

Notes

The Gallo-Roman boat from the Bay of Bevaix, Lake Neuchâtel, Switzerland

During a reconnaissance flight in December 1970, M. Michel Egloff, Cantonal Archaeologist of Neuchâtel, discovered a very long and narrow boat off Bevaix. It lay about 70 m from the shore in waters of exceptional clarity. The first investigation was postponed until May 1972, when M. Egloff had finally assembled a specialist team. Salvage began in December of the same year because of the damage being sustained by the wreck. Working in often difficult weather conditions, the team of divers from the Cantonal Archaeological Service succeeded in making a 1:10 plan in addition to two photographic surveys of the wreck, each consisting of 160 negatives. Clearing the boat posed hardly any problems since only a quarter of it was still covered with sediments, and these never exceeded 0.20 m in depth. They yielded no pottery, therefore the age of the boat could only be precisely established by means of C-14 analysis (Lv-666; 90 ± 60 AD).

Lying in only 2 m of water, between 426.50 and 427 m above sea level, the boat vibrated in every storm. One storm was particularly devastating in the shallow water and in two weeks ended in dislodging the boat, with the exception of the stern, thus confirming, if confirmation were necessary, the extreme urgency of the rescue operation. Happily the plan was completed and the planks numbered. More than 90% of the planks were recovered. Wrapped in polyethylene bags filled with a preservative solution containing formaldehyde, they are still waiting to be properly conserved.

Planking and framing

The ship is carvel-built from large oak (*Quercus robur*/*Q. petraea*) planks and measures 19.40 m in length with a beam of 2.90 m (ratio 6.7:1). It was characterized by a flat bottom and the complete absence of keel or central plank. In fact the four principal planks of the bottom (Fig. 1, 1–4) were arranged one beside another, each systematically staggered in relation to its predecessor. The planks measured between 10.70 and 12.70 m in length with a breadth of 0.60 m and thickness of 0.07 m.

By means of these four planks the Helvetian

carpenters formed the prow (left of Fig. 1) and the stern (right of Fig. 1), and thus the centre-line of the boat. The beam was also determined by the addition of the bilge-strakes; these were L-shaped in section and allowed a direct transition to be made between the flat bottom and the sides of the boat. The spaces left between the bilge-strakes and the four large planks were filled by two planks with an irregular outline, no. 5 (port forward) and no. 6 (starboard aft). The presence of traces of caulking on the upper edges of the bilge-strakes showed clearly that the sides had been heightened by one or two strakes of which unfortunately no element survives. The height of the boat can be estimated at about 0.80 m.

In addition to the six major planks (excluding the bilge-strakes) there were six others which comprise only 2.5% of the skin of the boat. Like the others they are 0.07 m thick, but are very narrow, never exceeding 0.15 m in width, and varying between 0.58 and 4.70 m in length. These planks are interpreted as evidence of repairs, and one of them, lying between frame-pairs 14 and 15, interrupts the channel cut to drain water away. These channels, carved in the thickness of the wood, run through from stem to stern, on port and starboard.

Twenty-two pairs of frames, also made of oak, are arranged head to tail. In place of the sixth pair is a single piece of oak, the mast-step, with a mortice cut in the centre; the bevel on the after face enabled us to identify which was stem and which stern. The framing is fastened to the shell with some 300 iron nails driven in from above. They pass first through the frame, and then the strake; any projecting point was hammered over at right angles. The nails are 0.01 m square in section and are 0.10–0.15 m long.

The six narrow repaired bottom planks were fastened to the frames by nails driven in from below. While the shanks of these nails are identical to those of the nails described above, three types of head were used, depending on the breadth of the planks. To prevent splitting, the planks were first drilled wherever nails were to be driven; in order to make the holes water-tight, the head of each nail was surrounded with the same moss which was used for caulking.

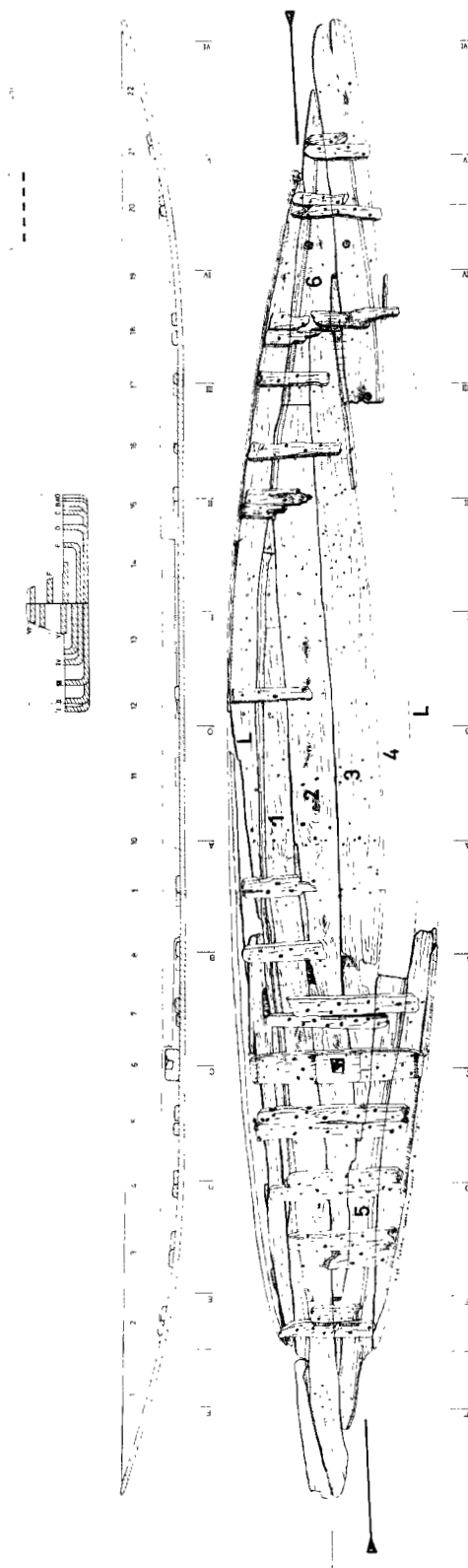


Figure 1. Gallo-Roman boat from the Bay of Bevaix (B. Arnold). The bottom of the boat was constructed from four large oak planks (1-4) arranged obliquely in relation to the centre-line of the boat.

Caulking

Caulking was uniformly present between the planks of the shell (Fig. 2B). All the seams of

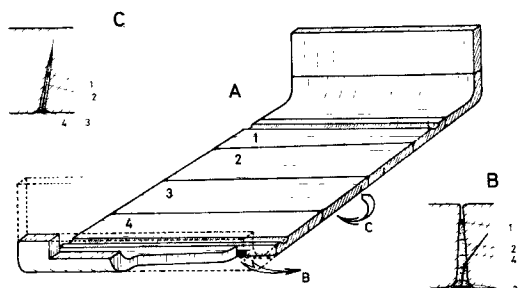


Figure 2. Section of the hull. A. Strakes fashioned with an L-section make a straight transition from the flat bottom to the vertical sides. B. Caulking between two strakes. C. Caulking in cracks of the strakes. 1, cord; 2, compressed moss; 3, willow lath, holding moss in place; 4, nail securing lath.

the planks, on their outboard surface, had a row of little curved nails (length: 0.05 m; diameter of head: 0.02–0.025 m), spaced at intervals of 0.04–0.045 m. Ninety per cent of them were attached to the same strake and this greatly facilitated the dismantling of the boat, since all the caulking adhered either to one strake or to its neighbour.

These nails held in place a lath of willow (*Salix* sp.) (Fig. 2B: 3) on top of which are three or four layers of moss (2), in turn overlaid by a two-ply twist of *Gramineae* stalk (1). In some instances, when the planks were imperfectly joined (at the bow, for example), a second row of these little nails fixed the cord to the inside of the boat.

Another caulking method, very similar to the preceding, was found in the cracks of the sub-

merged surfaces of the large planks of the hull (Fig. 2C). A row of little nails (0.04–0.07 m in length; diameter of head: 0.01 m) were driven in at intervals of 0.04 m along the line of the crack to fasten a narrow lath of willow. The lath held a layer of moss in position which was sometimes overlaid by a thin cord. All the moss used in caulking was of species *Neckera crispa*.

Treenails and type of boat-construction

Seven puzzling rows of round treenails were arranged perpendicularly to the axis of the four principal planks of the bottom of the boat (Fig. 1: 1–4), but not to the axis of the boat.

Driven into holes 0.02 m in diameter, the treenails of silver fir (*Abies alba*) transverse the thickness of the hull. Each row of treenails generally comprises one, occasionally two, per strake and was covered by a pair of frames in the sequence 3, 5–6, 8, 10, 12, 14, 16 and 18. They could therefore only have functioned before these pairs of frames were fitted during the building of the vessel.

Our explanation is as follows: once the four planks (1–4) had been placed side by side and slightly staggered in relation to each other, seven transverse rows of holes were drilled. The holes were transfixes by metal rods, or long stout treenails and a system of lashings would have bound each plank to its neighbour at the seven positions. Thus a rigid, tight-fitting bottom was achieved before the pairs of frames, nos 1, 2, 4, 7, 9, 11, 13, 15, 17, 19, and perhaps 20, 21 and 22 were nailed on. Subsequently, the lashings were removed and the seven rows of holes were stopped by means of the round fir treenails. The strakes remained tight-fitting owing to the first series of frames, while the second (3, 5–6, 8, etc.) was fastened over the treenails which lay in the zone in which the frames were to be fitted.

A second type of treenail, square-sectioned

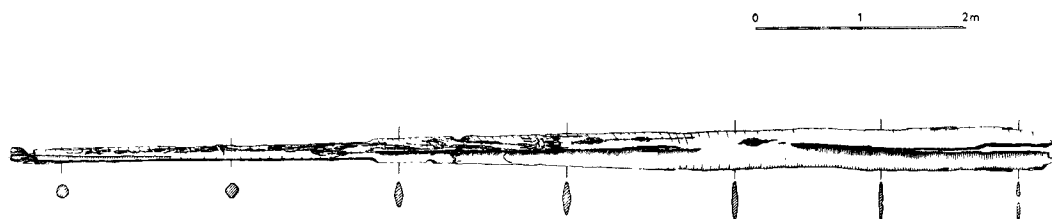


Figure 3. The 10 m long steering-oar found by fishermen in 1911. (J.-L. Boisaubert)

(sides measuring 0.01 m maximum), of fir or sometimes of oak, was used to fill the holes made by the extraction of nails before the frames were put in place. Square treenails were most numerous in the aftermost third of the vessel.

Finally the boat was caulked and fitted with mast and steering-oar (Fig. 3). The latter, found by fishermen in 1911 (Vouga), is in fact on exhibition in the Cantonal Museum of Archaeology

at Neuchâtel and measures some 10 m in length (C-14 date: Lv-269; 220 ± 100 AD).

Built in a way remarkable for its originality, this boat is not the only specimen of the period to be found in Switzerland. A second was excavated at Yverdon, a town also situated on the edge of Lake Neuchâtel, in 1971. Unfortunately, the construction of many modern foundations has badly damaged this vessel.

References

- Arnold, B., 1974, La barque gallo-romaine de la baie de Bevaix. *Cahiers d'Archéologie subaquatique*, (Fréjus) III: 133–50.
 Vouga, P., 1911, Gouvernail de barque romaine. *Musée neuchâtelois*, 8: 88.

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Translator's note: Readers are referred to Arnold (1974) for a fuller description.

The Pharos site, Alexandria, Egypt

In 1961 an Egyptian diver, M. Kemal Abu al Saadat of Alexandria, found colossal statuary, possibly from the original Pharos, one of the Seven Wonders of the Ancient World and the subject of this note.

In 1962 the Egyptian navy raised one of the female statues; now in the Serapion Gardens, it measures some 7 m even in its broken state (Fig. 1). In addition, M. Kemal Saadat found the remains of submerged buildings that may represent

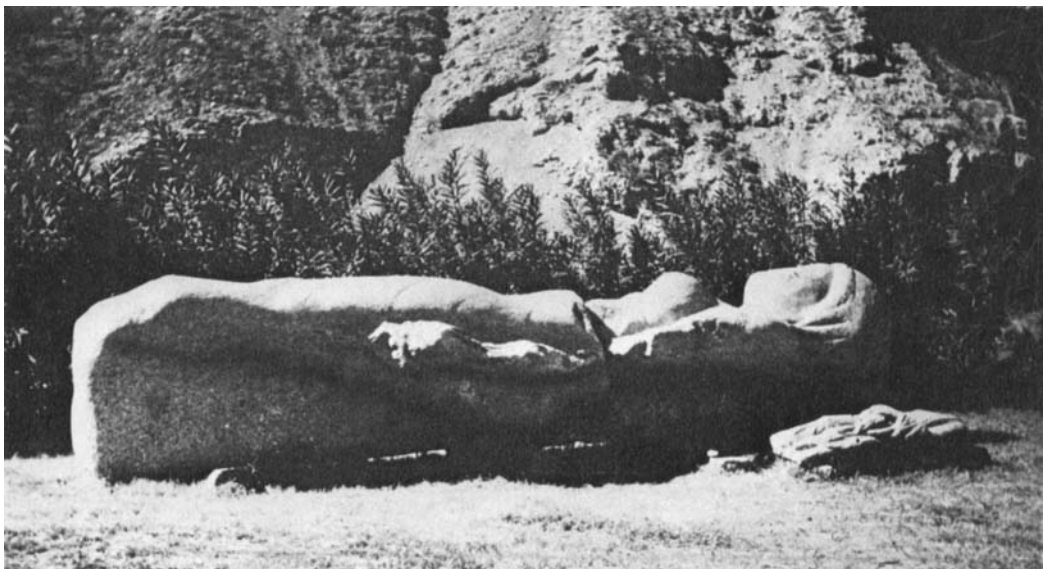


Figure 1. The 7 m Isis figure in the Serapion Gardens.

the lost Palace of Alexander and the Ptolemys (supposedly the final resting place of the glass sarcophagus containing the body of Alexander the Great). Thus, he has presented archaeologists with the potential locations of two of the most sensational sites in the Mediterranean (Fig. 2).

In 1968 the Egyptian Government, through the good offices of UNESCO, invited the geologist M. Vladimir Nesteroff (University of Paris) and myself to examine and report on the Pharos site, with a view to its eventual excavation. At the time, our work was reported in *al Ahram*

a survey of the remains. Further, the side they represent would have been directly to starboard of all ships entering the harbour and therefore the logical place to put significant inscriptions and decoration.

During six dives in October and November, the salient finds in an area of some 180 m², were planned by direct measurements as well as theodolite readings. Our photographic coverage was doomed in the choppy, cloudy, autumn sea, while the shallowness (3–4 m) made it impossible to 'frame' masonry several metres long using the

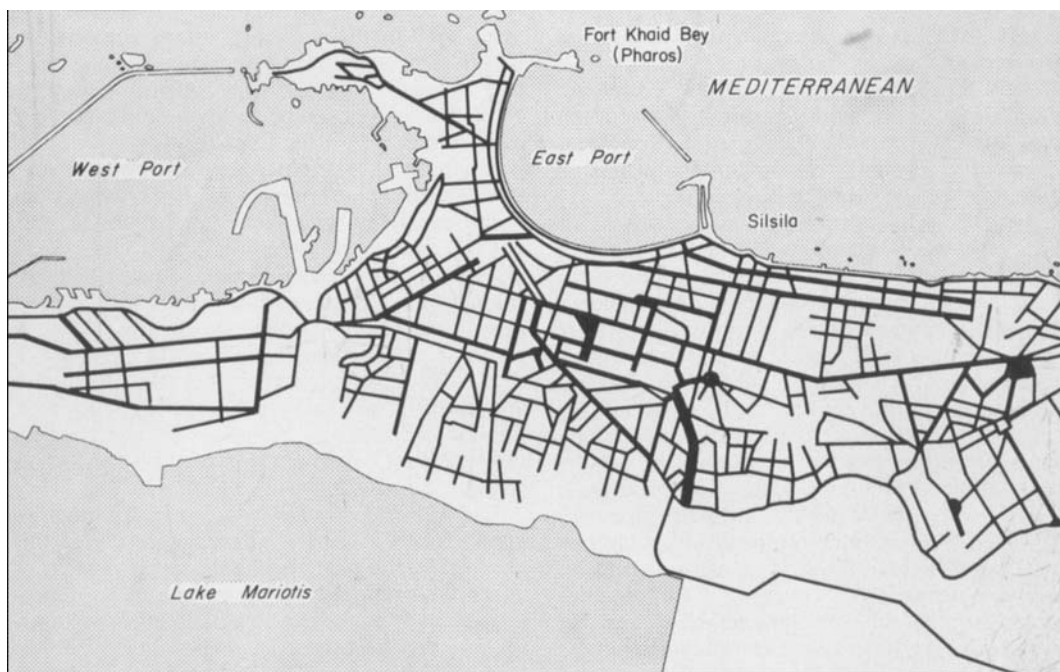


Figure 2. Sketch-plan showing the relative positions of the places discussed.

(30 Oct. & 2 Nov. 1968); now, I am indebted to the Egyptian authorities for their permission to publish the first finds in these pages.

The site in question lies in shallow water off Fort Khaid Bey which guards the entrance to Alexandria's Eastern Harbour. Tradition has it that this 15th century fort was built on the spot where the Pharos had stood until successive earthquakes finally destroyed it in the 14th century. The statuary and masonry now submerged, appear to lie where they had fallen; consequently it should be possible to deduce the character of this side of the original building from

small underwater cameras we had with us (suitable cameras exist and would naturally be used in a definitive survey). A general picture does, however, emerge from our summary documentation. It is of a highly decorated structure incorporating two female and probably two male (as yet only one of the latter has been identified) colossal pillar-statues, some 11 m high, on 3 m plinths, a detached Isis Hathor crown nearly 2 m high, two sets of sphinxes, a fragment of stone inscribed with a 0.40 m high Roman numeral and elements of masonry up to 6 m in length (see list below).

Such evidence would be multiplied a hundred-fold after a complete survey. To assess its potential importance, we should examine some of the existing information on the Pharos and the questions that it raises.

The Pharos was built early in the reign of Ptolemy Philadelphus, around 280 BC; on it was placed the famous inscription to the architect: 'Sostratus of Cnidos son of Dexiphanes, to the Divine Saviours for the sake of them that sail at Sea'. (Strabo xvii: I. 6; and Lucian, *How to write history*, 62.) Letrone remarks that the 'saviour gods' might not, as is usually supposed, mean Ptolemy Soter and his wife Berenice, because had this been so they would have been named (M. Letrone, *Recueil des Inscriptions Grecques et Latines de l'Égypte* 2, Paris, 1847: 527–33). Since the Isis crown which we found is of the same stone, workmanship and size as to have fitted either of the female statues, one may suggest that Isis and her companion Serapis or Osiris might have been the 'saviour gods'.

That the architect's inscription was placed on the north-north-east side of the building, i.e. facing the entrance of the harbour and near these statues, seems probable. Certainly the Roman numeral mentioned above, suggests that other inscriptions to later rulers were placed there. Of the early Arabic authors who saw the Pharos, Mqrisi notes an inscription on the north side of the building (*Kitab al Maouaiz* L: 159), while Omar Toussoun talks of an inscription on the south ('Description du Phare d'Alexandrie'. *Bul. Soc. Royale d'Archéol. d'Alexandrie* NS IX, 1937). Neither author could read the inscriptions, so their identification remains uncertain, but one observation of Toussoun's is of material interest in relation to the submerged stones. He says that leaden letters were let into *black marble* which the sea had eroded so that the letters stood out in relief.

A more important reference to stone is made by Strabo in what must be the key description of Pharos: '... at the extremity of the isle which is a rock washed all around by the sea and has upon it a tower that is admirably constructed of white marble. ...' (*Geog.* xvii. 1. 6). 'White marble' is a translation of *leucos lithos* which, literally, means 'brilliant' or 'white' stone and no more. Surrounded by the sea, marble would wear badly even when, as Toussoun has shown, it was placed on the sheltered, harbour side of the building. Be this as it may, we saw no white marble though we did find black marble in the sea. The majority of the larger architectural elements that we examined, are made of Assuan granite. This seems at variance with Strabo's description, yet

it is unlikely that he would have been mistaken in his impression of a white building. The apparent contradiction may be explained by the polychrome nature of Ptolemaic architecture, wherein the stone was covered with plaster before being painted. Lucian, for instance, notes that Sostratus covered the original dedication (bearing his own name) with plaster on top of which the king's name appeared. After the king's death the plaster wore off revealing the architect's name—a trick which could hardly have worked had the dedication been the only area of plaster on the building.

The destruction of the Pharos occurred as a result of the earthquake of 1303. Ibn Battuta (Ed. Defrémery, I: 29ff.) on his first journey in 1326, describes the Pharos as a square construction with a door 'high above the ground'; the signal-light was still in use. On his second voyage, in 1349, this last portion of the great building was in ruins and could not be entered.

Much has been written on the appearance of the Pharos, based on sundry representations found on, for instance, coins, and more recently on an engraved glass goblet from Afghanistan (J. Hackin, 'Recherches archéologiques à Begram, chantier 2', *Mémoires de la délégation archéologique Française en Afghanistan*, 9: figs 37–40 & pls 16–17. Henri Seyrig, *Syria*, 22, 1941: 262, n. 2). H. Thiersch argues that the distinctive architecture of early Alexandrian mosques, wherein each storey diminishes in size towards the top, must have been modelled on the Pharos (*Pharos*, Leipzig & Berlin, 1909).

The submerged remains may not add much to our idea of the general shape, especially as this area off Fort Khaid Bey holds only a portion of either the original building or one of its dependencies such as the shrine of Isis Pharia. Nevertheless, once the remains have been surveyed then studied by specialists in Ptolemaic architecture, they should provide an invaluable guide to the scale and character of the building as a whole.

It is evident that after the collapse of a colossal building that had been founded on only a small rock, its remains would spread over a wide area. At Fort Khaid Bey, blocks and columns do indeed project from beneath the recently constructed jetty while the odd stone can still be seen emerging from the ground in the built-up area that now joins the one-time islet to the mainland, and more columns are scattered out to sea to the west. In the 19th century these remains were still so obvious that the Abbé Suard programmed the following tourist excursion:

- '1. Departure from the north side of Consul's Square.
2. Embarkation on a fishing boat with one or

- two divers, a sound, ropes and harpoons.
3. From the harbour mouth to Diamond Rock (*our area*): soundings and dives, harpoonings of pieces of marble and numismatic stones (if any be found).
 4. The exploration over, a tour of the Island sketching the shoals, ruins, etc.
 5. Disembarkation near the Arsenal and while the sailors and divers return to Pirate's Creek, visit to the Palace of Abousir.
 6. Visit to the Lighthouse with picnic hampers; lunch on the terrace—return to the Creek, circuit of the Island on foot—re-embarkation and return to the town.

N.B. To do this excursion in one day, departure must be at sunrise and the return after sunset. It is the oblique rays of the sun that best light the depths of the sea.' (*Alexandrie ancienne et nouvelle*, Alexandria, 1899: 24.)

Happily, in the interests of marine archaeology, this muscular priest did not live to see the invention of SCUBA diving equipment!

But to return to the argument: the fact that one side of the Pharos appears to have collapsed into the sea and that it still lies *in situ*, unaffected by overbuilding, implies that the foundations of the original building must have been at water's edge. This form of architectural brinkmanship, dictated by local geography, is characteristic of other ancient harbour buildings along the Levant coast. Notably the walls of Arados and the off-shore harbour at Sidon. That this was so at Pharos, is inherent in early Arabic legends which hold that its foundations rested on '4 metal crabs' and 'arcs and vaults of glass' (Van Berchem, *Mémoires de la Mission du Caire* XIX, 1: 484). In other words the rock on which the great tower

was to be constructed, was so small that it had to be artificially reinforced. Certainly our recent observations show that sufficient evidence remains in the sea for it to occupy scholars for a considerable time.

List of some objects plotted in 1968

1. Female pillar-statue; neck to knee 4.90 m. Drapery represented over hips; console-shaped object carved on left thigh. Assuan granite (Fig. 3C).
2. Crown of Isis Hathor, flat backed as for pillar-statue. Length 1.80 m; depth at attachment to head 1 m. Assuan granite (Fig. 3A).
3. Torso of male pillar-statue, similar scale to the female. Assuan granite.
4. Plinth with square slot; mouldings at either end, 2.60 × 2 × 2 m. Assuan granite (Fig. 3B).
5. Another, except for feet-shaped socket with further slot inside it (Fig. 3B).
6. Partly buried block, 3 × 3 m. Assuan granite.
7. Oblong block, rounded moulding along one edge, the extremity cut to fit into a contiguous block; length c. 6 m. Assuan granite.
8. Segment of papyrus-bunch pilaster; length 1.80 m, diameter 1.0 m; fluting 0.40 m. Assuan granite.
9. Two segments of similar but fully circular columns.
10. Four sphinxes, all headless, probably from a series; 2.50 m at base, grey granite (syenite?).
11. Another but only 1.20 m at base.

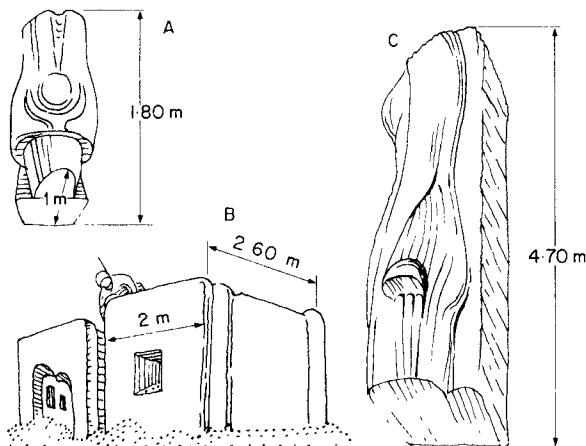


Figure 3. Tracings of the underwater photographs (unsatisfactory because of the size of the objects, the shallowness and turbidity of the water): A, Isis crown; B, two plinths; C, fragment of a female statue—?Isis.



Figure 4. Roman numeral incised on a block (much overgrown with weed).

12. Sarcophagus-like box, broken; interior floor measurement 1.20 × 0.60 m. Assuan granite.
13. Blocks measuring 4.40 × 1.40 × 1.20 m, cut in steps of 1 × 0.40 × 0.40 m, and 5.80 × 2.80 × 2 m; both Assuan granite.
14. Roman numeral: IV, slightly curvilinear incisions, 0.40 m high, on block measuring 1 × 1 × 0.50 m. Assuan granite (Fig. 4).
15. Column-drum, partially buried. Diameter 1.50 m. Assuan granite.
16. Two columns, broken, one with square slot at base, diameter 0.80 m. Assuan granite.
17. Fragments of smaller columns and a triptych (?) all black marble.

Acknowledgements

I am deeply grateful to the Director and members of the Egyptian Antiquities Department for their advice and to the Department for hospitality. For help in surveying, M. Nesteroff and I were particularly beholden to the Department's architect, M. Amir Abu el Wafa, and to M. Kolony Wozek of the Polish Mission at Alexandria, and finally to the discoverer of the site, M. Kemal Abou al Saadat, for his collaboration.

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An 18th century diving-suit from Brahestad in Finland

The today unimportant but once busy seaport of Brahestad (Raahe in Finnish) in the northern basin of the Gulf of Bothnia sports one of the earliest provincial museums in the country. This charming little edifice in blue, of mid-19th century design, possesses nautical treasures from bygone days, relevant to the city's once important fleet of locally-built coasters and traders, and especially the famous brigs of extraordinarily large dimensions. Yet the centre-piece of the museum is the funny-looking diving-suit, dated to the 18th century, well preserved and displayed in a glass case.

The author was to inspect the object himself, accompanied by staff personnel from the Bureau of Maritime History. A study of technical details was made, but the origin remains uncertain.

The label reads: A diving-suit from the 18th century, donated by Captain J. F. Leufstadius (a well-known master of locally-operated sailing-vessels in the first half of the 19th century). As no additional information was available a detailed description is of importance.

Description of the suit (Fig. 1)

The suit, sewn in shoemaker fashion, is put together from large sheets of pig-skin, reducing seams to a minimum. The whole object looks workmanlike and was obviously strong and well-greased as it is still in a good state of preservation.

The conical leather helmet joins the body-suit

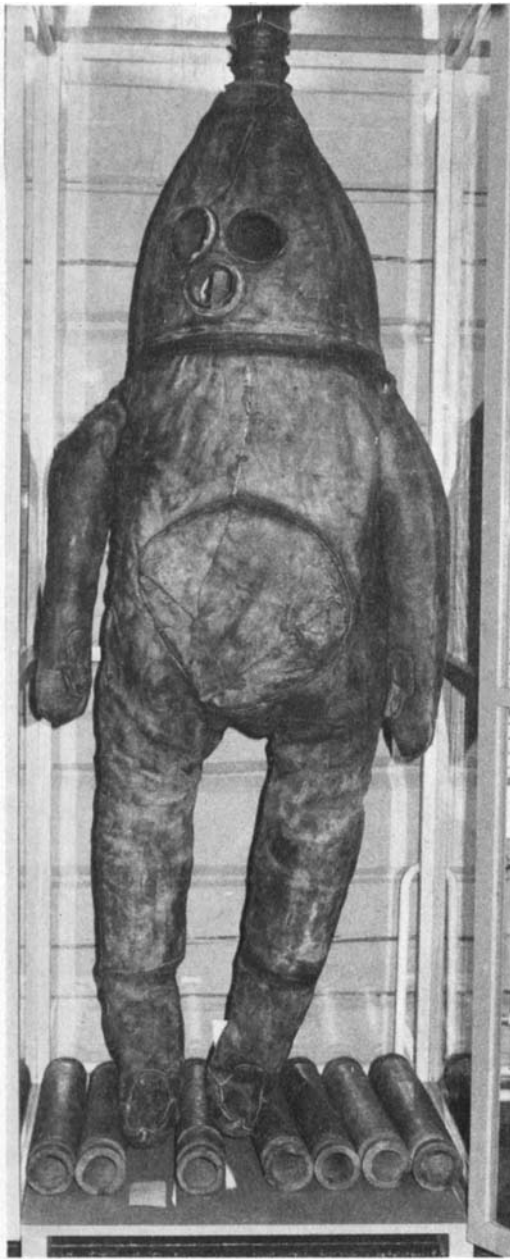


Figure 1. The diving-suit in the museum of Brahestad, suspended by the leather exhaust-hose (cut off at the flange). The round seam at the belly marks the entrance tube: the 'helmet' is permanently fixed. Observe the odd-looking but typically Finnish gloves and boots. Photo: H. Forssell, Bureau of Maritime History.

at a circular, stiff frame or flange, at neck-height. The helmet overlaps the flange and is kept in position by a seizing of four layers of tarred cord, sailor-fashion. This seizing is not undone when entering the suit. Immediately below the seizing there is a heavy seam around the flange, from whence starts the one-piece body suit, with seams at shoulders and knees only. The suit is entered from the front through a circular opening at belly-height. The opening is fitted with a tube, attached by a circular seam, which was closed like an old-fashioned rubber tobacco-pouch and probably secured by a cord seizing.

Arms are tailored in single pieces, ending in typical Finnish forester's gloves with only the thumb free. From the seam at knee-height downwards the suit is finished as loose leather-boots, cut like the typical Finnish farmer's and forester's pointed boots, designed to fit primitive skis with a single leather strap only. A single vertical seam rises from ankle- to knee-height, and continues up to the armholes.

Openings for visibility

There are three holes in the helmet, set in a triangle and stiffened by circular wooden frames. The skin is secured by seizings, while the glasses are cemented in window-fashion. The design looks fragile and would not stand up against pressure.

Openings for air

There are two attachments for air in the suit: 1. the entry for fresh air in the back, about 0.10 m below the stiffening flange in the neck; 2. the exhaust-hose at the top of the helmet-cone. Both are made of wooden tubing, lathe-turned, with grooves and flanges, to fit the pig-skin and the piping respectively. The pig-skin is nailed on with small nails, sailor-fashion, with a seizing of tarred cord. The hoses (see below) are fitted with leather connecting-hoses, secured by cords between the flanges. The openings are of similar dimensions. Obviously the escape-openings were also fitted with a hose reaching the surface. No valves exist.

The hoses

Seven wooden lathe-turned tubes (Fig. 2) are preserved and displayed together with the suit. With these short segments a flexible hose was built up, the tubes being coupled by leather hoses, held by seizings at the lathe-turned grooves. The material, a reddish hardwood free of cracks, is not



Figure 2. The boots of the suit, of typical Finnish design, to fit skis with a single strap. At bottom, wooden pipe-sections for the air-supply, made of foreign reddish hardwood. Photo: H. Forssell.

Scandinavian. The length of the tubes is 0.598 m, the outer diameter roughly 0.08 m, the inner diameter 0.05 m. The six standard tubes are fitted with a single groove for the hoses to suit the protruding attachments, fitted with double grooves.

The air-supply

Nothing whatsoever is known of a pump, nor of the method of carrying the necessary weights. We have reasons to believe that bellows were the maker's solution for air-supply.

The question of influence

There is no reason to suspect the donor's information that the suit dates to the 18th century. The suit is certainly not imported from abroad, but tailored in Finland: the design of the pointed boots, as well as the protruding thumbs, is Finnish beyond doubt. Only the skill of a shoemaker, a carpenter and a sailor were required for the making of the suit. But the question of motive and influence is still open. What did the inventive

maker see, which caused him to build a near replica? Finland was a province of the Swedish realm until the Napoleonic wars, in the course of which, in 1808, the country was annexed by the Tsar of Russia. This did not cut off cultural relations with Sweden, but in fact stimulated trade and shipping in all directions. Soon the diminutive but active seaports along the Gulf of Bothnia entered North Sea trading, bringing merchants into direct contact with British trade and industry. The wives of well-to-do burghers in Brahestad knew London fashions better than the couture of Stockholm or of the Imperial capital, St Petersburg. Observant officers of Finnish—more correctly Russian—ships were thus in a position to study British technical advances, and why not the popular devices for diving, such as the working diving-bells and the many dubious diving-suits, finally made workable by Augustus Siebe in 1819?

Siebe's soon well-known copper helmet with the armour-like breastplate is, however, entirely alien to our soft pig-skin suit, with the exception of the simple principle of inspection-openings. Siebe's suit relied on effective air-pumps, supplying the diver with a surplus of air into the pressure-resistant helmet with automatic or manually

operated air-vents. The whole conception is a product of the developed British metal shop industry.

The Brahestad suit stands for older principles, when the constants of water pressure were not fully known, and the idea of sucking air from a distant surface through long hoses still lingered on. Only the wooden tubes indicate that the menace of water-pressure was understood by the local inventor. A pump, capable of supplying the suit with air, was not at hand, and was technically impossible to manufacture in the remote country of Finland. Pumps for divers did exist in England, even highly developed air pumps for physical experiments, but only at the centres of civilization and education in France, Switzerland and England.

A Swedish suit from 1727

A watercolour sketch (Fig. 3), showing a diver in a suit in action, was by chance handed to the author. The picture was once attached to a letter from the Swedish Admiralty to His Majesty the King of Sweden (Frederic I of Hessen) in the year 1727. Sweden, weakened by the military catastrophes of the Great Nordic War, still maintained a navy of importance. The Admiralty controlled a multitude of nautical matters, among others salvage activities and related technical questions, mainly handled by certain privileged companies. Without doubt this picture represents a new invention, offered to the members of the College for approval of Admiralty. The suit consists of a helmet, similar to our conical one, with a hose (the air supply?) connected to the top, but with two inspection-holes only. The seam between the helmet and the body-suit is not detailed, but gives the impression of being stiffened by a frame or a flange. The diver's body is covered by a soft fabric (?), finished below the waist by a stiffening tubular (metal?) frame, fitted with hooks for two conical weights. These are secured to the legs by cord seizings. Maybe the suit is to be understood as an open suit, ending at the stiffened waistline, which is ballasted so as not to rise and to let out the air trapped in the body suit. The legs are probably covered by some sort of trousers, maybe even naked? The air-supply hose is simply indicated as in most sketches and drawings from the Renaissance and Baroque epochs, ignoring air-pressure and other unpleasant technical facts.

In spite of obvious technical faults the Swedish project, contemporary with Edmund Halley's working diving-bell, and with Becker's leather diving suit fitted with a metal helmet, possesses indisputable merits. Its real value appears in the

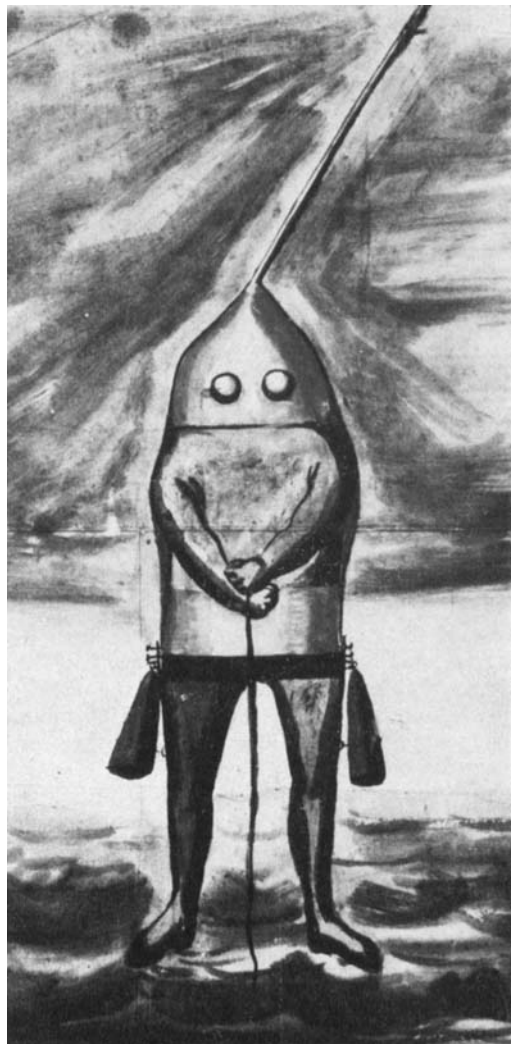


Figure 3. A project presented to the Swedish ruler by the College of Admiralty in 1727. Svenska Riksarkivet, Stockholm.

likeness to the Brahestad suit. Was there a prototype, developed within the official institutions or privileged companies, overseen by the Admiralty? Did the most active salvage companies (the Northern and the Southern), with technical depots for heavy diving material located in the main seaports of the realm, experiment with a diving suit parallel with the well-functioning diving bells of the early 18th century?

Hardy Finns played an important role in daring salvage operations. Maybe one of these

men, returning to his native shores with first-hand underwater experience, started to put technical failures and misconceptions right by private design. To his aid he called fellow-craftsmen: the shoemaker and the carpenter, while he, as a boatman and sailor, did the assembling of the

hoses with his own hands. Possibly he called in a third expert: the maker of bellows. This craftsman, who served smiths and maybe the smelting-ovens of the small Finnish ironworks, could not fulfil the requirements for air-supply, and thus the scheme came to naught.

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The Penlee cannon site. Preliminary report

Historical

The first reports of the site came from Messrs Terry Harrison, Alan Down and George Sandford, who, in 1967, followed a trail of cannon balls to a series of cannon lying in gullies in 20–30 ft (7–10 m) of water close inshore off Rame Head. They informed Lt.-Cmdr. Alan Bax, RN of their discovery, and he and his partner James Gill led a series of dives on the site as part of the work for the School of Nautical Archaeology, Plymouth. Numerous volunteers from various diving clubs have worked on the site over the past few years, the Hampstead branch playing an important part in the early stages, and the Slough Sub-Aqua Club later on. An intensive three-week period of work on the wreck was undertaken in July 1971, under the direction of Commander Bax, Ian Morrison, Lecturer in geography and archaeology at Edinburgh University, and Robert Farrell, Associate Professor of English, Medieval Studies and Archaeology at Cornell University. In another intensive two-week season in the latter half of August 1973, Bax and Farrell led a group of some 25 divers from the Bradford University and Guildford branches of BSAC in a search and survey of the area, which included some preliminary attempts at excavation. The Guildford branch has continued work during the winter season whenever weather conditions were suitable. The area now explored with considerable care is some 200 × 100 m and there are clear indications that the extent of the site is considerably greater, for other remains have been seen to seawards and to the west (Fig. 1). Progress on the site has been slow for a number of reasons. Weather and sea conditions off Rame Head are often difficult, and the nature of the site is such that even a moderate sea makes sustained work impossible because the divers are moved about in the gullies with the flow and ebb of the waves. In addition, visibility

is often poor, in part because dredging operations have been in progress over the past years, and an incoming tide will often bring with it a quantity of fine silt in suspension, reducing visibility to less than 1 ft (0.30 m). Much work remains to be done, both in the field and in library research, but the purpose of this report is to give a brief indication of what has been found.

The finds

1 Ordnance

So far 38 cannon have been found. It would perhaps seem a simple task to survey them, but work is hampered on this type of exposed rocky coastal site. Rock and cannon are covered in a dense layer of kelp (*Laminaria hyperborea*) and there are few days when work is not hindered by wave motion on the sea floor, or the general 'ruggedness' of the underwater terrain described above. The details of the cannon are of interest, for to date the armament of the ship provides a major clue to the size of the wreck and its identification. Accurate measurement is further hampered by a layer of concretion which has formed over most of the iron objects, typical of this type of site.

In order to increase accuracy the normal Fibron measuring tape was abandoned and a rigid graduated rod with a right angle at one end was manufactured.

Consideration was given to stripping the cannon of concretion (Martin, 1973; Price, 1974) in the hope that identifying marks might be revealed. However, in view of the number of cannon and the difficulty of selecting typical specimens, work so far has concentrated on assessing the cannon as the armament of the vessel rather than as individual pieces.

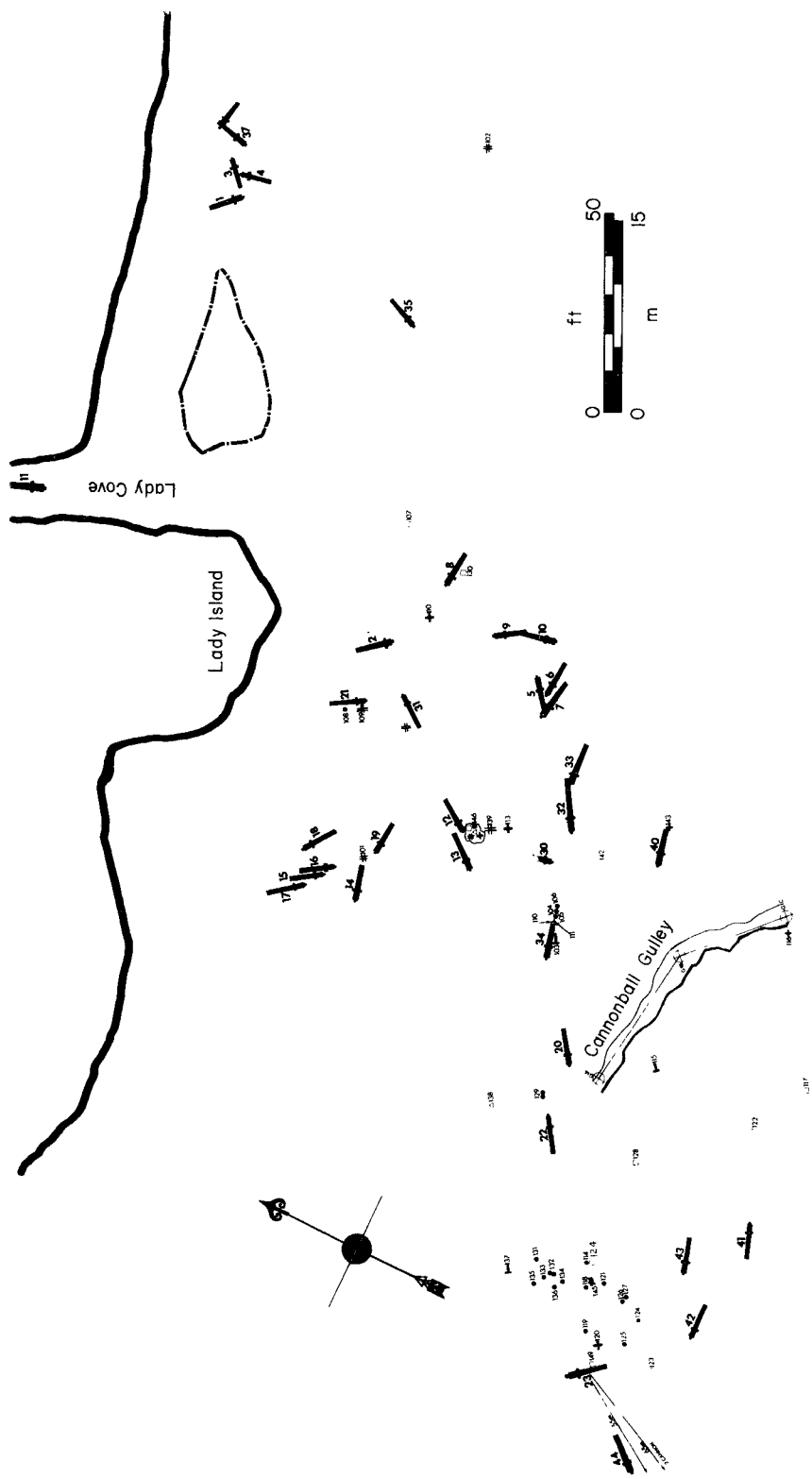
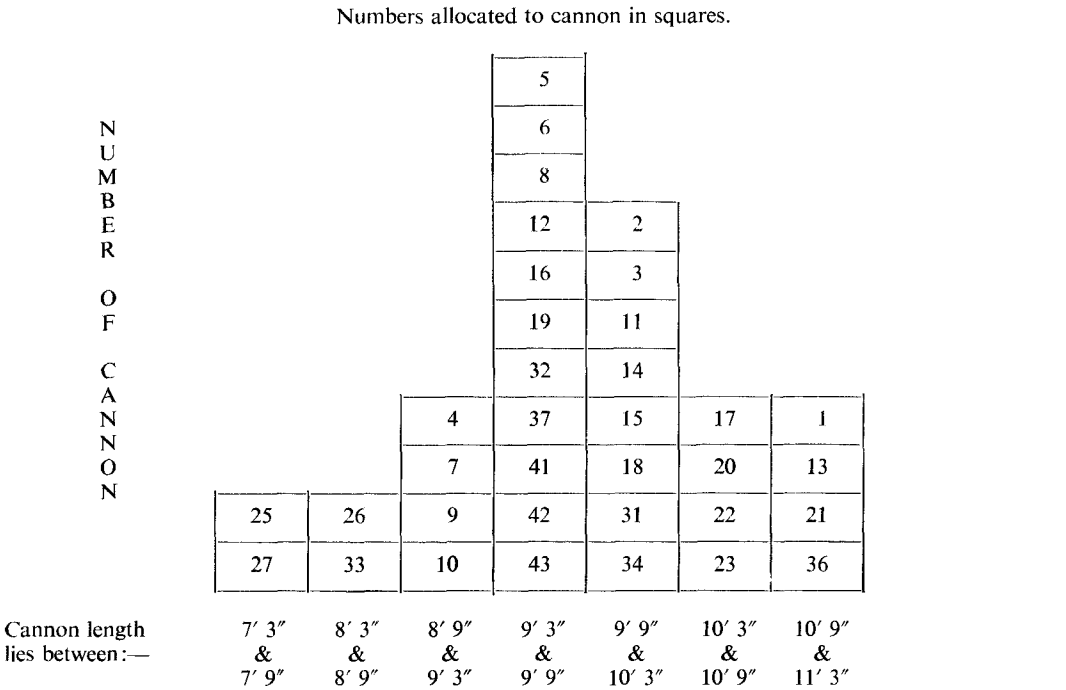


Figure 1. Penlee cannon site, August 1973. +, Iron; ●, cannon ball; #, lead; †, lead scupper; △, glass; □, pottery; ○, bronze.

The parameters which would seem to provide the best clue to cannon type are length, calibre and weight. Of these, length would appear the simplest to establish as thickness of concretion would affect this measurement least. Even so, the best collation so far is shown in Fig. 2. These lengths would indicate that guns were manufactured no later than the early part of the 18th century, for Muller (1757) is already writing of

Many of the cannon have unusual projections whose positioning and size appear to be quite random. They are generally parallel to the longitudinal axis between 5 and 18 in (0.12-0.45 m) long, 3 to 5 in (0.06-0.12 m) high, and about 1 in (0.025 m) thick. The number on any one piece varies between 1 and 3. Such projections, or 'fins' as they have become known, have been observed on other sites. Middlewood (1972:



NOTE: The length of a cannon is taken as breech ring to muzzle. This is, however, a difficult measurement to take under water; so in order to aid consistency the *overall* length was measured and an arbitrary one foot deducted to give the length.

Figure 2. Table of cannon sizes.

the maximum length of old cannon as being 9.5 ft (2.9 m), while Smith (1692) tables lengths up to 12 ft (3.66 m). Using the formula suggested by Hogg (1970) for 10 of the pieces for which sufficient data has been collected, and making an arbitrary allowance for the thickness of concretion (1 in = 0.025 m), the weight of three cannon (5, 6 and 8 from Fig. 1) can be assessed at about 5600 lb. Their calibre is about 6.5 in (0.16 m), so they may perhaps be identified as ordinary demi-cannon (Smith, 1692). Regrettably no other relationship between weight and type can so far be determined.

145) reports them on an unidentified site off Plymouth and they have also been photographed on guns from the *Romney*, lost in 1711 in the Scilly Isles. During the removal of small areas of concretion on Cannon 8 one fin was quite easily prised off. It appeared to be part of the concretion unrelated to any underlying projection from the cannon, but further investigation of other specimens is required before a definite conclusion can be reached.

An increasing number of round shot is being found (see Fig. 1); sizes (including concretion) have generally fallen quite neatly into the follow-

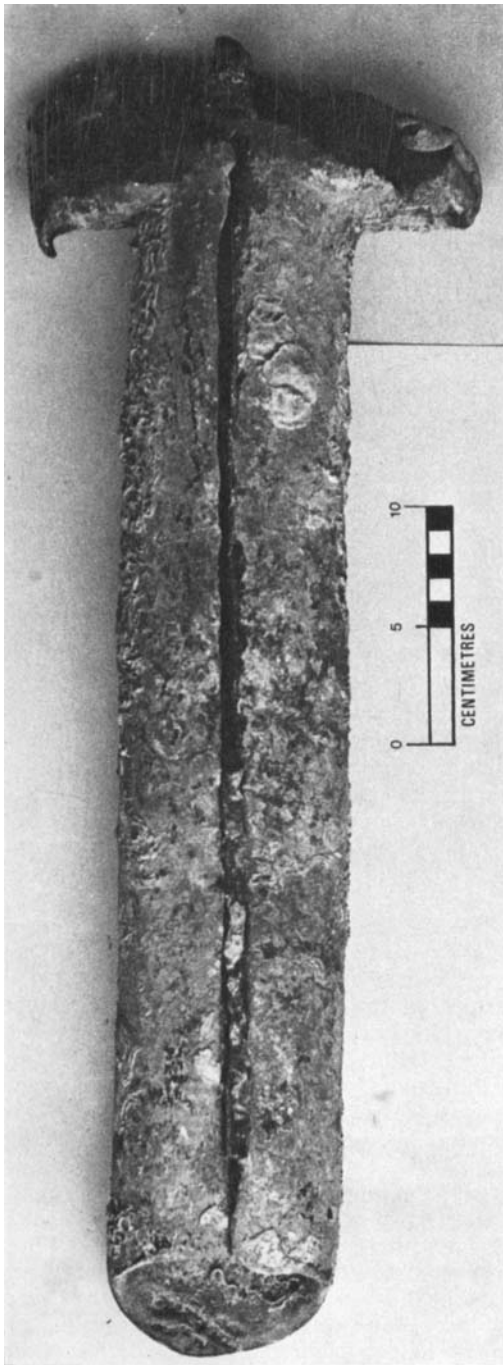


Figure 3. Lead scupper.

ing diameters: 8, 7, 6.25, 5.5, 4.3 and 2 in (0.20, 0.18, 0.16, 0.14, 0.11 and 0.05 m). Not enough

information is available to determine a precise relationship between the cannon and shot, but a number of these will have to be stripped of their concretion, in order to obtain precise measurements.

2 Lead

Numerous small fragments of lead have turned up on the site; some pieces of considerable size and all of the same thickness. Three of these, of sheet lead 0.1 m in thickness rolled into cylindrical form, appear to have been scuppers. All three are about 0.5 m long. Two have been bent out of shape and worn, but the best preserved has an interior dimension of 0.5×0.7 m and has part of the original strip-seal in place (Fig. 3). The other large piece is 0.5×0.3 m and appears to have been some sort of basin, for a flange with nail-holes can be seen, and the original drain hole (Fig. 4).

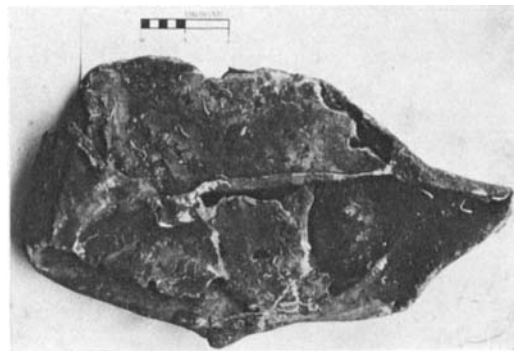


Figure 4. Lead container with drainage hole.

3 Concretion

The most interesting discovery was made by Brian Coope of the Guildford branch of BSAC. It is a large mass of concretion, some 2×1 m in plan, extending into the compacted gravel of the bed of the gully in which it lies; it appears to be free of the bottom and some 0.6 m thick at one end.

A small sample was cut from the concretion to a depth of about 0.15 m, a total of something like one cubic foot of material being raised. This was broken open on shore and numerous objects recovered, including large and small shot, pieces of wood, leather, glass and rope. Even at this surface level many of the objects are remarkably well preserved. We had planned to raise the concretion during January 1974, when Professor

Farrell was in England to work on the site, but weather conditions made this impossible. Commander Bax and the Guildford Sub-Aqua Club will attempt to raise the concretion in accordance

with plans made in January. Conservation will be done by Robert Child, Conservator of RAM Exeter. The Guildford group will continue work during the year.

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Underwater archaeological research in the German Democratic Republic

Underwater archaeological research in the German Democratic Republic has proved an important complement and aid to archaeological excavations of a general kind. Since a large number of archaeological sites, settlements as well as forts and fortifications, lie on islands or by lakes, the main aim of the underwater work has been to establish the presence of underwater structures belonging to these settlements and forts, and to search the bottom in the adjacent waters. In this way the following major investigations have been completed or at least begun (Fig. 1):

1. A system of bridges was found and measured in (lake) Ober-Ückersee near Prenzlau. One of the bridges was some 2200 m long and ran across a depth of water of 2-4 m; the second was only 400 m long, but crossed water 18-20 m deep. The remains were so well preserved that it was possible to determine clearly the ground-plan and construction of the bridges (summary report: Herrmann, 1966). The installation belonged to the 11th-12th century AD and lay on the line of the main route which led from the Rhineland via Magdeburg to the lower Oder (and especially Szczecin, formerly Stettin).

2. In connection with the excavation of an important 7th-8th century fort which was a centre of the Slavonic tribe of the Wilzi (the excavation indicated a population of 1000-3000 people in the fort), an underwater excavation was carried out

on the bed of Lake Breiter Luzin near Feldberg, Neustrelitz district; a dugout, several fish-traps and other objects were found. A number of sections cut in the lake bed made it possible to establish a good stratigraphy which synchronized the periods of the fort's construction and destruction with the deposits in the lake bed. (The results of the underwater work have not yet been published, but they are referred to in the publication of the excavations in the fort, and several finds are illustrated there: Herrmann, 1969: 56-9.)

3. After the encouraging experiences in the Ober-Ückersee and near Feldberg, work was carried out in Lake Teterow (Teterower See), with the aim of verifying the system of bridges and roadways. Excavations on the island in Lake Teterow had proved the existence of a Slavonic fort of the 9th-12th centuries. Furthermore, most of a 750 m long bridge had been uncovered and the details of its construction clarified (Fig. 2, Bridge 1; see Unverzagt & Schuldt, 1963). What remained unclear was the connection between the island, on which lay the fort rampart, and the west shore of the lake. The excavators rejected the possibility that there could have been a bridge at this point, for the water is 6-7 m deep. The underwater investigations produced the following main results: a large number of stumps of sturdy piles were found in the lake bed, which was covered by deep layers of sediment; the evidence from Ober-Ückersee (1 above)

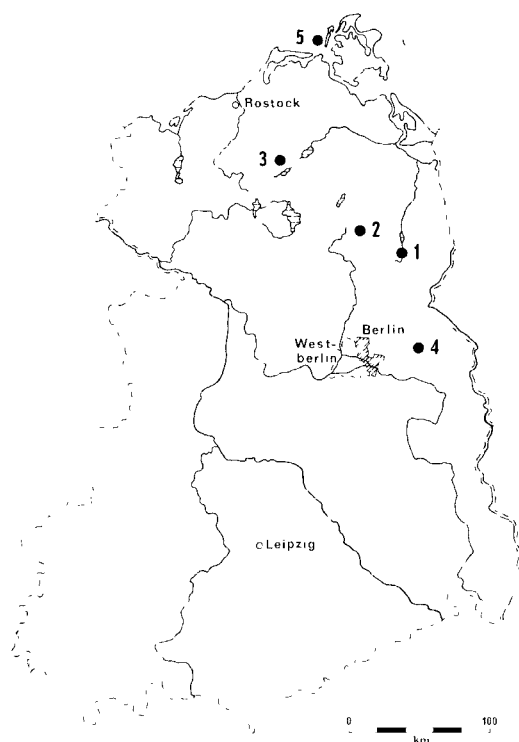


Figure 1. Map, showing the sites where systematic underwater archaeological research has been carried out. 1: Ober-Ückersee, Prenzlau district; 2: Feldberg, Neustrelitz district; 3: Teterow, Teterow district; 4: Schermützelsee near Buckow, Strausberg district; 5: Baltic Sea, off Hiddensee.

shows that they belonged to a complicated bridge construction. Surveying was begun, and between and near the piles were found parts of the superstructure of the wooden bridge. Furthermore, in the deposits on the lake bed a large number of important finds of the 10th–12th centuries were salvaged; they had clearly been lost during crossing of the bridge or in battles around the bridge. The most numerous items were battle-axes ('bearded axes'), some still retaining their shaft (Fig. 3). One axe still bore remains of silver inlay (Fig. 4). Also found were spear-heads, wooden clubs, remains of sickles, horse-trappings, clay vessels and the lower part of a wooden stave bucket. The layers of sediment also contained skulls and larger parts of the skeletons of horses and cattle. It is planned to continue the diving operations with the use of larger suction pumps.

As at Ober-Ückersee, the chief result of the work at Teterow was the demonstration of the existence of a bridge-system which, lying as it did on one of the major long-distance communication routes, took through-traffic on to the island bearing the fort and thus made it easily controllable by the feudal power—Teterow was the centre of a province in the state of the Obodriti.

4. Similar reconnaissance work was carried out in (lake) Schermützelsee near Buckow, Strausberg district. Near a fortified settlement of the Bronze Age and early-historical/Slavonic period, upper parts of the original timber fortification were found on the bed of the relatively clear lake, together with various other finds. Here too the work has not yet been completed.

5. Work in the Baltic off Hiddensee and Rügen identified several medieval wrecks including a merchant ship with a cargo of bog-ore (limonite).

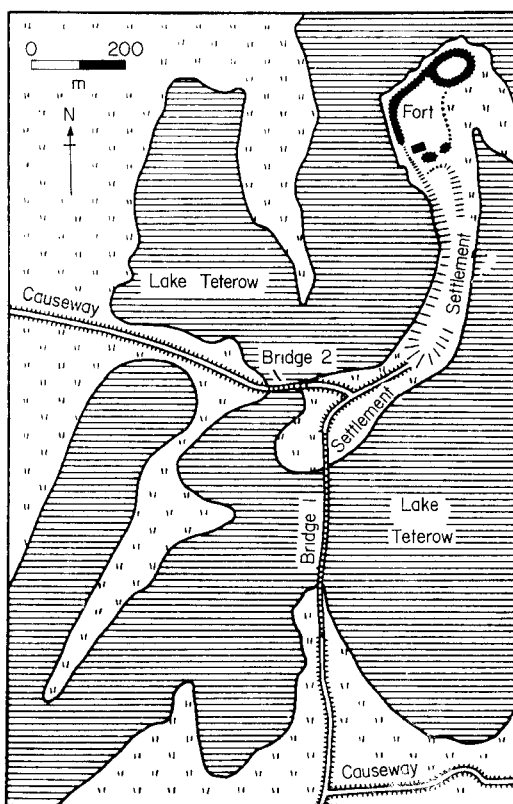


Figure 2. System of roadways and bridges at Teterow in the 11th–12th centuries. Bridge 2: the bridge revealed by underwater archaeological research.

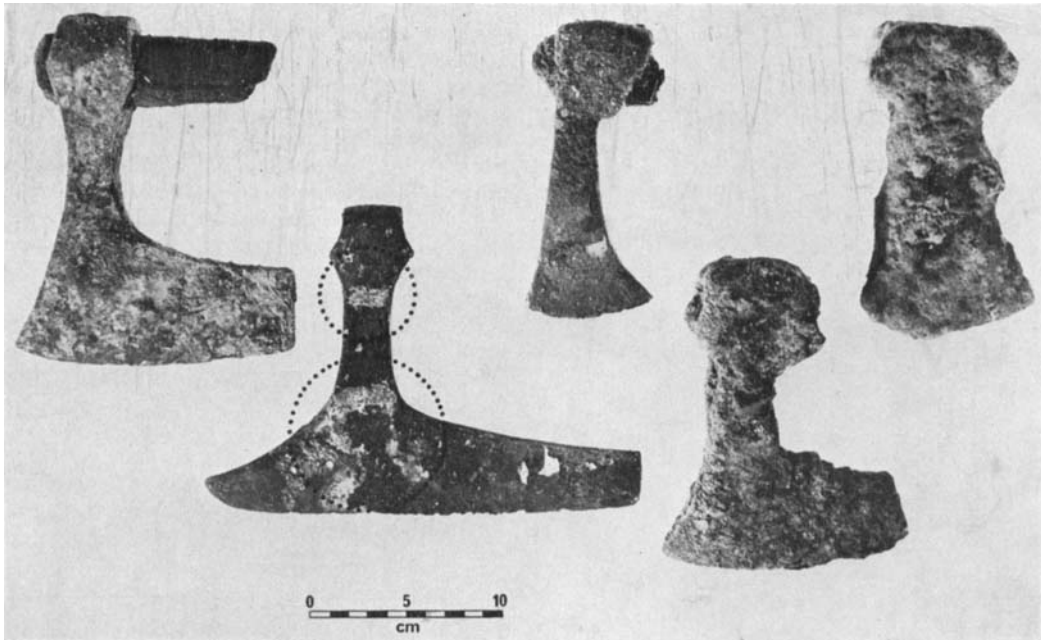


Figure 3. Bearded axes of various forms from Bridge 2 at Teterow.

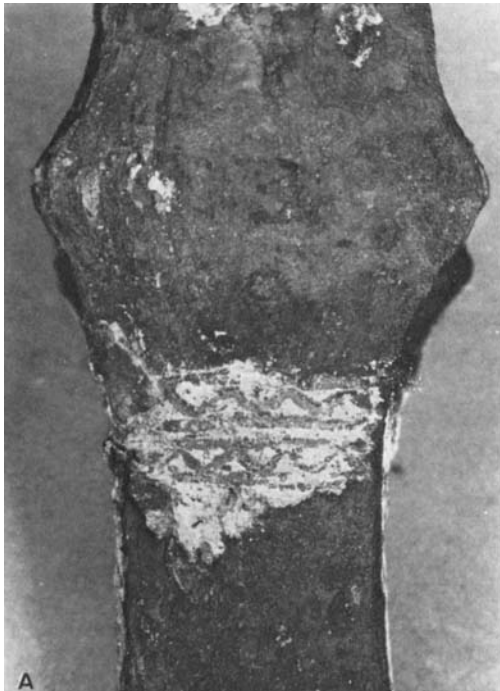


Figure 4. Axe from Teterow still bearing remains of silver inlay, see Fig. 3.

Investigation was discontinued, since no special scientific value was to be attached to the wreck finds.

Besides the projects mentioned above, various

diving groups have in recent years made archaeological observations under water, mainly in inland waters, but without making significant discoveries.

Note

Besides the author, the team at Teterow included Dr Martin Rauschert (Central Institute for Ancient History and Archaeology, Academy of Sciences of the German Democratic Republic), who was responsible for the diving and the scientific-organizational work.

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