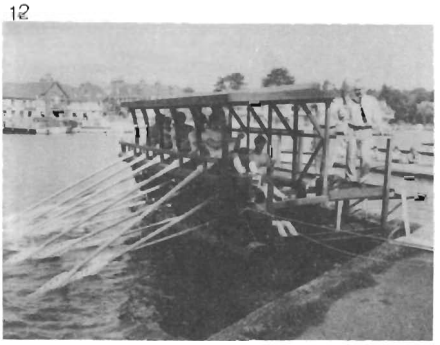
11

10

12



THE PROBLEM OF THE BILGE AND THE PUMP IN ANTIQUITY

Perhaps the oldest reference about the use of a bilge pump is from Archimedes, when he attempted to use the water screw, which bears his name, for this purpose in the big ship built for Hieron II at Siracusa (ab. 250-220 BC).[1]

This could mean, that at the end of the third century BC there was no proper solution of how to get water out of ships, as this screw is not a satisfactory pump for this work.

Therefore we could date the invention of the chain pump to some time in the second century BC, since we have archaeological proof for this type of pump at la Cavalière,[2] about 100 BC, and, for the second half of the first century BC, also at Los Ullastres[3] and Cap del Volt.[4] All these finds correspond to the simplest type of this pump, which had the disadvantage of squirting much water around. The wreck at Port Vendres I,[5] first century AD, shows the solution to this problem; a second pipe in which the pistons return to the bilge, without wetting the hold. At Saint Gervais II, the wreck of ab. VI century AD, the use of this construction is confirmed and we can say the same of all later chain pumps, as there is only a substitution of materials; iron takes the place of wood for the pipes, and the chain the place of the rope. The system remains unchanged for bilge pumps till the beginning of the XIX century. It has, therefore been used for about 2.000 years. I have been informed verbally by Comandante Cazorla of the Instituto de Historia y Cultura Naval, Cartagena, Spain, that from the notes about spare parts which Columbus bought in the Canary Islands, one can see that his ships had chain pumps.

It is astonishing that there is no information about older bilge pumps, considering that big ships had been built for a long time in the BC period, as we can see from the one found near the Cheops pyramid and which is of ab. 2.500 BC. But this was a flat bottomed ship, without a bilge. The water had to be bailed with bailers or sponges, as the pumps, either the screw or the chain pump, leave a depth of about 10 cm. of water which they are not able to absorb and this would have

left much water and a big wet surface within the ship.

The situation changed when the ships became round bottomed and the water concentrated near the center, but the possibility of reducing considerably the wet surface within the ship came with the invention of the bilge, which demanded the use of a keel.

We have to remember that the keel did not exist at the beginning of any type of shipbuilding. Neither the flat-bottomed Egyptian ships, nor the ancient Chinese junks, or the oldest, but relatively modern Viking ships had a keel.

Construction by the shell first method does not need a keel. The reinforcement with floors and futtocks is sufficient, so long a they have flat or rounded bottom.

It was the necessity to construct a bilge that compelled the use of a thick central timber to take all the holes and mortises at different angles to fix the succeeding strakes. With the keel the ships got also the garboard on each side of the keel, a strake of special form and generally thicker than the others.

In principle we have the same problem and the same solution which the shipbuilders found when the ships changed from flat to rounded bottom: Thick timbers, the stem and stern posts received the ends of the strakes and offered the possibility of fixing them, closing the ship at both ends. The wrecks at Los Ullastres and Cap del Volt show this first construction. What we actually call the keel of these ships is only a central plank, thicker than the others, just sufficient to allow the union with the thick timbers forming the stem and stern posts.

One could even think that the water collecting in the narrow pit at the foot of the stern post, as soon as the ship raised the stem, gave the idea for the bilge.

If we observe the bilges of the Roman wrecks we know, we get the impression that these have been simply hung under the ship as something supplementary. In most cases there does not exist any union of the keel and the bilge with the floors, and often there are irregularities in spacing, leaving the floors without contact with the keel, and the limber holes without use, as the water can flow freely under them.

Once the ships had a bilge, the surface of water in the hold was reduced and therefore also the humidity. As soon as the water accumulated in the bilge it reached adequate depth to be bailed out with a pail. Later, with the ships getting higher, some sort of pump was necessary. This was so effective, that pumps were erected even in ships without bilge, as we have seen at Los Ullastres and Cap del Volt.

In the Roman wrecks we know, republican or imperial, we can see three different constructions:

One, ships without keel nor bilge, only with the thicker central plank to connect the posts at stem and stern (Los Ullastres, Cap del Volt), two, ships with a broad bilge, the keel without rabbet, only the upper edges cut oblique at 45^0 to receive a garboard of special form (La Cavalière, Palamós), three, those with a deep bilge, keel with rabbet and garboard rising ab. 65^0 (Dramont, La Madrague

de Giens). All these details refer to the central part of the ship.[6]

The Nemi ships do not enter exactly into this classification, but are similar to the type with a broad bilge.[7]

As we have now established the probable relation between pump and bilge, we can follow with other details, such as the possibility of use of other types of pumps, known in Roman times, of which four were found in the Dramont wreck.[8] All these are of a special type of bronze force pump not known elsewhere. The lack of pipes or other elements and the insecurity of their situation in relation to the keel, leave the question open, whether these were equipment of the ship, or cargo. Technically it is improbable that there would be in a ship a group of four expensive pumps forming one unit, operated by two *"sentinatores"*, as the more usual two piston fire pump would have done the same work better. From literary evidence (St. Paulinus of Nola ep. 49) we know of only one *"sentinator"* in a ship and therefore we have to suppose that the type of pump used was driven by a single man.

This brings us to the question of the driving system of the wooden chain pump. The lack of illustrations showing the "sentinator" working, and the literary evidence obliges us to suppose that the driving system was in the hold. We have therefore to think about a pump of limited height, sufficient to get the water out, but not bring it up to deck. This would be in concordance with the finds at Los Ullastres, where two fragmented lead pipes, which conducted the water from the pump to both sides of and outside the ship, as we can see from the ends of these pipes, were found resting on the amphoras of the lower layer, in a space where there was no upper layer. We suppose that this free room was occupied by these pipes, the upper part of the pump and the driving system, whether this was by hand or by foot.

Finally, we can consider the question of the humidity in the hold, probably the most important for this association of pump and bilge. We have shown that there have been bilge pumps in ships without bilges and that, owing to the construction of the pump, a residue of water, with a depth of ab. 10 cm. could not be taken out. In these flat rounded ships without bilge, 10 cm. could cover the floors. Even in the case when the water concentrated near the stern, the wet surface and the moisture in the hold would be excessive for many wares, especially if grain was transported under deck.

Only with a bilge could this wet surface and the moisture in the hold be reduced. Therefore we can suppose that the decisive motive for the creation of the bilge was the transport of grain and the use of a pump the logical result. This could explain why Archimedes tried in Siracusa, one of the grain exporting ports of antiquity, to use the screw to get the water out of the bilge of a big ship.

Federico Foerster Laures
Consejo de ciento, 335
08007 - Barcelona

Notes

1. Moschion, Archimedes, waterscrew in the ship build for Hieron II at Siracusa, probably 250-220 BC.

2. Carlin, G., Gassend, J.M. & Lequément, R., 1978, *L'épave antique de la baie de Cavalière.* Archaeonautica 2: 9-94.

3. Foerster, F., 1979 *Los Ullastres, Discovery of objects which may be a bilge pump in the wreck of the 1st. century BC.* IJNA 8.2.: 172-4.

1982 *El pecio de Los Ullastres,* Vida Submarina, 10: 34-41.

1984 *Ein roemisches Wrack bei Los Ullastres,* Das Logbuch 1: 17-20.

1984 *New views on bilge pumps from Roman wrecks.* IJNA 13.1: 65-94.

1984 *Considerations on the capacity of the Roman Bilge pump* IJNA 13.4: 327-328.

4. Nieto, F.J. & Foerster F., 1980 *El pecio romano de Cap del Volt,* Gipsela III: 163-72, Gerona.

Foerster, F., 1980 *A Roman wreck off Cap del Volt,* Gerona, Spain. IJNA 9.3: 244-53.

1981 *Iberische Schiffe aus Christi Zeiten,* Das Logbuch 1: 7-10.

1982 *El pecio de Cap del Volt,* Vida Submarina 5; 47-56.

5. Liou, B., 1974 *L'épave romaine de l'anse gerbal a Port-Vendres,* Acad. Inscrip. et Belles Lettres: 413-33.

6. Foerster, F., 1983 *Roman Naval construction, as shown by the Palamos wreck.* IJNA 12.3: 219-228.

7. Ucelli, G., 1950 *Le Navi di Nemi.*

8. Joncheray, J.P., 1973 *Dramond D.,* Cahiers d'Arch. Sub. 2.

Captions

Fig. 1. Pieces recovered from Lake Nemi, after G. Ucelli.

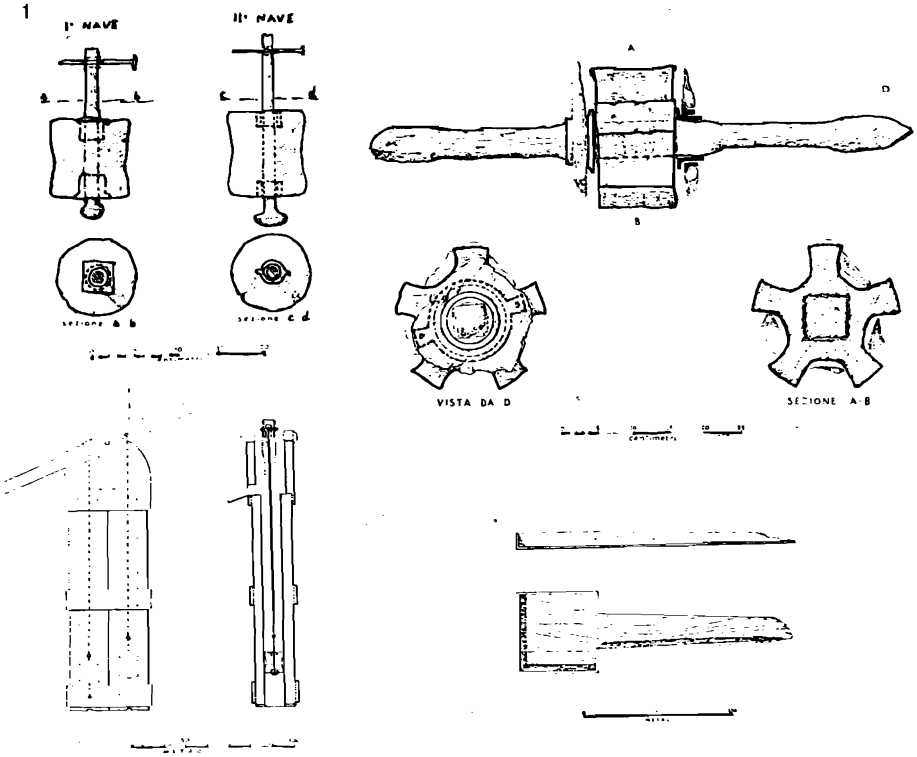
Fig. 2. Inferior part of the pump recovered at Los Ullastres, IJNA, vol. 8. n. 2, may 1979.

Fig. 3. a. Reconstruction of a bildge pump based on the finds of Los Ullastres, IJNA, 8/2, pp. 172-174.

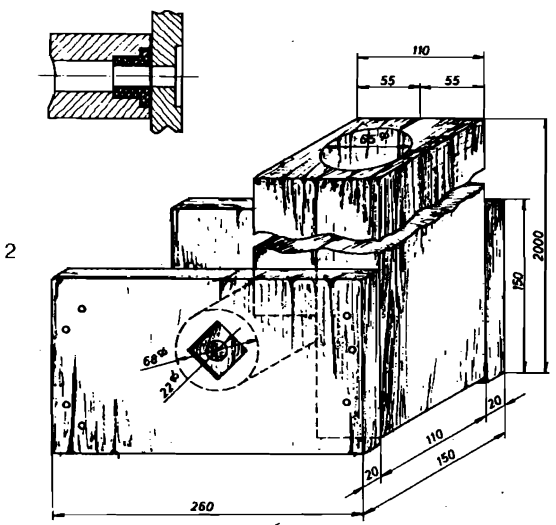
3. b. Reconstruction of a pump with pistons and chain with a combination of the parts found at Los Ullastres and Nemi.

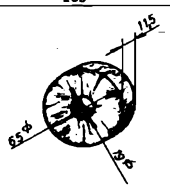
Fig. 4. Bronze bearings recovered from Los Ullastres, 1980. Measurements in milimeters.

1

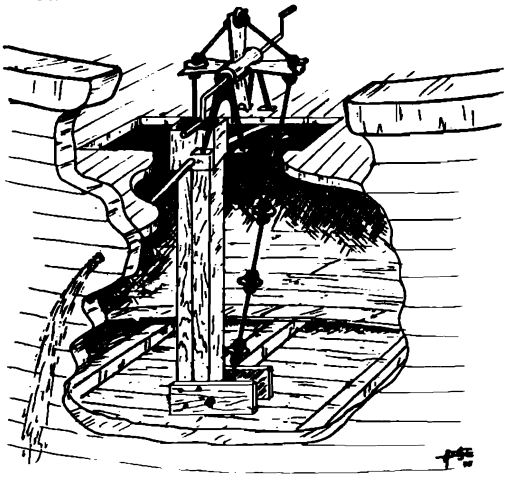

I° NAVE
II° NAVE
VISTA DA D
SEZIONE A-B

2

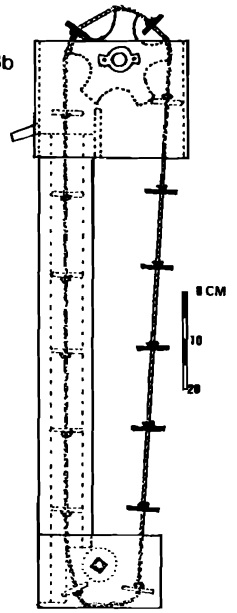

110
55
55
2000
150
68
22
20
110
150
20
260

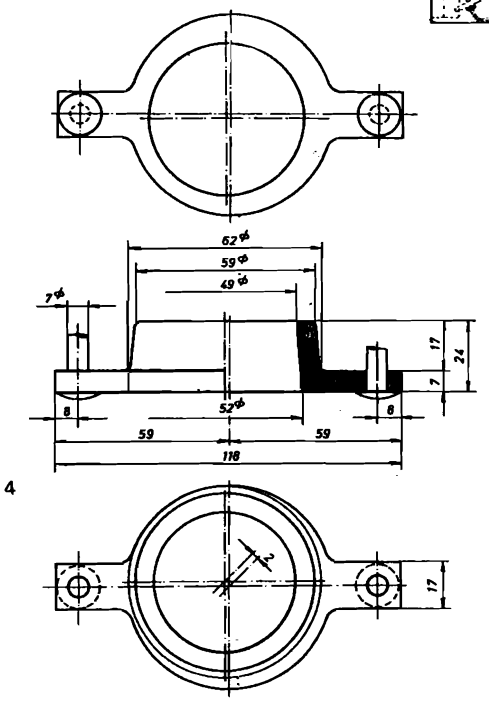

115
65
19

3a



3b





4

1st INTERNATIONAL SYMPOSIUM

ON

SHIP CONSTRUCTION IN ANTIQUITY

PIRAEUS, 30 AUGUST — 1 SEPTEMBER 1985

PROCEEDIGNS

SPONSORED BY THE MINISTRY OF CULTURE

Published by the Organizing Committee of the Symposium, Athens 1989.
Editor: Harry E. Tzalas.
Cover design and layout: Yannis Pantzopoulos.