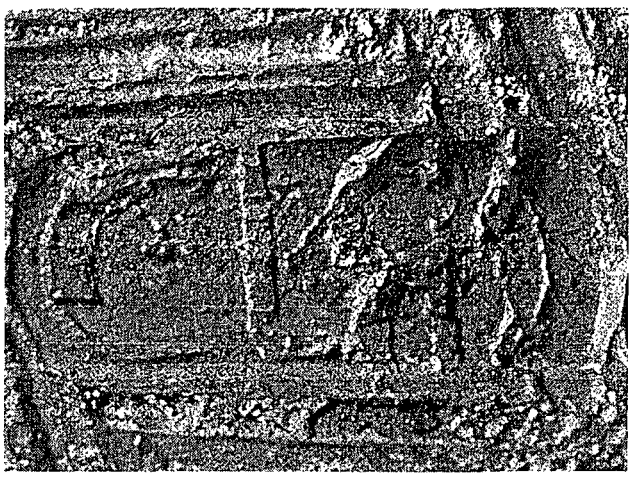

Fig. 13
Stamp from Classis Britannica bearing inscription CL.BR

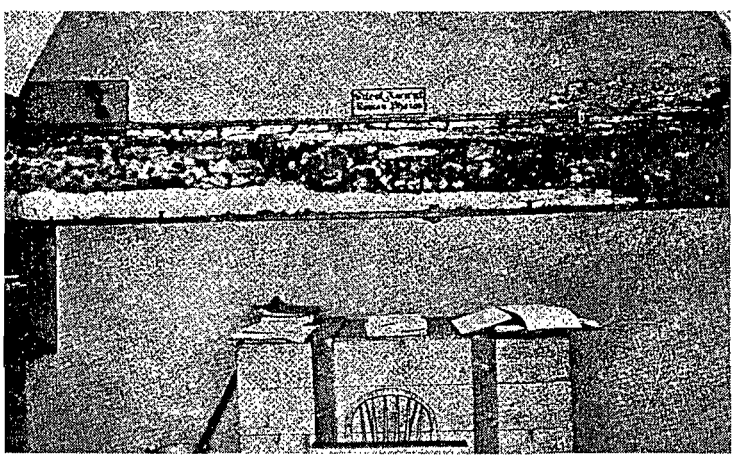

Fig. 14
Remaining part of the Western Pharos as part of the walls of the army barracks at Dover.

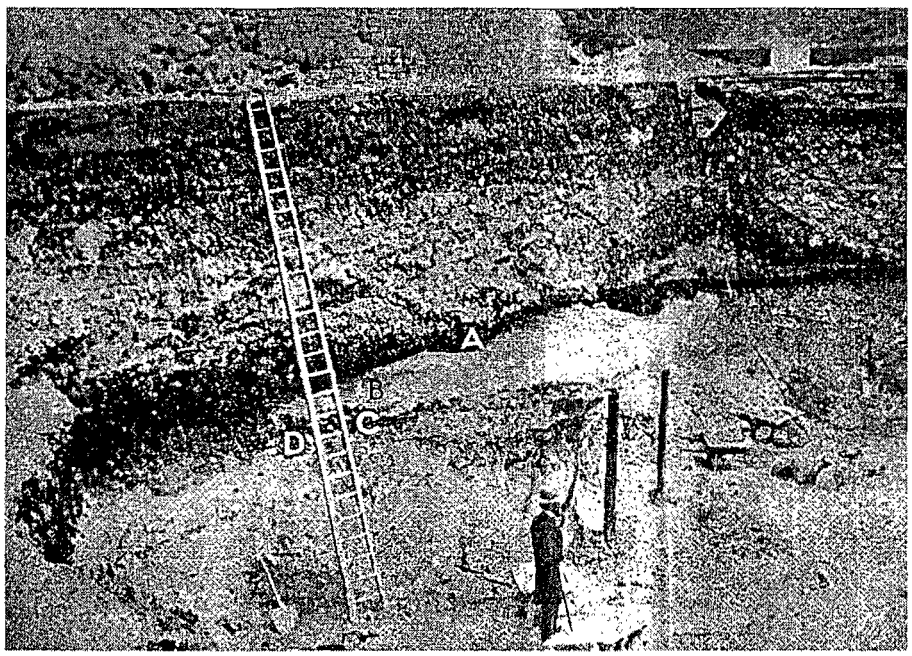

Fig. 15

The strata from the excavation of the Western Pharos.

"A" represents charcoal from wood and animal bones, "B" is mortar, "C" represent the layer of flint and "D" is the Roman construction.

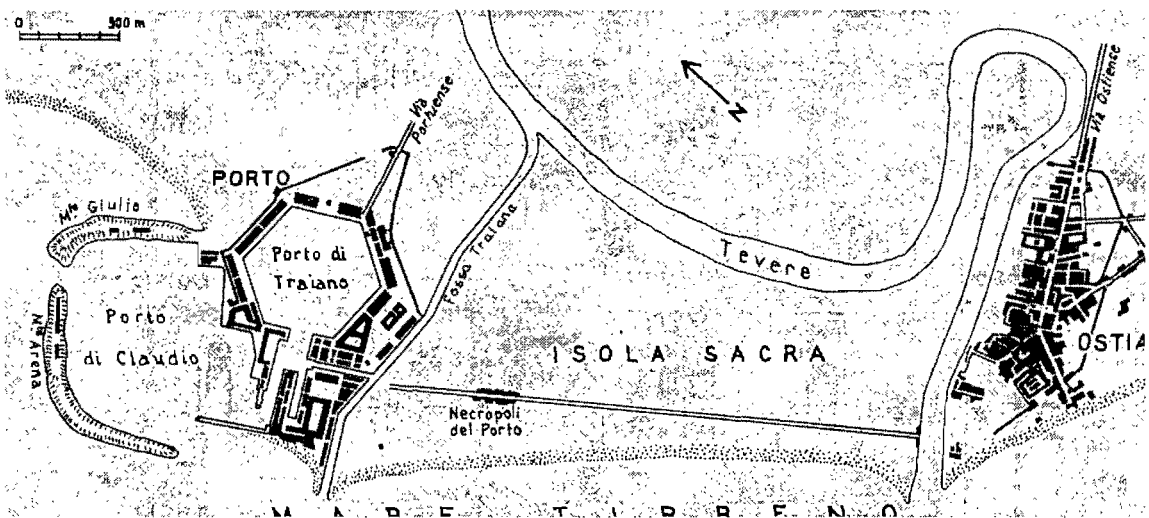

Fig. 16

Plan of Ostia.

To the left, on the upper tip of mount Arena, is the location of the lighthouse.

Fig. 17
Photo of concrete base of lighthouse.
The outline shows the size of the ship sunk and filled with concrete to make the base of the lighthouse.

Fig. 18
Mosaic from l'Isola Sacra, Ostia.

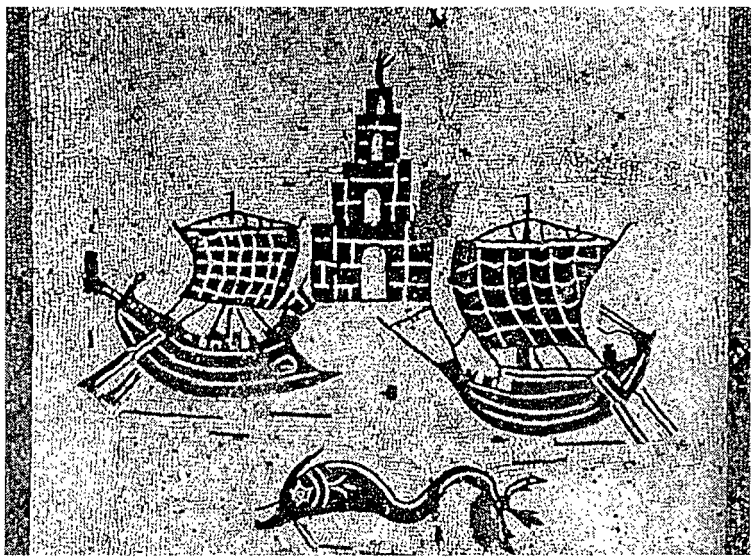

Fig. 19
Mosaic from The Place of Corporations, Ostia.

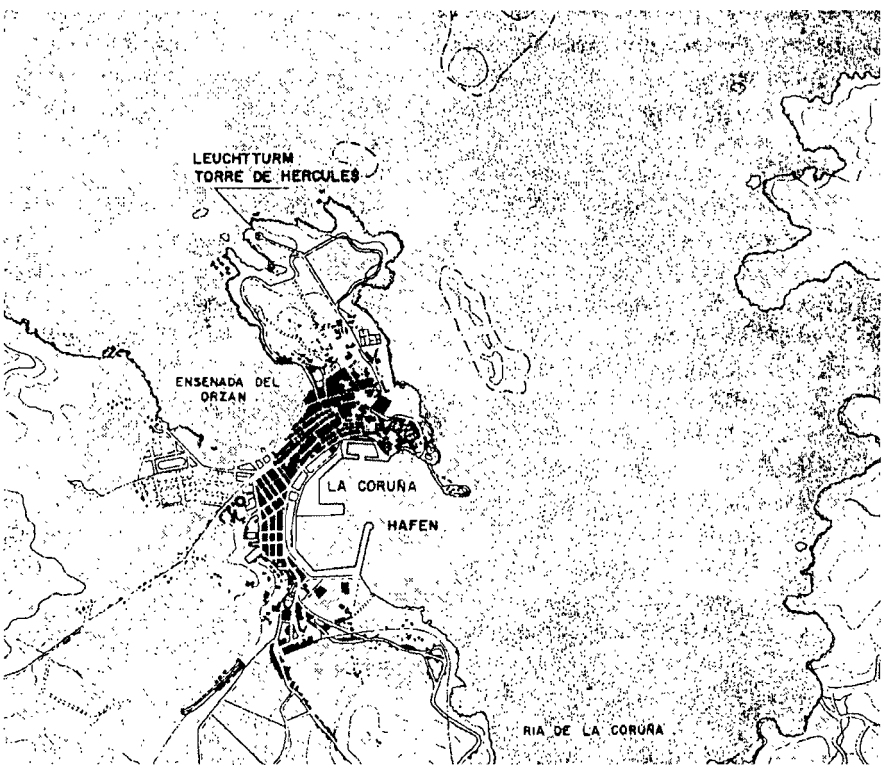

Fig. 20
Harbour at La Coruña.
The lighthouse is located at the north-west of the port.

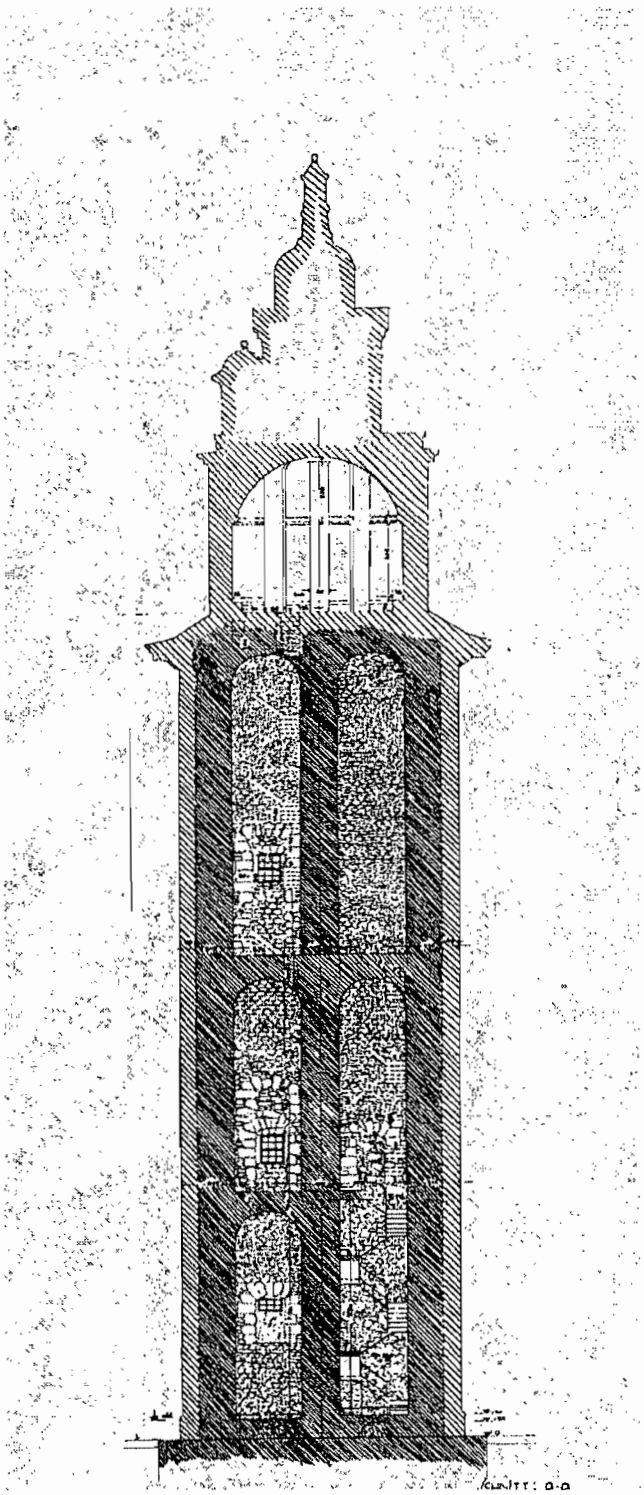

Fig. 21
The modern lighthouse at La Coruña.
The pale cross-hatch represents the modern casing over the Roman masonry, represented by the darker cross-hatch. The upper section was added later.

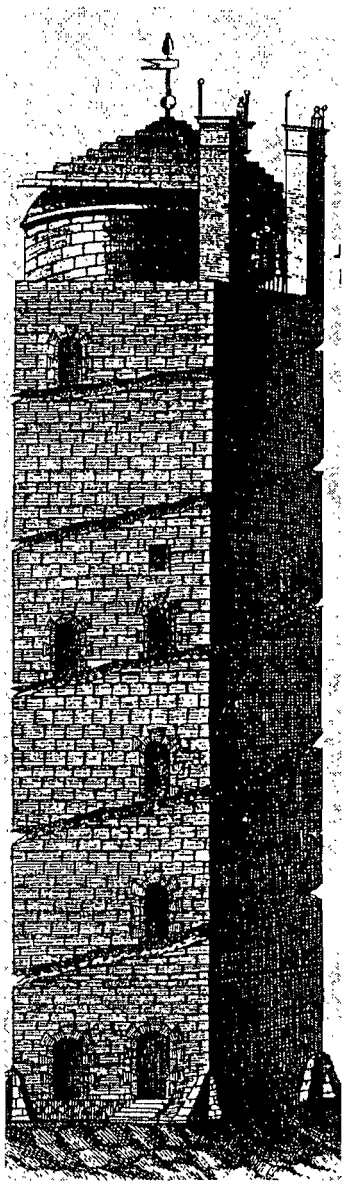

Fig 22
A 1685 representation of the lighthouse of La Coruña.
The continuous indentation along the wall of the lighthouse
is the area where the staircase/ramp leading to the beacon used to be.

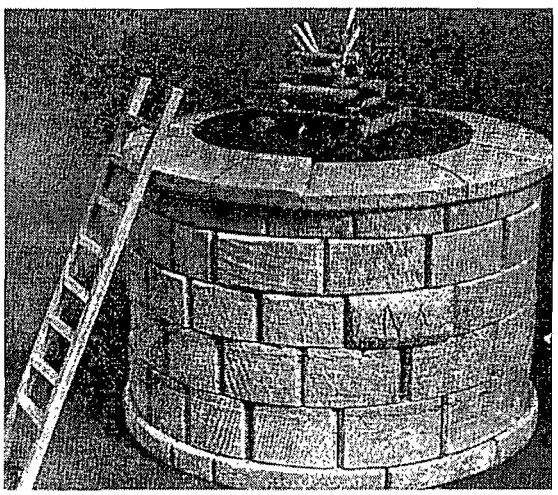

Fig. 23
Reconstruction of the lighthouse at Thasos.

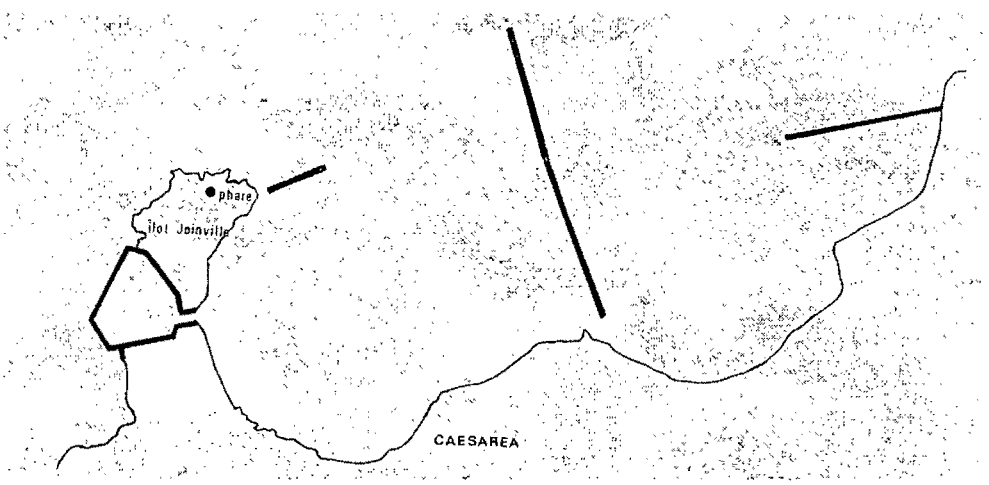

Fig. 24
Harbour at Cherchel.

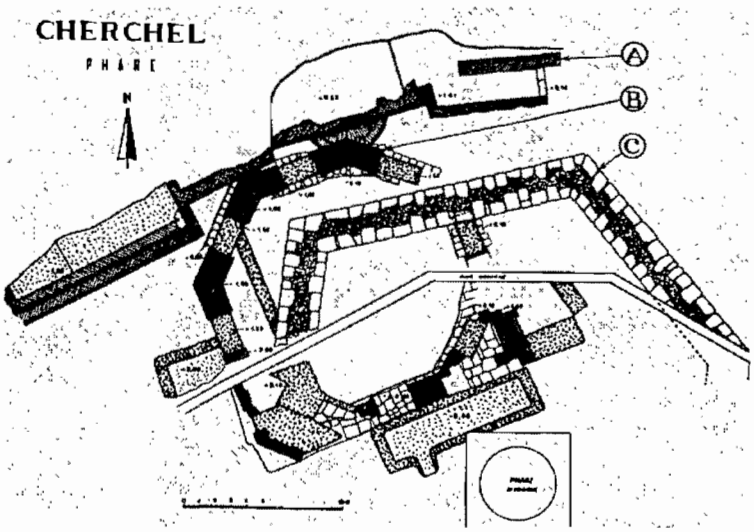

Fig. 25
Floor plan of the lighthouse at Cherchel.
"B" represent the base of the lighthouse, "C" represents the Turkish ramparts and "A" is the evidence for the apsidal building.

Fig. 26
Archaeological evidence from the lighthouse at Cherchel.

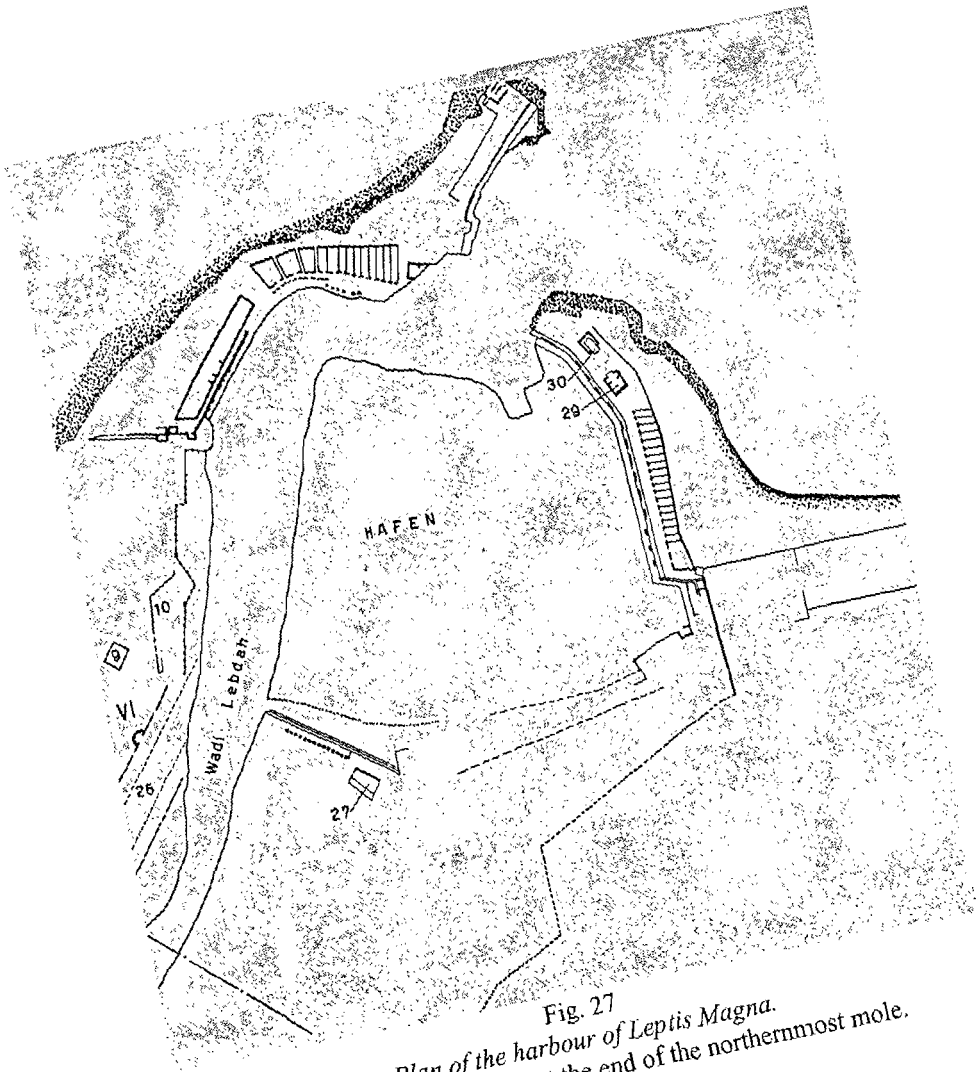

Fig. 27
Plan of the harbour of Leptis Magna.
The lighthouse is located at the end of the northernmost mole.

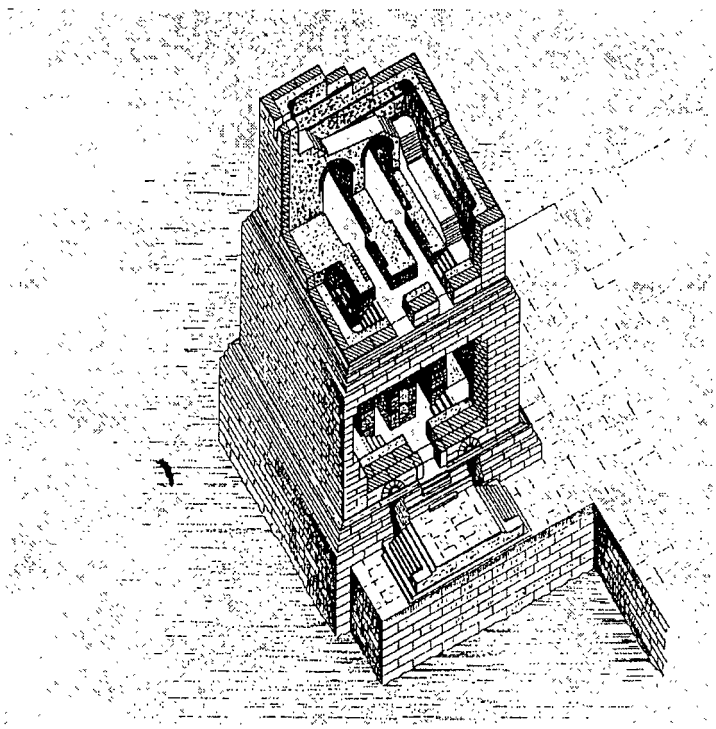

Fig. 28
Reconstruction of the lighthouse at Leptis Magna (from R. Bartoccini).

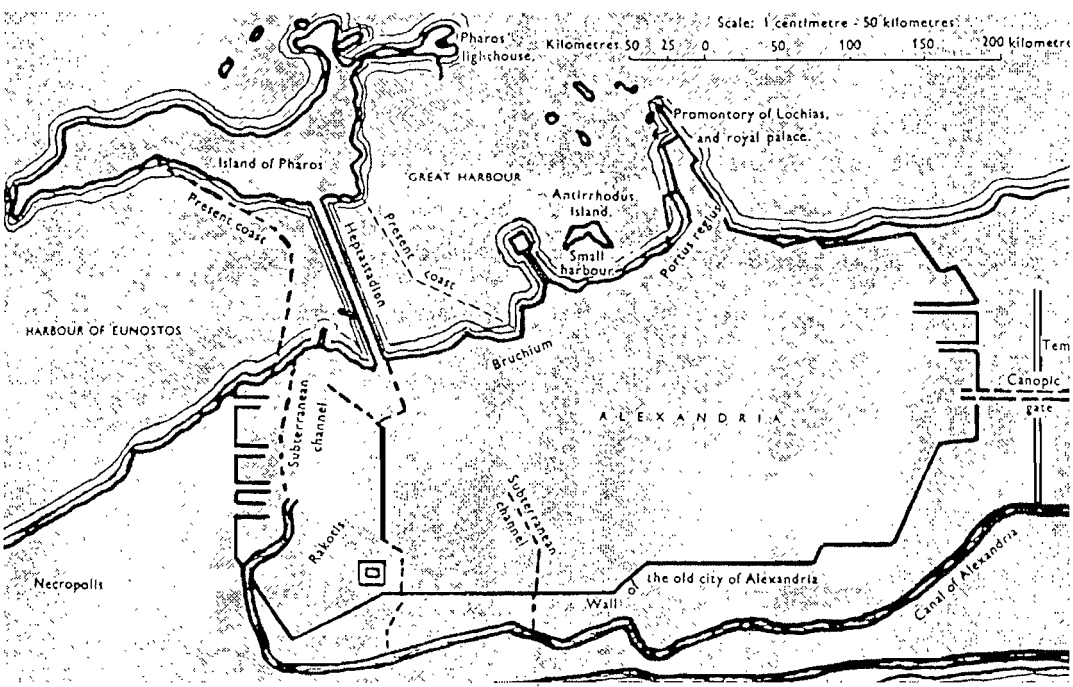

Fig. 29
Harbour at Alexandria.
The lighthouse stood at the end of the north-east mole.

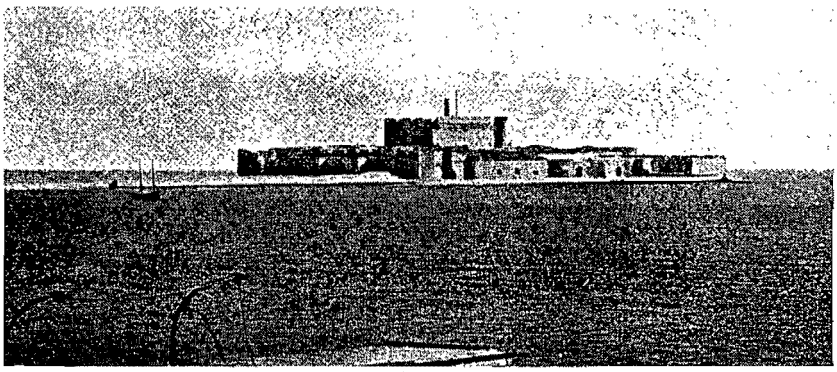

Fig 30
Fort Qaitbay today.
The lighthouse is believed to have been erected there.

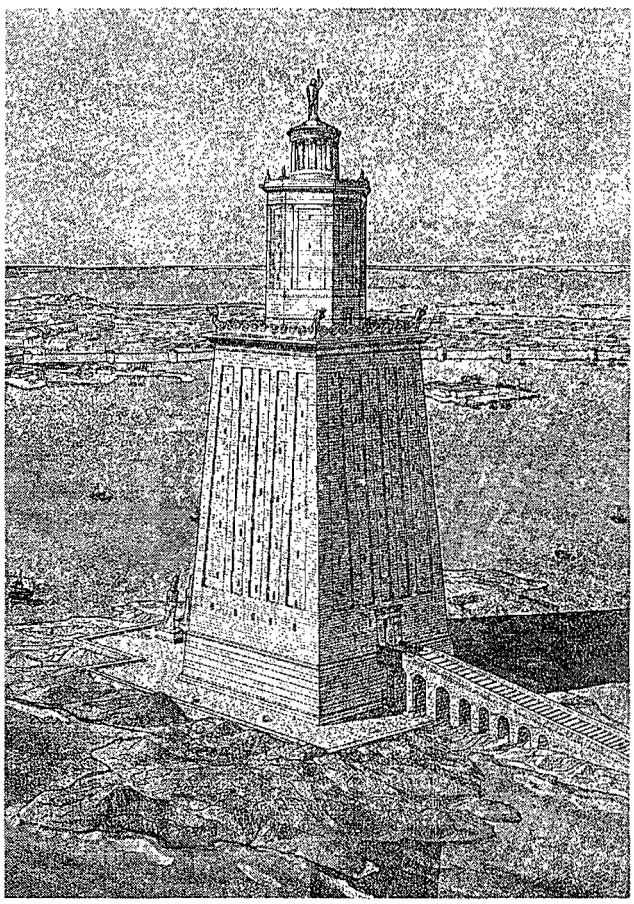

Fig. 31
Reconstruction of the lighthouse at Pharos.

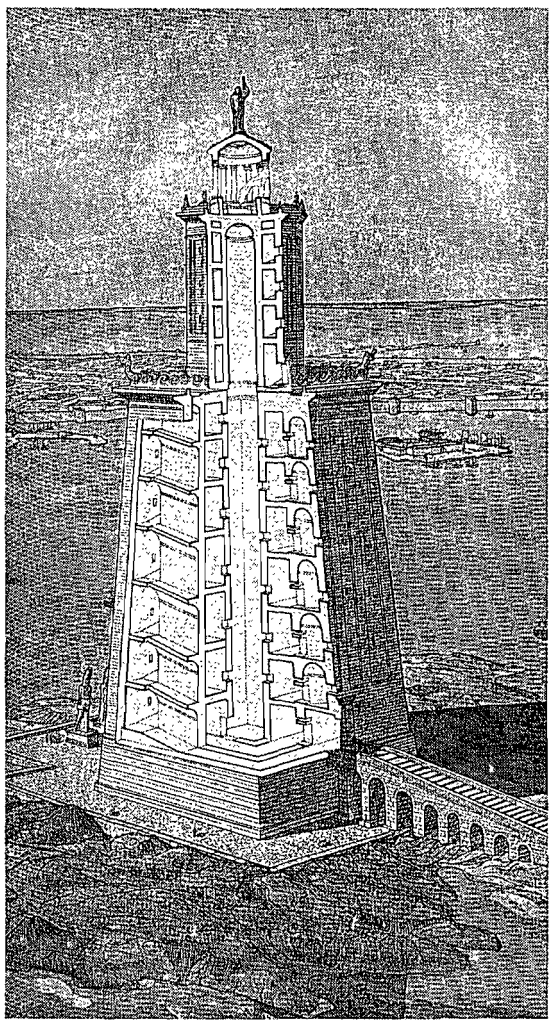

Fig. 32
Reproduction section of the lighthouse at Pharos.

Fig. 33
The Begram Vase.
Note the Triton represented on the four corners of the structure.

Fig 34

Two coins from Pharos.

Note that the tritons are the one constant which is reproduced on images of the lighthouse at Pharos.

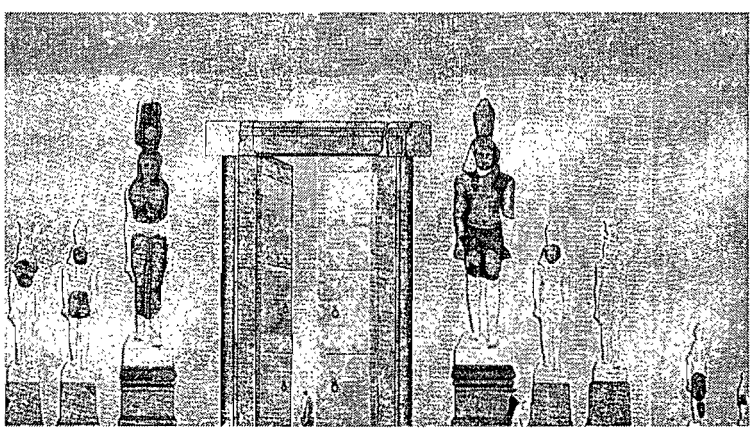

Fig. 35

Reconstruction of Monumental Entrance at the lighthouse at Pharos.

The darker shading on the statues represents artefacts already recovered from the sea.

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