

How the obelisks reached Rome: evidence of Roman double-ships

Armin Wirsching

Hoheluftchaussee 32, 20253 Hamburg, Germany

The Egyptians transported obelisks to Alexandria for the last time shortly before 30 BC. The Romans learned from them after their annexation of Egypt in that year. In 13/12 BC two obelisks were transported from Heliopolis to Alexandria under Roman supervision. The hypothesis put forward is that in the light of this experience the Romans constructed a special sea-going version of the Nile vessels for onward transport to Rome—a double-ship with three hulls. © 2000 The Nautical Archaeology Society

Key words: obelisk, double-ship, Portus, Rome.

Introduction

The cultural achievements of Egypt have impressed the world for over 2000 years, and to share in these achievements was an enterprise well worth the undertaking. With Egypt's annexation in 30 BC, the Roman Empire gained the opportunity to import cultural, as well as material, goods from the region. Nothing symbolized spirit and power more than the obelisks, and nothing seemed more suitable to the Roman conquerors for demonstrating their own might. Augustus (Emperor 27 BC–AD 14) therefore gave the order to transport obelisks to Rome, and in 10 BC the Romans started transporting the obelisks across the Mediterranean. Contemporary reports give clues to how the ships which brought them were built, but these clues alone are not sufficiently clear. Furthermore, it is known that Claudius (Emperor AD 42–54) sank the obelisk-ship of his predecessor Caligula (Emperor AD 37–41) in the new harbour of Ostia to serve as a foundation for harbour facilities. Preserved traces allowed Testaguzza (1959) to recognize a ship 104 m long and 20.3 m wide. Subsequently doubts have been cast on the accuracy of his conclusions.

Given the bold scope of Augustus' enterprise, it can only be assumed that the Romans had studied Egyptian methods used in transporting obelisks on the Nile, putting these to the test between 13–12 BC when two obelisks were brought from Heliopolis to Alexandria. These experiences could have then been used for designing a transport to

Rome and constructing a ship appropriate to the task. As a result of recent discoveries concerning the Egyptian methods, the Roman undertaking should be reconsidered.

The obelisks: a general overview

Two obelisks weighing 230 and 260 tons first reached Rome in 10 BC (Table 1). Afterwards, two even heavier obelisks were transported along with an unknown number of smaller ones. Today 13 obelisks stand in Rome, although not in their original places. The history of the obelisks in Rome has been repeatedly described.^[1]

After their victory over the Egyptians, the Romans found an obelisk in Alexandria which was about to be raised. The first Roman prefect in Egypt, Cornelius Gallus, dedicated the obelisk to Augustus and erected it in 30 BC in the Forum Iulium (Alföldy, 1990: 36). It stood there until Caligula had it lowered in AD 40 and brought to Rome. This so-called Vatican Obelisk is the only obelisk that the Romans did not have first to bring down the Nile to Alexandria.

The Flaminian Obelisk was the first obelisk to reach Rome in 10 BC (Kroll, 1932: obeliskos), and was followed immediately thereafter by the Campensis Obelisk. Both obelisks had stood in Heliopolis—today a section of the city of Cairo—and first had to be brought down the Nile to Alexandria. In order to consider the state of Roman transport technology it is important to

Table 1. *The four largest obelisks at Rome*

	Flaminian obelisk	Campensis obelisk	Vatican obelisk	Lateran obelisk
Height (m)	22.84	21.79	25.31	32.15
Weight (tons)	263	230	330	500
Donor/Pharaoh	Sethos I, 19th dyn.	Psametik II, 595–589 BC	Cleopatra before 30 BC	Tuthmosis III, 18th dyn.
Original stand	Heliopolis	Heliopolis	Alexandria	Karnak
Transport on Nile	Romans, 11–10 BC, Alexandria	Romans, 11–10 BC, Alexandria	—	Constantine I, AD 337, Alexandria
Transport to Rome	Augustus, 10 BC, Circus Maximus	Augustus, 10 BC, Campus Martius	Caligula, AD 37–41, Circus Vaticanus	Constantius II, AD 357, Circus Maximus
Re-erection in Rome	Sixtus V, 1589	Pius VI, 1792	Sixtus V, 1586	Sixtus V, 1588
Stand today	Piazza del Popolo	Monte Citorio	Piazza S. Pietro	Giovanni Laterano

note that the Romans had previously—in the years 13–12 BC—brought two obelisks down the Nile from Heliopolis to Alexandria. In the 19th century these same obelisks were brought to London (1877) and New York (1879).

Augustus also intended to bring the largest of all obelisks, the Lateran Obelisk, to Rome but the technology was insufficient at the time to move the 500-ton stone. Under Constantine I (306–337) this obelisk was transported from the temple in Karnak to Alexandria. His son and successor Constantius II (337–361) allowed for the completion of the transport and finally brought it to Rome in 357.

Contemporary reports on obelisk transport

For one of the most significant engineering feats of antiquity, it would be expected that a quantity of information would have been handed down, in particular how the ships were constructed and how they were loaded. That, however, is not the case. Short reports on the subject are given by Pliny (Plinius Secundus, *c.* AD 23–79) and Ammianus Marcellinus (330–*c.* 393), but they contain very little information.

In connection with a report on obelisks in Egypt and a description of an obelisk transport in the 3rd century BC, Pliny (Nat. Hist. 36; 14, 70) reports on the transport to Rome:

Above all, there came also the difficult task of transporting obelisks to Rome by sea. The ships used attracted much attention from sightseers. That which carried the first (of two obelisks) was solemnly laid up by Augustus of Revered Memory in a permanent dock at Puteoli to celebrate the remarkable achievement; but later it was destroyed by fire.

The ship used by the Emperor Gaius for bringing an obelisk (the third) was carefully preserved for several years by Claudius of Revered Memory, for it was the most amazing thing that had ever been seen at sea. Then towers of earth were erected in its hull at Puteoli, whereupon it was towed to Ostia and sunk there by order of the Emperor, so as to contribute to his harbour works. (Trans. Eichholz, 1962)

On another occasion Pliny (Nat. Hist. 16; 76, 201–202) comments on an obelisk-ship in connection with large trees in Rome at that time:

An especially wonderful fir was seen on the ship which brought from Egypt, at the order of the Emperor Gaius, the obelisk erected in the Vatican Circus and four shafts of the same stone to serve as its base. It is certain that nothing more wonderful than this ship has ever been seen on the sea. It carried 120,000 modii of lentils for ballast, and its length took up a large part of the left side of the harbour of Ostia, for under the Emperor Claudius it was sunk there with three moles as high as towers erected upon it, that had been made of Puteoli earth for the purpose, and conveyed to the place. It took four men to span the girth of this tree with their arms . . . (Trans. Eichholz, 1962)

Ammianus Marcellinus (Book 17; 4, 13–14) reports on the transport of the Lateran Obelisk in AD 357, under Constantius II, from Alexandria to Rome; but tells us only that the obelisk was loaded into a ship of unprecedented size, rowed by 300 oarsmen. The transport met with great difficulties travelling up the Tiber. Upon reaching Rome's vicinity, the obelisk was pulled on a sledge into the city.

The report made by Ammianus only mentions the ship's 300 oarsmen, but the reports made by Pliny contain more information. First, it can be deduced that the Romans built two obelisk-ships.

The first of them was sent to the shipyard in Puteoli by Augustus as a memorial, where it was destroyed by a fire. The second ship built by Gaius (Caligula) was sunk in Ostia Harbour by Claudius. Further statements on the obelisk-ships taken by themselves are not clear. In the following analysis, it will be investigated if, and how far, the reports made by Pliny and Ammianus can be made intelligible when viewed in the context of modern considerations and models, as well as facts concerning Egyptian transport technology. The investigations carried out by Testaguzza in the former harbour at Ostia are also important for considering the construction of the obelisk-ship.

Modern views

Iversen (1968: 21, 56, 65) and Habachi (1977: 115, 119), both engaged in the history of obelisks, refer singularly to the reports of the aforementioned historians. Dibner (1950: 17) does not mention Barber (1900: 101) but states that the ship which transported the Vatican Obelisk had 300 oarsmen and carried in addition ballast of 1000 tons of grain: placed in sacks and fitted around the obelisk to keep it from shifting when the vessel rolled.

Korres (1997: 232) assumes, as did Choisy (1904: 121; quoted in Korres, 1997: 232) before him, that the obelisks as well as the stone cupola to form Theoderic the Great's mausoleum in Ravenna (after AD 500) were not transported in one ship alone, but rather with two ships travelling side by side—as described by Plinius (Nat. Hist. 36; 14, 67–68). Choisy believed it possible that the obelisk was suspended in the water between the ships in order to lessen the weight. Korres rejects this hypothesis and asserts that the obelisk lay on the beams which connected the ships—on the grounds that all surviving evidence speaks against the freight having been carried in water. Choisy's hypothesis is supported by Orlandos (1968: 29) who makes reference to the use of double-ships to transport heavy stones in antiquity. Knowledge of the transportation of marble blocks across the open sea with double-ships called *Amphyprymnoi* is given by reports on the construction of a large temple in Didyma near Miletus about 300 BC (Wiegand, 1958: 37–39).

Of special interest are the opinions of experts on shipbuilding in antiquity and nautical research concerning the transport of obelisks. Torr (1964: 26) adds the weight of the Vatican Obelisk (330

tons) and the weight of its four pedestal blocks (155 tons) to the ballast of 120,000 modii of lentils (800 tons) and writes that the ship could have carried a load of 1300 tons. Casson (1995: 188) calculates in the same manner. However, neither author mentions how it was possible to pull a ship with a 1300-ton load up the Tiber. In practice the freight of large trading ships had to be loaded onto ships with a lesser draft at the mouth of the Tiber (Nissen, 1883: 317; Blackman, 1982: 187). The contradiction is only apparent; research shows that there never were obelisk-ships with a capacity of 1000 tons and more. The assumed existence of such ships lies on a misunderstanding.

Archaeological investigations

From 1959 onwards Testaguzza studied stone structures recently unearthed on the southern edge of today's Fiumicino airport. These once belonged to the harbour of Ostia, built under Claudius after AD 42. In the angle made by the streets Via F. de Pineo and Via dell'Aeroporto lies the end of the former western mole which was denoted as the 'left' mole. Here Testaguzza found imprints of planks, beams and holes in which beams were once placed and identified these traces as the obelisk-ship of Caligula (Testaguzza, 1970: 105–109). The ship lies on the side of the mole which faced the harbour with the bow pointing to the west and is partially covered by the stones of the mole. What is discernible, according to Testaguzza, is the ship's bow and a part of its port side. Set on the stones of the mole next to the ship, remains of the tower are preserved that marked the entrance to the harbour. The depth of water at the mole was once 7.5 m, and the imprints of planking reach approximately 1.5 m above the water-level (Fig. 1).

According to Testaguzza, the total length of the ship was 104 m, being 90 m at the waterline. Because he could discern the starboard side, he was able to establish the beam as 20.3 m. He assumed the height of the ship to be 12.5 m. From imprints of beams lying horizontally he ascertained the height of the decks to be approximately 2 m. From this evidence, he concluded that the ship including the hold had six decks. Speculation regarding the disproportion between the length of the obelisk (25 m) and the length of the ship (90–104 m) is not included in the report. The report also gives no mention of the draft of the loaded ship and how it was possible to pull the

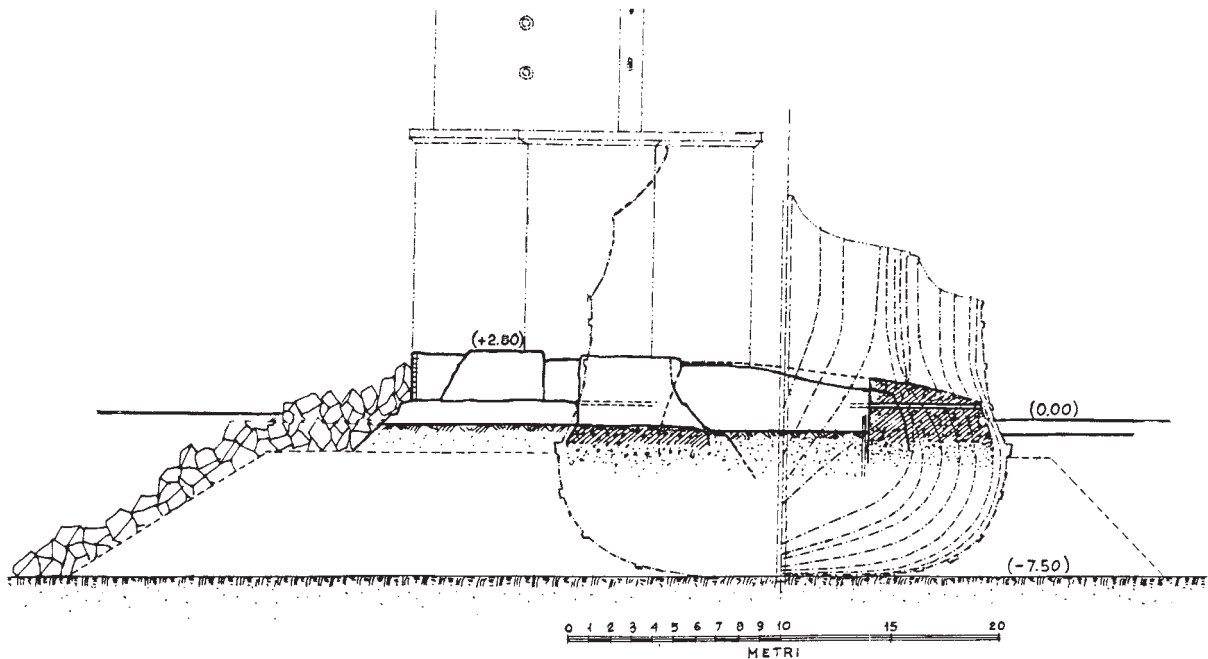


Figure 1. Section of Caligula's obelisk-ship. (After Testaguzza, 1970: 115)

ship up the Tiber. Casson (1971: 189) comments on the findings only in a footnote: 'his identification of the stern and starboard side, which leads him to assign a size of 104 m × 20.3 m is by no means sure'.

Clearly false is Testaguzza's translation of remarks made by Pliny. The ship was not sunk in order to raise a tower consisting of three levels. Pliny wrote that three moles as high as towers made of Puteoli earth were raised on the ship before it was sunk: *cum tribus molibus turrium*. This seemingly insignificant and obscure detail will prove to be an important clue for the construction of the ship.

The Romans learned from the Egyptians

How was it possible for the Romans to transport stones 22 m in length and weighing 250 tons 'from its resting state' securely across the open sea? There was neither a development in Roman ship construction that made such a feat possible, nor did they have the necessary loading technique. The answer is: the Romans used Egyptian know-how. Although the Egyptians had no seagoing ships of note, their river-navigation was highly developed. Before the first transport to Rome, engineers and shipbuilders had an opportunity of studying the Egyptian technology of transporting obelisks on the Nile. Because Cleopatra had an

obelisk brought to Alexandria immediately before Egypt's annexation in 30 BC, the know-how of the specialists became available to the conquerors. It can, therefore, be assumed without a doubt that the 209-ton and 224-ton monoliths (Dibner, 1950: 59) were transported between 13–12 BC by Egyptian specialists under Roman supervision from Heliopolis to Alexandria. Building on these experiences, the Roman navy was capable of constructing an appropriate ship for the transport of the Flaminian Obelisk and the Campensis Obelisk in 10 BC. This is much more likely than that Roman naval architecture, in the brief span of 3 years, made a developmental leap to a suitable ship with a capacity of 1000 tons. The task was accomplished only on the basis of Egyptian technology and Roman ships adapted to the purpose.

The Egyptian transport technology

In the mortuary temple of Queen Hatshepsut in Deir el-Bahari (Western Thebes), there is the only depiction of an obelisk transport (Fig. 2).

Until now, the obelisk-ship of Queen Hatshepsut has always been interpreted as it appears. In 1934 Koester deduced the length of the ship to be 84 m from the length of the obelisks. Sølvér assumed in 1939, as did Ballard in 1920, that the obelisks lay side by side and that

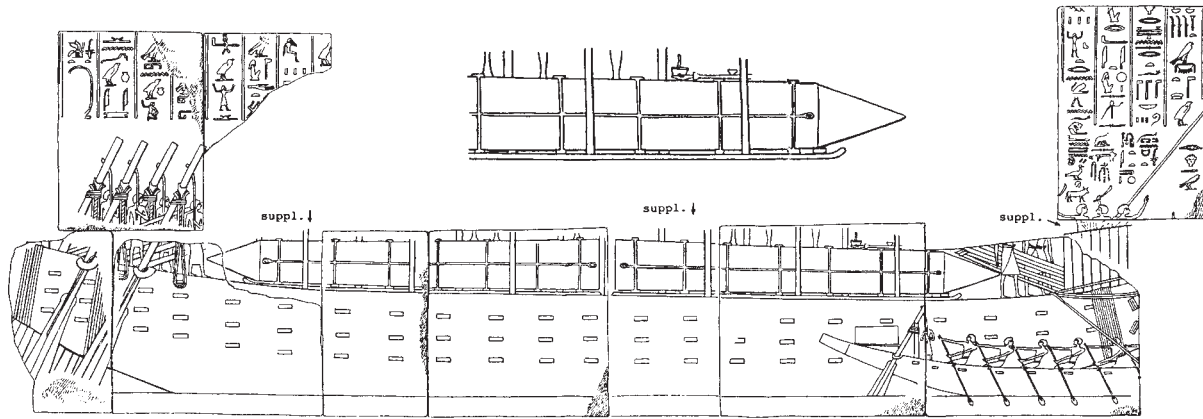


Figure 2. Queen Hatshepsut's obelisk-ship. (After Landström, 1970: Fig. 381)

the ship was 63 m long.^[2] But was the barge really a giant on the Nile and 60–84 m in length, 6–7 m in height, and up to 28 m in beam? The artist who painted the picture was no expert on Egyptian ships, in that he made apparent mistakes (Clarke & Engelbach, 1930: 39). He probably worked using the descriptions of spectators who saw the ship on its arrival in Karnak, but he was not personally familiar with the transport technology. In order to interpret the picture correctly—also taking the principles of Egyptian painting into account—it is helpful to use older representations in which the transport technology is documented (Fig. 3).

Until now it was believed that heavy, granite objects such as columns were laid on top of ships at the stone quarries near Aswan, and then brought northward. Goyon (1970) reconstructed the barges with this procedure in mind, and as they appear on reliefs in the causeway to the pyramid of Pharaoh Unas in Saqqara. This assumption can no longer be upheld. Instead the columns were transported hanging in water between two ships. As granite has a specific gravity of 2.66, it means that the total weight each ship had to carry was only 0.5 $(2.66 - 1.0) \times 100 / 2.66 = 31\%$. The step-by-step reconstruction (Wirsching, 1999: 396) has shown that the freight,

that is the two columns on transport sledges, was attached to a longitudinal load-beam. This is supported by long crossbeams resting on the decks of both ships. For reasons of clarity, the load-beam is depicted twice in the author's proposed reconstruction: first in relation to the ship and second to the freight (Fig. 4).

The columns and transport sledges are fastened with ropes to the load-beam. The timber with suspensions is the same as the uppermost timber in the picture; that is, the foremost timber of the flat lying load-beam. The slabs on the bow and stern, which until now were thought to be rafts made of tamarisk used to control the vessel downstream (Goyon, 1970: 29), otherwise known as *Herodotus Steering*, are to be identified as planks that lie horizontally across bows and sterns, and connect both ships at deck level. The lower planks near the bow and stern are to be understood as planks that, if tipped backward from the picture level and turned, connect both bows and sterns to one another from the waterline to deck level (Fig. 5). Because the bow and the stern of the double-ship is rounded with planking, an observer standing on the bank would not see *two ships side by side*, but rather a very wide ship.

The loading of the double-ship was easy and convenient. Both ships were loaded with ballast,

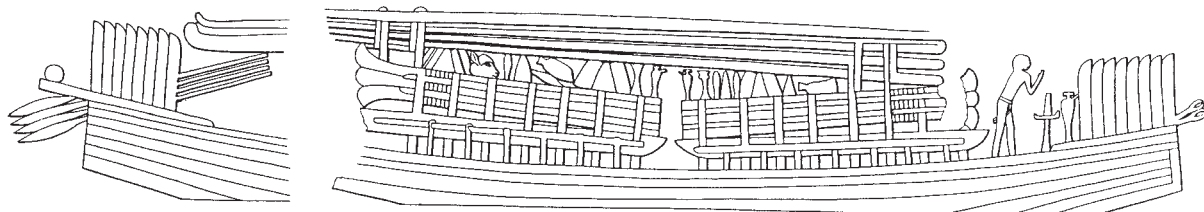


Figure 3. One of the ships in the causeway to the pyramid of King Unas. (After Hassan, 1955: 135)

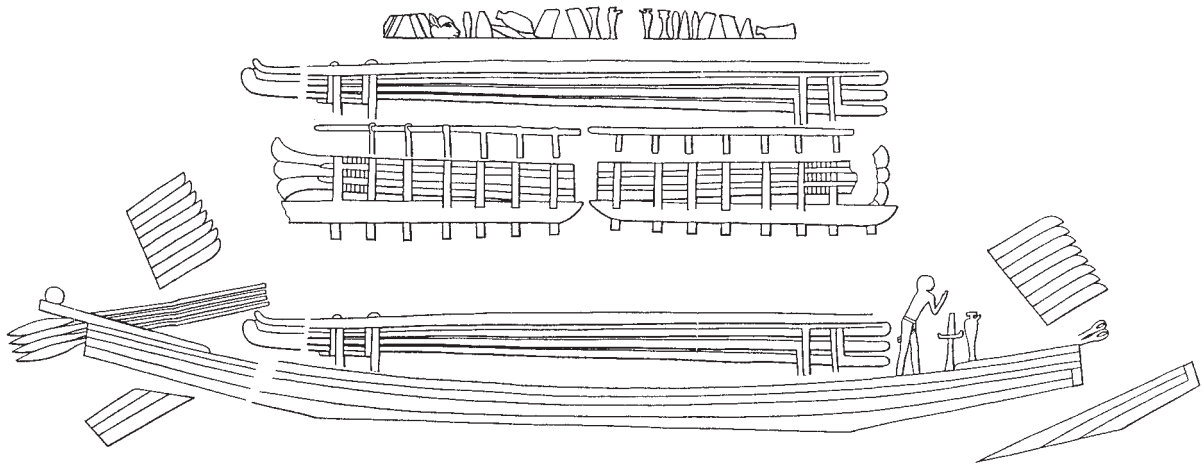


Figure 4. The parts of ship and freight have been separated and given a new arrangement. (Drawing: author)

so as to lower the draft to a level significantly deeper than the normal draft, and then brought over the stone which was laying below the water level. Without using any power, the freight could then be attached to the load-beam. When the ballast was removed, the double-ship rose and lifted the freight. Double-ships could be loaded in water to the utmost limits of their capacity without upsetting the balance. For barges on the Nile, the downstream current was sufficient for propulsion. As barges cannot be steered when floating

freely with the current, they had to be towed by oared boats in order to direct their course.

To carry still heavier freight and in particular obelisks, the double-ship was further developed into a *doubled double-ship*. Triangular supporting frames were substituted for the load-beam and the long crossbeams, and the bases of these rested on top of the load-beams of the two double-ships. Horizontally-placed ropes braced the supporting frames as well as the bow and stern of the ship (Fig. 6).

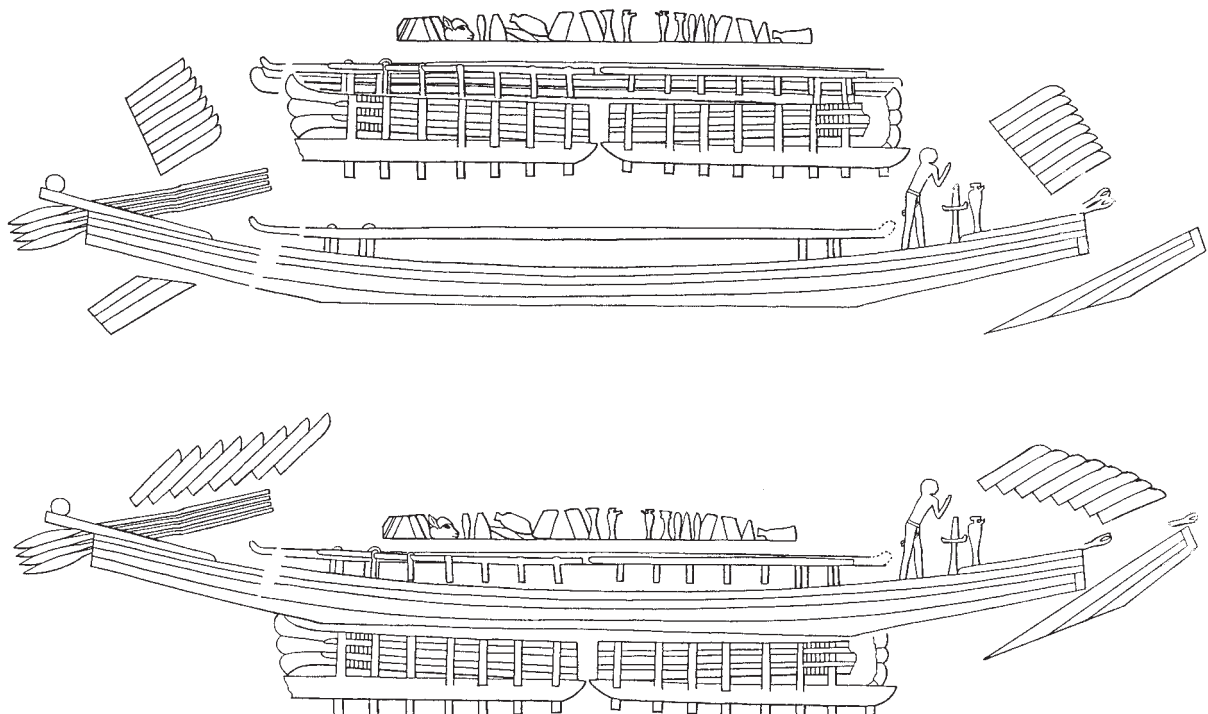


Figure 5. Parts of the ship and freight have been connected in a new way. (Drawing: author)

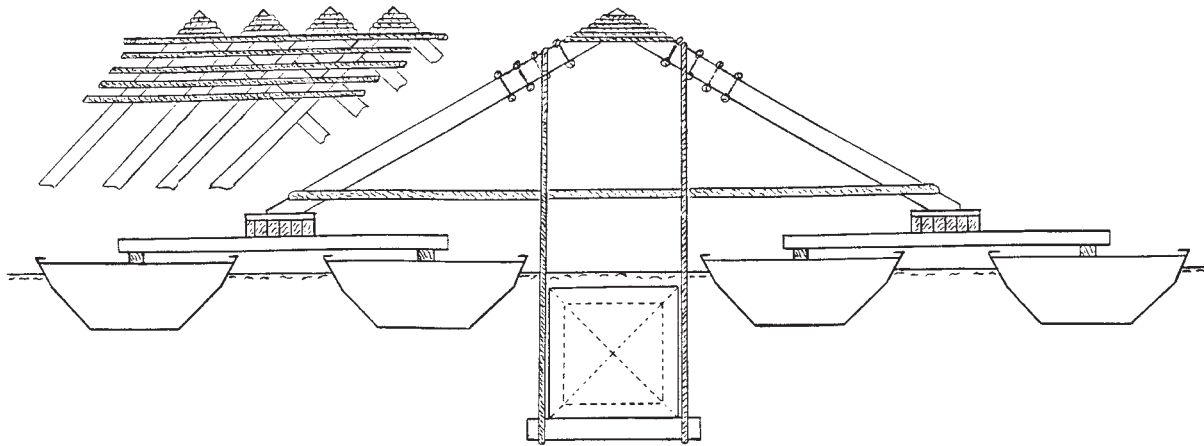


Figure 6. General sketch of the doubled double-ship. (Drawing: author)

In the light of knowledge of Egyptian transport technology the representation of Queen Hatshepsut's obelisk barge must be interpreted as a low-built doubled double-ship (Wirsching, 1999: 406). To be more precise, the depiction represents two doubled double-ships, closely attached one behind the other, and because the obelisks were not visible being suspended under water, the spectators saw mock-up obelisks on deck. Due to planking around the bow and stern, the ship appeared to be a single hull with an enormous beam and this was what the observers saw in Karnak and related to the artist. The artist accentuates the width in the Egyptian manner; in other words, the ship's beam is expressed by an extreme height at the picture level.

The three rows of rectangles on the ship's side do not indicate that there is a frame in the hull, but rather three rows of beams at deck level; the smaller ship in the picture reveals these rectangles to be oar-banks. The artist wanted to show that *the ship was as wide as four normal ships*; therefore, he portrayed a ship and three rows of oar-banks, which means there are *three ships behind the ship*. The timbers of the supporting frames are also visible, as well as the ends of the tension ropes on the bow and stern.

Four ships with a waterline length of 30 m, beam of 4.2 m and draft of 1.0 m have a displacement which makes it possible to carry an obelisk of 300 tons. These four ships with two load-beams and the supporting frames comprise a total beam of about 21 m. This measurement coincides with the 120×40 cubits, that the official Ineni gave for the obelisk-ship built by himself for Thutmose I (Breasted, 1906: 105). The ship (that is to say, two

ships attached one behind the other) was capable of carrying two obelisks at the same time.

The use of double-ships in 300 BC can also be proved. In order to bring an obelisk to Alexandria for Ptolemy II Philadelphos (285–246 BC), Pliny reports:

it was conveyed by Phoenix, who by digging a canal brought the waters of the Nile right up to the place where the obelisk lay. Two very broad ships were loaded with cubes of the same granite as that of the obelisk, each cube measuring one foot, until calculations showed that the total weight of the blocks was double that of the obelisk, since their total cubic capacity was twice as great. In this way, the ships were able to come beneath the obelisk, which was suspended by its ends from both banks of the canal. Then the blocks were unloaded and the ships, riding high, took the weight of the obelisk. (Nat. Hist. 36; 14, 67–68)

Pliny was not acquainted with the Egyptian transport technology. Had he known better, he would have modified only a few words: . . . *the ships were towed above the obelisk, which lay underwater, and then fastened to the beams between the ships* . . .

Basic assumptions concerning the Roman obelisk-ship

Shipping across the Mediterranean fundamentally differs from shipping on the Nile in one point. During a northward passage on the Nile ships float with the current; although they make *over-ground progress*, they do not *cut through water*. The form of the ships, therefore, did not have to be hydrodynamic. It was quite adequate for

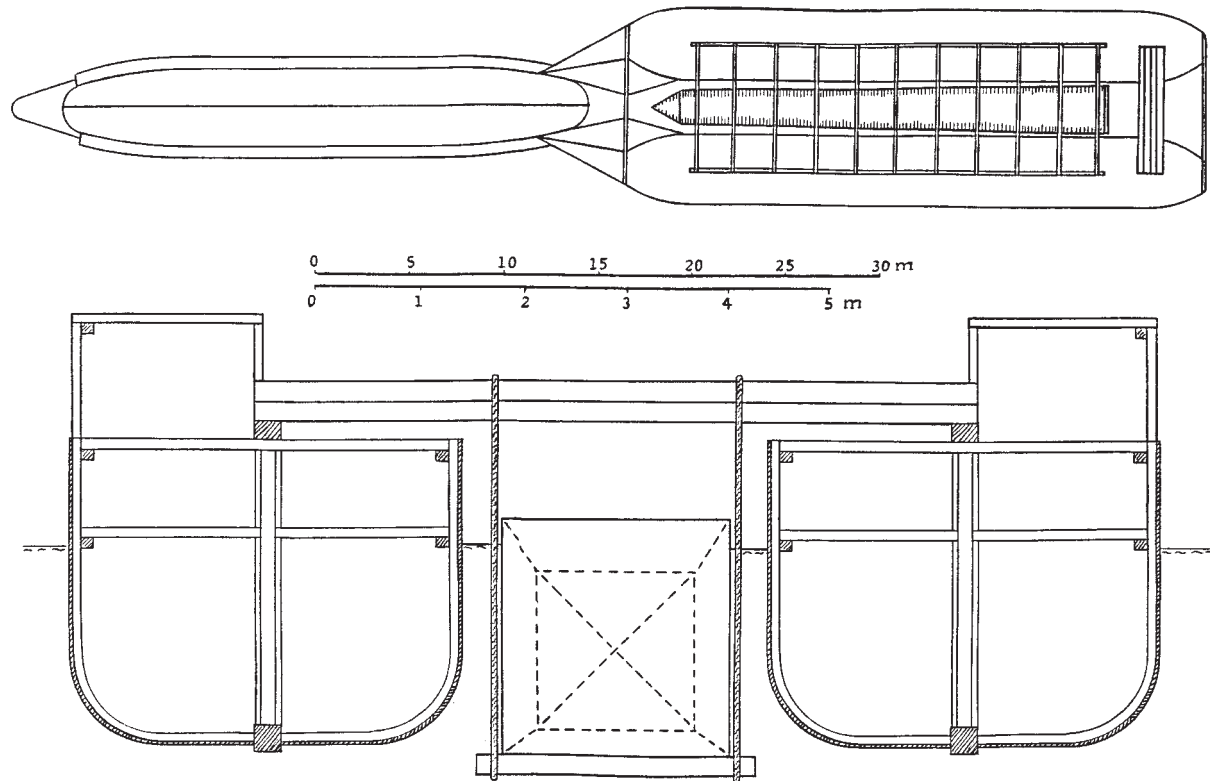


Figure 7. General sketch of the Roman double-ship. (Drawing: author)

Egyptian obelisk-ships to be rectangular in shape. Seagoing vessels, however, must take hydrodynamics into consideration, because they must make over-ground progress, as well as cut through water. Frictional resistance of water must be overcome by oarsmen and wind power. Two carrying ships by themselves would be unsuitable as a seagoing double-ship. If, however, a third ship was built to go before the two, then the double-ship would be long and slender as a whole and have the necessary hydrodynamic form (Fig. 7).

The reconstruction of the centuries-old longship—the trireme—displaced about 30 m of water with an overall length of 37 m (Foley *et al.*, 1982; Morrison & Coates, 1986: 203); it had about the same waterline length as the Egyptian obelisk-ships. The Roman ship had to suit the form of the obelisk and therefore needed straight sides 25 m in length. How the two carrying aft-ships were built will not be discussed here in detail. In a later simulation of parameters for the aft-ships the question relating to the size of the hold, as well as a minimum draft must be considered (McGrail, 1992: 354).

The oarsmen and mast were placed in the fore-ship which also was built like a trireme.

Because the fore-ship was centred between the two aft-ships, a few oars towards the stern could not be used, so that the standard number of 170 rowers was reduced to 150–160. The load-beam which provided an even displacement of weight essential for the weakly constructed Egyptian double-ships was not imperative for Roman double-ships, due to the stiffness of their hulls. The obelisk was hung under long crossbeams that were connected along the longitudinal axes of the aft-ships, together with the carrying hulls.

With these deductions the Roman double-ship is roughly outlined. The Roman double-ship, here defined, consisted of three ships in all, and can be taken as a hypothesis at the second stage of inquiry in ship archaeology (Coates *et al.*, 1995: 294). A test of this hypothesis will be carried out with reference to contemporary reports. The question is whether the available accounts support the hypothesis, and, if that is the case, whether enough facts are preserved to confirm the use of double-ships.

Evaluation of the contemporary reports

The Roman obelisk-ship was of a very unusual length: *its length took up a large part of the left*

side of the harbour of Ostia. This comparison made by Pliny is not very precise, but can at least serve as circumstantial evidence. The hypothetical double-ship was approximately twice the length of a trireme, and, with some 60 m, would have made for the longest Roman ship at that time.^[3]

The impression that the obelisk-ship made on the observer was enormous: *it was the most amazing thing that had ever been seen at sea. It is certain that nothing more wonderful than this ship has ever been seen on the sea.* The size alone cannot account for such emotions, because there were also a good many grain-carriers at the time which were also very large.^[4] Only the hypothetical double-ship can explain the astonishment: it was not only extremely long, but also had a beam which increased abruptly in the middle. When viewed from behind, it had three times the width of a normal longship; and due to the planking around the stern, no one would have believed that it contained two ships inside which were separated by approximately 4 m of water.

The ship that Ammianus described had 300 oarsmen, and this remark fits the likely scenario. In order to keep up a constant speed, it is assumed that the oarsmen were divided into shifts, so that at any given time only a part of the crew was active. If the crew was divided into two shifts, then 150 oars were necessary. This number of oars could be held in the fore-ship. When the oarsmen were not on duty, they could be comfortably kept on the two aft-ships.

The obelisk-ship had a mast of such a thickness, that *it took four men to span the girth of the tree with their arms.* To Testaguzza's mind (1970: 105) four men have to put their arms round one another's shoulders, and this indicates a mast 0.9 m in diameter. The mast on the ship proves that the double-ship consisted of three hulls; for reasons of symmetry the mast could only be placed on the fore-ship's keel. Had the obelisk been laid on two ships, or hung between them without a fore-ship, then no mast could have been erected.

The statement that the obelisk-ship carried *120,000 modii of lentils for ballast* is misleading, and has led to false conclusions. The ship by no means carried an extra 800 tons of ballast on its trip to Rome in addition to the 330 ton Vatican Obelisk and the 155 ton pedestal blocks. However, what is correct is that a ballast of significantly lower weight was needed for the empty trip to Alexandria. The comment made

by Pliny about the amount of ballast is neither false nor superfluous; but rather an important insight into the nature of the Roman double-ship. The ballast was not used on the open sea, but rather while the double-ship was being loaded: so as to lower its draft to an extreme level. As Pliny (Nat. Hist., 36, 14, 68) reports, the Egyptian double-ship was lowered with ballast weighing twice the weight of the obelisk. Because the Roman double-ship was constructed of three instead of two hulls, it was necessary to use approx. three-fold the weight of the 330 ton obelisk, or 800 tons of ballast, during the loading procedure.

Definite clues about the Roman double-ship technology also surround the end of the obelisk-ship's career. Claudius used the ship *to contribute to his harbour works.* From the beginning of his reign in AD 42 onward, Claudius began building a harbour to meet the demands of increasing long-distance trade and shipping (Blackman, 1982: 187). The new harbour, *Portus*, was built 3 km northward from the mouth of the Tiber, and was connected by canal to the river. Pliny's remark that the obelisk-ship was brought to Ostia, and there sunk, is not inconsistent since the village near the mouth of the Tiber and the new harbour were unified (Lehmann-Hartleben, 1923: 185). There can be no doubt that the ship was sunk on the western side of the harbour entrance, in the area explored by Testaguzza. On the construction of the harbour the Roman historian Suetonius (c. 70–140) comments:

He (Claudius) shaped the harbour in such a fashion that on both left and right sides, moles stretched out like two arms into the sea; and near the entrance, where the water was deep, a bulwark was built. So as to give the bulwark a secure foundation, the ship that had carried the mighty obelisk from Egypt was sunk. On pillars, resting on the ship, he erected a very high tower after the example of the Pharos-tower of Alexandria. This tower was then used to direct ships on their way at night using fiery symbols (Claudius 20; trans. author).

It is irrelevant whether the lighthouse stood on the ship or on the nearby mole. What is important is Pliny's account of the preparations which preceded the sinking. Before the ship was sunk, *towers of earth* were formed on board. The ship was sunk *with three moles as high as towers erected upon it made of Puteoli earth.* Earth of Puteoli (pozzolana) is a volcanic ash with the characteristics of hydraulic mortar. When mixed with

sand and lime-mortar, a rock-hard concrete can set underwater, thereby making it a standard material for Roman harbour construction (Oleson, 1988: 149). This report is exceptional, in that the description of the building procedure only makes sense in relation to the unique form of the obelisk-carrying double-ship: when sunk, both aft-ships and the fore-ship settled down to the floor without tilting the *moles as high as towers made of Puteoli earth* (Pliny), respectively, the *pillars* (Suetonius). The superstructure rose vertically to the surface after the ship was sunk. Any other ship would have laid on its side, due to the roundness of its hull, and could not have served as a base for vertical pillars. Spoken in technical terms, the *moles as high as towers* were wooden, box-like forms (Caissons), in which the Puteoli earth was packed and stamped down (Oleson, 1988: 149). With a height of the ship at 3–4 m from keel to deck, the distance to the surface was also 3–4 m. It therefore made sense to erect longitudinal caissons on the ship's hulls and a platform on top of that. Pliny's remark (Nat. Hist. 16, 76, 201–202) 'three moles as high as towers on the ship', Testaguzza translates as follows: *per edificarvi sopra una torre (il faro) composta di tre ripani con inerte trasportato appositamente da Pozzuoli*. Pliny does not speak of a tower with three levels. On the other hand wall-like pillars on the ship would be unintelligible, due to its height of 12 m (as assumed by Testaguzza): 4 m above sea-level.

Pliny tells us there were three moles built on the ship. The number of wall-like pillars confirms that the Roman double-ship had three hulls: there were three caissons, of which two were

carried by the two aft-ships, and one by the fore-ship.

Conclusion

As the result of this investigation every detail contained in contemporary reports corresponds to the construction of the hypothetical Roman double-ship:

- the length of the ship and its amazing appearance;
- the number of oarsmen;
- the mast;
- the weight of the ballast;
- the ship as a foundation for a building;
- the wall-like pillars on the ship when it was sunk; and
- the number of the caissons on the ship.

These observations only become understandable in light of a Roman variation to the obelisk-carrying Egyptian double-ship; that is, with an attached third ship. The fore-ship that was built onto the two carrying aft-ships, gave the obelisk-ship a slender, hydrodynamic, and therefore navigable form—in addition to accommodating an increased number of oarsmen and a step for a mast. This hypothesis on the construction of the Roman obelisk-ship is confirmed by the statements of Roman writers.

Acknowledgements

I would like to thank my son, Jörn Wirsching, for our joint discussions on the evidence of Egyptian and Roman double-ships.

Notes

[1] Dibner, 1950; D'Onofrio, 1967; Iversen, 1968; Habachi, 1977; Alföldy, 1990.

[2] The last were Wehausen *et al.* (1988): 296, see also bibliography.

[3] For an outline of Ostia Harbour see Chevallier (1986: 122) and Blackman (1982: 198; taken from Meiggs (1977: Fig. 5).

[4] Casson, 1971: 186; Landels, 1979: 199.

References

- Alföldy, G., 1990, *Der Obelisk auf dem Petersplatz in Rom. Ein historisches Dokument der Antike*. Heidelberg.
- Barber, F. M., 1900, *The Mechanical Triumphs of the Ancient Egyptians*. London.
- Blackman, D. J., 1982, Ancient harbours in the Mediterranean, Part 2. *IJNA*, **11**: 185–211.
- Breasted, J. H., 1906, *Ancient Records of Egypt*, II. New York (Reprinted 1962).
- Casson, L., 1971 (2nd edn 1995), *Ships and Seamanship in the Ancient World*. Princeton.
- Chevallier, R., 1986, *Ostie Antique: Ville et Port*. Paris.
- Choisy, A., 1904, *L'art de Bâtir chez les Égyptiens*. Paris.
- Clarke, S. & Engelbach, R., 1930, *Ancient Egyptian Masonry: the Building Craft*. London.
- Coates, J., McGrail, S., Brown, D., Gifford, E., Grainge, G. & Greenhill, B., 1995, Experimental boat and ship archaeology: principles and methods. *IJNA*, **24**: 293–301.

- Dibner, B., 1950, *Moving the Obelisks*. Cambridge and London (Reprinted 1970).
- D'Onofrio, C., 1967, *Gli obelischi di Roma*. Rome.
- Eichholz, D. E., 1962, *Pliny: Natural History*. London and Cambridge.
- Foley, V., Soedel, W. & Doyle, J., 1982, A trireme displacement estimate. *IJNA*, **11**: 305–318.
- Goyon, G., 1970, Les navires de transport de la chaussée monumentale d'Ounas. *Bulletin de l'Institut Français d'Archéologie Orientale*, **69**: 11–41.
- Habachi, L., 1977, *The Obelisks of Egypt: Skyscrapers of the Past*. New York.
- Hassan, S., 1955, The causeway of Wnis at Sakkara. *Zeitschr. für ägyptische Sprache u. Altertumskunde*, **80**: 136.
- Iversen, E., 1968, *Obelisks in Exile*, I. Copenhagen.
- Korres, M., 1997, Wie kam der Kuppelstein auf den Mauerring? *Mitteilungen des Deutschen Archaeologischen Instituts, Roemische Abteilung*, **104**: 219–258.
- Kroll, W. (Ed.), 1932, *Paulys Real-Encyclopädie der classischen Altertumswissenschaft*. Stuttgart.
- Landels, J. G., 1979, *Die Technik der Antiken Welt*. München.
- Landström, B., 1970, *Ships of the Pharaohs. 4000 Years of Egyptian Shipbuilding*. London.
- Lehmann-Hartleben, K., 1923, Die antiken Hafenanlagen des Mittelmeeres. *Klio Beiheft XIV*. Leipzig.
- McGrail, S., 1992, Replicas, reconstructions and floating hypotheses. *IJNA*, **21**: 353–355.
- Meiggs, R., 1973 (2nd edn), *Roman Ostia*. Oxford.
- Morrison, J. S. & Coates, J. F., 1986 *The Athenian Trireme: The History and Reconstruction of an ancient Greek Warship*. Cambridge.
- Nissen, E., 1883, *Italische Landeslunde*, I. Berlin.
- Oleson, J., 1988, The technology of Roman harbours. *IJNA*, **17**: 147–157.
- Orlandos, A., 1968, *Les matériaux de construction et la technique architecturale des anciens Grecs*, II. Paris.
- Rolfe, C. (Ed.), 1935, *Ammianus Marcellinus*, I. London (Reprinted 1982).
- Testaguzza, O., 1970, *Portus: Illustrazione dei porti di Claudio e Taiano e della città di porto a fiumicino*. Rome.
- Torr, C., 1964, *Ancient Ships*. Chicago.
- Wehausen, J., Mansour, A., Ximenes, M. C. & Stross, F., 1988, The Collosi of Memnon and Egyptian barges. *IJNA*, **17**: 295–310.
- Wiegand, T., 1958, Didyma. In R. Harder (Ed.), 2. Teil: *die Inschriften*, *Deutsches Archäologisches Institut*. Berlin.
- Wirsching, A., 1999, Das Doppelschiff: die altägyptische Technologie zur Beförderung schwerster Steinlasten. *Studien zur altägyptischen Kultur—SAK*, **27**: 389–408.