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A Group of Exceptionally Heavy Ancient Sounding leads: New Data Concerning Deep-water Navigation in the Roman Mediterranean

By Ehud Galili, John Peter Oleson and Baruch Rosen, pp 136–148

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A GROUP OF EXCEPTIONALLY HEAVY ANCIENT SOUNDING LEADS: NEW DATA CONCERNING DEEP-WATER NAVIGATION IN THE ROMAN MEDITERRANEAN

By Ehud Galili, John Peter Oleson and Baruch Rosen

As a part of an ongoing endeavour to collect and evaluate ancient sounding leads from the Mediterranean as evidence for the history of navigation, we present here a group of eight exceptionally heavy sounding leads, seven of which were recovered from underwater sites off the Israeli coast, several of them recently. One lead in the study group was excavated from a shipwreck off Mahdia, Tunisia, between 1908 and 1913 (**Figs 1** and **2**). Consideration of the leads as a group highlights their special significance to the history of navigation and reminds us that seemingly minor artefacts can preserve important information. Galili and Rosen have been constructing a corpus of ancient sounding leads from Israeli waters, while Oleson has been collecting information on this type of artefact from the entire Roman world.[1]

SOUNDING LEADS AS NAVIGATIONAL INSTRUMENTS AND AS ARTEFACTS

A sounding lead (alternatively, sounding weight) is a navigational instrument routinely used from at least the late sixth century BC until well into the twentieth century to measure the depth of a body of water and sometimes to retrieve a sample of the bottom. Recognized ancient examples are nearly all cast in lead, but a few weights have been found that were carved from stone.[2] Early modern and recent examples consist of a conical lead weight or long, faceted lead or iron bar with a suspension hole at one end and a cavity at the other. These leads were generally suspended from a rope provided with cloth and string markers to indicate the depth attained. In use, the lead was cast toward the bow of a ship underway from some point along the windward gunwale. In a sailing ship underway, her speed often was reduced by turning windward prior to sounding. The rope was allowed to slip freely through the sailor's hand until the lead touched bottom, at which time the sailor noted and called out the depth and hauled in the lead.[3] The method of noting the precise depth in antiquity is uncertain but most likely involved observation of markers on the rope, as in historical European practice.[4] It is also possible that during the retrieval phase the rope was stretched between two spread arms (a 'natural' fathom) and the number of fathoms called out, as artisan fishermen still do. The latter procedure, however, would not provide the immediate depth reading required in a hazardous navigational situation. When required for navigation, fishing, and coral or sponge harvesting, the composition of the sea floor could be determined by examining the sample of the bottom adhering to a tacky material – usually tallow – inserted in a cavity ('tallow cup') in the base of the weight.[5]

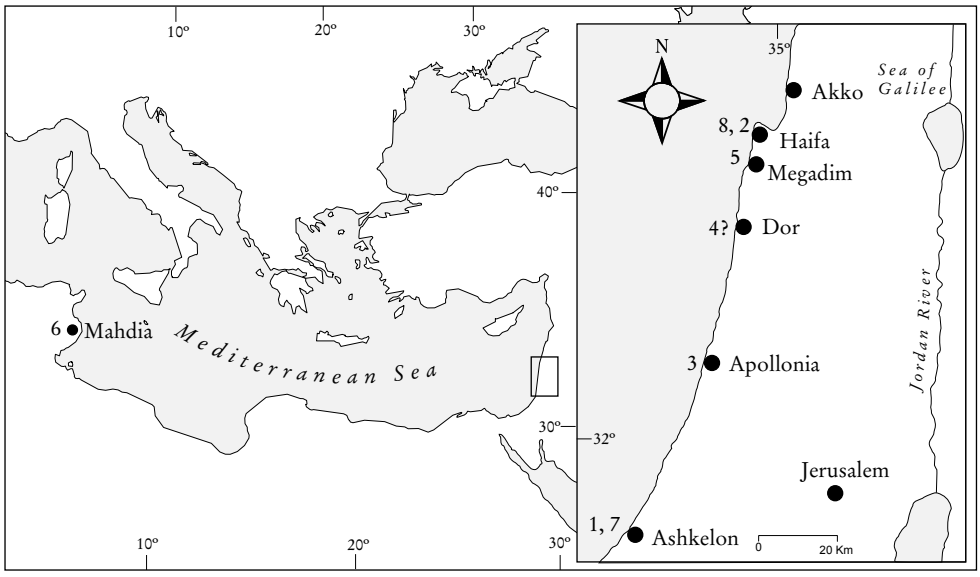


Figure 1 Location map of sounding weights.

Prior to the appearance of the magnetic compass in the fourteenth century, the sounding lead was the only man-made device that could provide navigational information for a ship in fog, under a cloudy sky, or out of sight of land. Naturally, sailors would evaluate this information in the context of an approximate idea of their location obtained by means of the ship's log, wind direction, wave patterns, the behaviour of seabirds and marine life and distant cloud patterns, as well as by referring to previously accumulated data bank on the nature of local and foreign seabeds.[6] Up to this point, all ancient sounding leads available for study have been recovered underwater, from shipwreck sites or shoal waters, and occasionally from rivers. The apparent absence of such artefacts from terrestrial sites is not surprising, given that their natural place was on watercraft, and allowing for the constant salvage and recycling of metals in antiquity. The sounding leads from Israel originate mostly from the wreck sites of ships that went aground close to the coast, and rarely from the rocky fishing grounds farther offshore. The majority of the shipwrecks probably occurred when ships were driven on to this hazardous lee shore during storms and broken up in the surf zone. Given the active environment most, or all of the hull has usually been lost, and these sites consist mainly of metal artefacts and other heavy objects, scattered on the sea bottom at a depth of 2–5 m at a distance of 50–200 m offshore.

Two corpora of ancient sounding leads have recently been published. One covers the whole Mediterranean, containing approximately 161 specimens, including 44 from Israel.[7] Another collection containing 63 sounding leads, all from the Mediterranean coast of Israel, was published the following year.[8] For the purpose of this article the collection from the whole Mediterranean has been used as the background reference, augmented by the seven recently published, particularly heavy lead sounding leads. The selected group of eight leads, the lightest of which

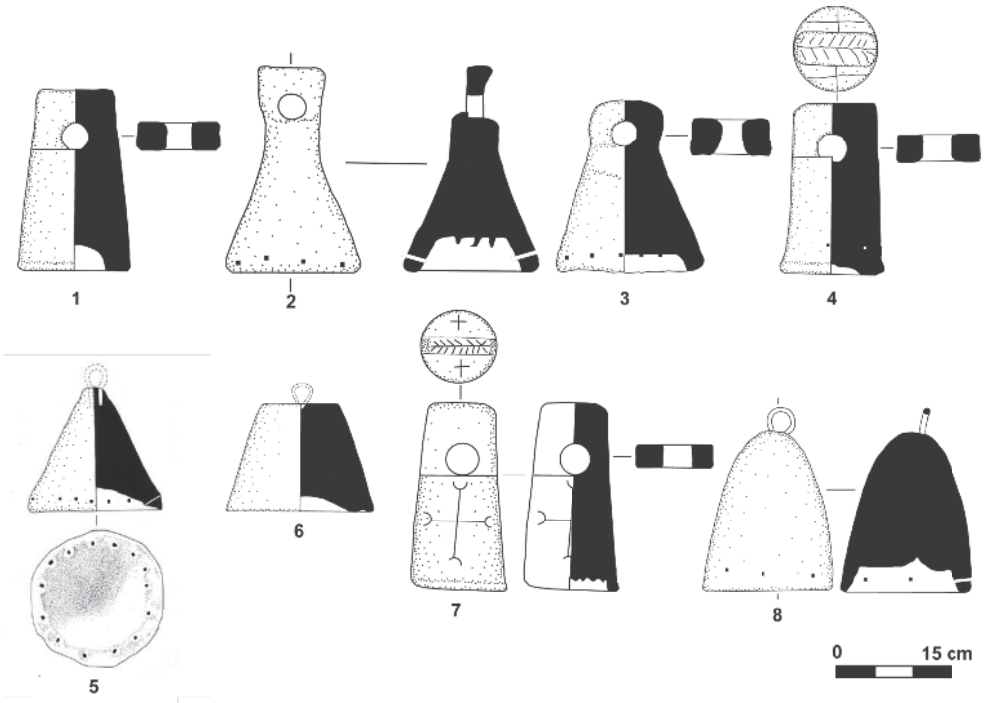


Figure 2 Profiles of the heavy sounding leads.

weighs 14.9 kg, stands out as exceptional in both the published collections. One of these leads was found on the Mahdia wreck off the coast of Tunisia at the beginning of the twentieth century (**Figs 1** and **2.6**).[9] The seven others were found off the coast of Israel (**Figs 1, 2.1–2.5** and **2.7–8**). Of these seven, one was recovered from Apollonia one in the Dor anchorage and five from the Carmel coast and Ashkelon.[10] Of the seven heavy sounding leads recovered in Israel, two specimens were part of a pair of heavier and lighter leads. The average weight of this group of eight, 17.88 kg, is 2.5 times heavier than the average weight of the ancient sounding leads from the Mediterranean in Oleson's catalogue (7.27 kg). The median weight of the group of eight, 17.88 kg, is 3.25 times heavier than the median weight of Oleson's corpus (5.5 kg).[11] The standard deviation (StD) of the heavy group is 2.23 kg, is less than half that of the entire corpus (4.66 kg), indicating a significant homogeneity for the group we are considering.

The next heaviest group in Oleson's corpus, six leads ranging in weight from 13.5 kg to 12.55 kg, cluster tightly around a median of 13.0 kg (average weight 13.05 kg, StD 0.36 kg; Oleson 2008: nos. 021, 055, 061, 137, 139, 155). Nevertheless, this lighter group shows fewer anomalies with the overall corpus than the eight heavy examples noted above: examples have been found throughout the Mediterranean, they are much closer to the average weight of the corpus, and only three have nails in the tallow cup.

Leaving aside the heaviest examples, the range of weight of the other ancient sounding leads found off Israel resembles that of the pan-Mediterranean corpus.[12]

The following catalogue summarizes the information on the heavy group of sounding leads and is arranged in descending order by weight of the artefact. Since many of these wreck sites are located in shallow water and little or nothing of the wooden hulls has survived, it is not always completely certain that the weights belong with the other, more easily dated artefacts recovered.

CATALOGUE OF THE EIGHT HEAVIEST KNOWN ANCIENT MEDITERRANEAN SOUNDING LEADS

1 Israel: Byzantine shipwreck assemblage off Ashkelon, IAA collection, sixth century AD (Class 4A, Tall bell, of Oleson, 'Testing the Waters'; type 1, sounding lead no. 7 of Galili et al., 'Ancient Sounding Weights'). **Figs 2.1** and **3**.

Tall, nearly cylindrical body: with straight sides tapering inward slightly toward the sharply defined shoulder. Flat upper surface: carrying a thick, rectangular suspension lug that springs from the outer edges of the shoulder. The edge of the base has spread out slightly from impact. The shallow, smooth-walled tallow-cup is 3.2 cm deep. H. 23.5 cm; base D. 13.8 cm. W. 20.65 kg.

Figure 3 Weight no. 1.

This lead was recovered along with no. 7 below, off Ashkelon Mayumas (the north municipal beach); both leads most likely belong to the same shipwreck. The assemblage containing the sounding leads was scattered over the flat, sandy sea floor at a depth of 3–4 m, about 60–120 m. from the beach.[13] The assemblage included pot-sherds of Gaza wine amphoras and various metal artefacts. Among these were several iron anchors, remnants of lead sheathing, copper ship-nails with square cross section and mushroom head, along with coins, tools, and fishing gear. The coins, Byzantine 40 nummi folles minted in Constantinople, Nicomedia, Antioch and Cyzicus by the rulers Justinian II and Sophia, dates the assemblage to the sixth century AD.

2 Israel: offshore find near Haifa. Israel Antiquities Authority, generously donated by R. Wirtheim. The chronology of this sounding lead is unknown (Class 5A, Cone, of Oleson, 'Testing the Waters'; type 4, sounding lead no.6 of Galili et al., 'Ancient Sounding Weights'). **Figs 2.2** and **4**.

Tall conical body with slightly concave neck; apex flattened and expanded to form a thick, rectangular suspension lug with central tethering hole. D of tethering hole about 3.3 cm. Casting flanges around one side of the suspension lug suggest that a separate plug was inserted at the top of a two-

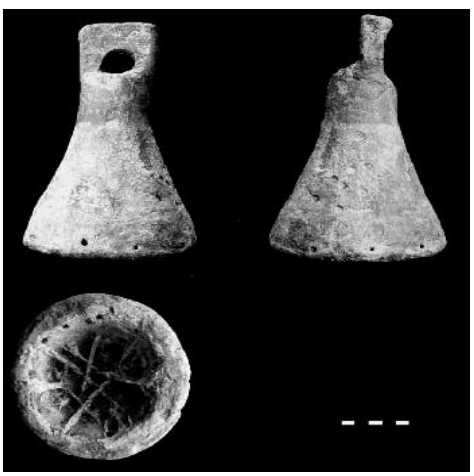
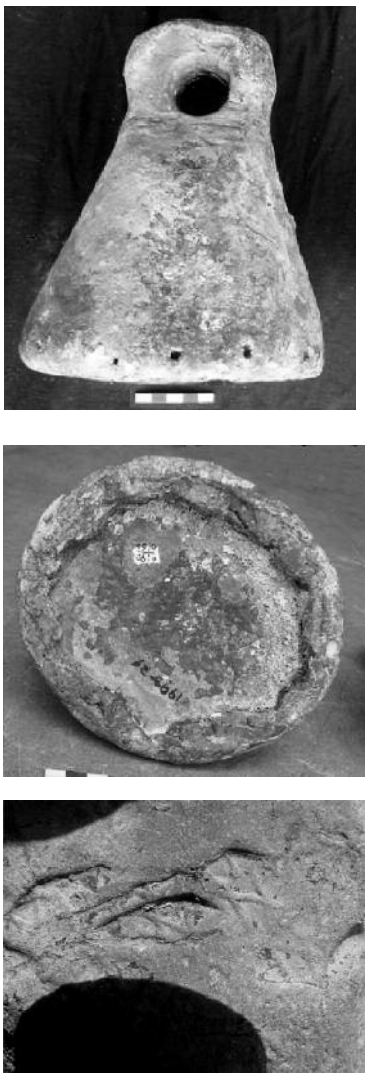


Figure 4 Weight no. 2.

piece mould and held in place by the mould to form the suspension hole when the molten lead was poured around it. The roughly hemispherical tallow cup is fairly deep (4 cm), with many thin, random septa walls produced by chopping at the mould. There are ten nail holes penetrating through the rim into the cup. A random pattern of seven circular depressions on one side may be the result of accidental ancient damage. H 26.5 cm; base D. 17.8 cm. W. 20.6 kg.

Lead no. 2 was found by a treasure hunter off the north section of the municipal beach of Haifa, a straight and sandy part of the coast with no shelter for watercraft. It was recovered from an area where several shipwreck deposits had already been discovered by the Israel Antiquities Authority, including Bronze Age, Hellenistic, Roman and Late Roman wrecks.[14] It was not possible to securely assign this artefact to any of these assemblages, but two very similar sounding leads (no. 3 below, and the weight found with it) were recovered in the Apollonia anchorage.



3 Israel: anchorage of Apollonia. IAA storage. Chronology possibly second or first century BC. (Oleson, 'Testing the Waters', class 5A, cone; class 4 according to Galili et al., 'Ancient Sounding Weights'). **Figs 2.3** and **5**.

Conical body, tapering upward from a rounded lower edge to a heavy suspension lug with projecting, rounded outline. Tethering hole D about 3 cm. Body worn or eroded. On one shoulder beneath the tethering hole there are three stamps showing two slightly overlapping X marks: 'XX' = '20'? The rounded, smooth walled tallow cup is shallow (about 1.5 cm). Twelve holes through the lower edge probably accommodated nails that held the tallow charge in position. H 23 cm; base D. about 17.5 cm. W. 19.0 kg.

This lead was found a few metres away from an identically shaped but smaller weight (13.5 kg), at 2.5–3.0 m depth, some 150 m off shore.[15] In this same location a second or first century BC wreck assemblage was discovered, including a broken life size bronze statue, bronze nails with round cross sections, and a lead sheet with Latin inscription.[16] It seems likely that the two weights belong to this assemblage. The smaller weight has the same 'XX' mark as no. 3, impressed by the same stamp, once near its base and twice below the suspension lug. Since both weights belong to the same shape class and have the same stamps, they clearly were a pair.

Figure 5 Weight no. 3. Top, side view; centre, base; below, stamps on shoulder.

Figure 6 Weight nos 4 (right) and 7 (left).

4 Israel: found by a fisherman in shipwreck assemblage offshore from the southern Carmel coastline. Presently in Hamizgaga Regional Museum in Nahsholim. Second half of the first century AD (Class 4A, Tall bell of Oleson, 'Testing the Waters'; type 1, according to Galili et al., 'Ancient Sounding Weights').[17] **Figs 2.4** and **6**.

Tall, nearly cylindrical body, with straight sides tapering inward slightly toward the sharply defined shoulder. Flat upper surface, carrying a wide, rectangular suspension lug that springs from the outer edges of the shoulder. A fishbone pattern is incised on the upper surface of the lug and a cross on each shoulder, below the tethering hole. The lower edge of the tethering hole (D 3.5 cm) is recessed slightly into the surface of the flat shoulder. The shallow, rough surfaced tallow cup has a deep central dimple; the edge of the cup has been roughly hacked with a blade or chisel to provide better purchase for the tallow. The drawing in the original publication omits the crosses and the hacking on the base.[18] Five square (0.6 x 0.6 cm) nail holes are visible approximately 3.2 cm above the base, but they do not seem to penetrate the tallow cup. H. 22.3 cm; base D. 13.1 cm. 18.75 kg.

Tilley suggests that an ancient sponge diver might have used the lead to descend quickly (cf. Oppian, *Halieutica* 5.634–8).[19] Lead, however, seems unnecessarily expensive and specialized for such an application, and 18.75 kg is far heavier than a naked breath-hold diver would require. Along the Lebanese coast, the Arabic term for a breath-hold diver's weight is *balata* ('plate of stone'), and early modern pearl divers in the Persian Gulf used stones for this purpose.[20] More importantly, this lead was found on a Roman shipwreck along with a lighter lead that is surely a sounding lead.[21] The dating of the wreck, based on the shape and epigraphy of some inscribed lead ingots, is conjectural but likely.

5 Israel: Hellenistic shipwreck assemblage off Megadim. Israel Antiquities Authority No. 1199/57. Second century BC (Class 5B, Cone with added suspension ring of Oleson, 'Testing the Waters'; type 6, sounding lead no. 9 of Galili et al., 'Ancient Sounding Weights'). **Figs 2.5** and **7.**

Squat cone with small, rounded apex. Two holes in the apex probably held an iron suspension loop (now lost). Shallow, rounded, smooth-walled tallow cup

Figure 7 Weight no. 5.

(3.0 cm deep). 15 nails (now lost) were driven through the rim of the weight into the tallow cup at an angle. H. 15.8 cm; lower D. 17.5 cm. W.17 kg.

This weight was recovered at a depth of about 3 m, 100 m off Megadim.[22] The coastline in this area is sandy and straight, with no shelter for watercraft. In 1982 a cluster of hundreds of artefacts was discovered scattered on the clay sea floor at the same site, dating to the second century BC The assemblage included mostly metal items and other heavy objects: stone and lead anchor stocks, bronze nails and fittings, broken bronze anthropomorphic and zoomorphic figurines, and fragments of life-size anthropomorphic statuary, along with bronze and silver coins of the Ptolemaic and Seleucid dynasties. The coins dated the assemblage to the second century BC.[23] In addition, the cargo included a wine amphora in secondary use containing tens of kilograms of metal scrap: copper ingots, metal fittings, jewellery, and pieces of large bronze statuary intended for recycling. The sounding lead was recovered in the same area as a lead anchor stock, 20 m east of the main cargo. Both the weight and anchor had probably been stowed at the bow of the ship, ready for use.

6 Tunisia: Mahdia shipwreck. Now in the Bardo Museum, Tunis. 110–90 BC Class 6B (Truncated cone with added suspension ring; Oleson, 'Testing the Waters', 146, no. 022). Lead with iron ring (now lost). **Figs 2.6** and **8**.

Truncated conical body with broad upper surface.[24] A large hole in the upper surface probably held an iron suspension ring or loop cast into the body. The rounded, smooth-walled tallow cup is shallow. Marine encrustation covers the base, but 6 or 8 nails seem to have been driven downward diagonally through the lower edge of the lead into the cup. H. 12 cm; lower D. 19 cm. W. 16.9 kg.

Figure 8 Weight no. 6.

A second, smaller sounding lead (Class 1B, hemisphere with added suspension ring; 12.82 kg) was also found on the wreck.[25] The ship, which had a keel 26 m long, carried a cargo of marble architectural elements and bronze statuary weighing approximately 250 tons.

7 Israel: Byzantine shipwreck assemblage off Ashkelon (found with weight no. 1). Sixth century AD (Oleson, 'Testing the Waters', Class 4A, Tall bell; type 1, no. 8 in Galili et al., 'Ancient Sounding Weights'). **Figs 2.7** and **6.**

Tall, nearly cylindrical body, with straight sides tapering inward slightly toward the sharply defined shoulder. Flat upper surface, carrying a wide, thick suspension lug that springs from the outer edges of the shoulder. The edge of the base has spread out slightly from impact. Shallow, flat-roofed tallow-cup (1.5 cm deep); the roof is roughened with irregular raised lines. H. 24.0 cm; base D. 11.7 cm. W. 15.2 kg.

For the context, see no. 1. above, recovered from the same wreck site.

A cross appears on both sides below the tethering hole (H. 11.7 cm; W. 8.5 cm), each arm of the cross terminating in an outward facing semicircle. This cross can be compared with crosses on Late Roman C ware ceramics of the fifth to seventh centuries.[26] The parallels in a common class of utilitarian ceramics suggest a possible date in the fifth or sixth century as well for the utilitarian sounding leads. Two equal armed crosses without semicircles appear on the flat upper surface of the lead, one on either side of the suspension lug. A stylized fishbone motif, with two opposing 'ribs' at one end, runs along the top of the suspension lug. Given the crispness of their execution, all these motifs were probably engraved after casting. Apart from these engravings, and the slightly smaller diameter, this weight is nearly identical to no. 1.

Figure 9 Weight no. 8.

8 Israel: random offshore find near Haifa. Israel Antiquities Authority no. 96.1334. Chronology uncertain, but probably imperial (Class 4C, Tall bell with added suspension lug of Oleson, 'Testing the Waters'; type 6, sounding lead no. 10 of Galili et al., 'Ancient Sounding Weights'). **Figs 2.8** and **9.**

Tall body with convex sides tapering to a rounded apex, into which a bronze suspension ring was put. Thin-walled base with shallow, flat-roofed tallow cup. There is an inset line around the weight, just above the base, through which 6 nails were driven into the interior. H. about 0.21; base D. about 0.14. W. 14.9 kg.

Galili and Sharvit date the context to the 'Roman' period, on the basis of a find of 'silver dinars'. An imperial date seems likely.[27]

THE FUNCTION OF THIS GROUP OF HEAVY SOUNDING LEADS

The concentration of the find spots of these atypically heavy leads along the coast of Israel clearly requires some discussion and explanation. Why have all but one of the heaviest ancient sounding leads been found in this relatively small area? The intensive exploration of these waters by authorized and unauthorized divers over the last forty years cannot be the only explanation, since even more intensive activity off the coasts of France, Italy and Spain have not yielded similar sounding leads. An examination of the shape classes of the leads also does not answer this question. Although examples of Oleson Class 4 and 5 sounding leads are frequently found off

the coast of Israel, they show a wide range in weight. Furthermore, the presumed chronological range of this group of heavy sounding leads, from the second century BC to the sixth ad, is too wide to suggest their connection with a single local event or short historical period. One pattern that is unique to the group is the high frequency of nails pounded through the wall of a weight into the tallow cup, presumably to secure the tallow in position. Five of the eight leads show this feature (62.5 per cent), as opposed to 59 of the 174 leads in Oleson's catalogue (34 per cent). Catalogue no. 4 above preserves five nail holes on the exterior, but the nails do not seem to have penetrated the tallow cup. Given the apparently inconvenient weight of these sounding leads, an examination of their possible use in the context of ancient navigation routes may provide the most convincing answers.

The Apollonia lead (no. 3 above; 19.0 kg) was found with a sounding lead of identical form but seemingly more practical weight (13.5 kg). The Mahdia lead (no. 6 above; 16.9 kg) was also part of a heavy pair, the second lead again significantly lighter at 12.82 kg.[28] The pair of leads found off Ashkelon (nos. 1 and 7 in the present list) also shows significant disparity in weight (20.65 kg vs 15.2 kg). It is difficult to reconstruct how the heavier of these pairs of leads could have been thrown and retrieved conveniently, but obviously they were procured and taken aboard for practical reasons by a person or persons who intended and were able to use them routinely. It is probable that – like the heavier early modern sounding leads – they were intended for sounding in deep water and were retrieved with a winch or roller or by a group of trained people, much like the groups hauling lines, manually and in unison, on pre-modern sailing ships or docks. Deep-water sounding for the purpose of routine navigation does not require the rapid recovery and immediate redeployment of the weight. At the same time, the use of a heavy weight assures the rapid descent of a great length of rope despite the drag caused by the greatly increased friction and buoyancy. A heavy weight will also make contact with the bottom more apparent to the sounder, and the rope can be pulled taut against submarine currents without fear of losing contact. Finally, the cage of iron nails that held the tallow securely in position on the majority of the surviving heavy sounding leads probably reflects the special importance of obtaining a sample of the sea floor when navigating in deep water. The heavy leads of Oleson's Class 4A catalogued above (nos. 1, 4 and 7) uniformly lack nails hammered through to the base, while the rest of the leads in our catalogue have them. This might suggest a different function for the heavy Class 4A weights, but in fact no Class 4A weights of any size show this feature. Furthermore, the tallow cups of nos 4 and 7 above have been roughened to hold a charge of tallow. In shallow water situations the simple depth was of the most urgent importance. A heavy sounding lead will function in both shallow and deep water, while a light one will not function well in deep water.

In the seventeenth century, 7 lb (3.18 kg) weights were used to sound up to 20 fathoms (36.6 m), and 14 lb (6.38 kg) weights in deeper water. For more recent sounding leads those weights were doubled, perhaps because mechanical windlasses could be used to recover the lead: 14 lb for shoal water and 28 lb (12.7 kg) for deeper water, and some deep-sea leads weighed 60–70 lb (27.22–31.75 kg).[29] Parry cites 7 lb weights for shallow water and 14 lb. weights for 100 fathoms. Cornell and Hoffman record the recent everyday use of a sounding lead of 7–14 lb (3.18–6.38 kg) for entering and leaving ports and generally in places where the depth of water did not

exceed 20 fathoms (36.6 m).[30] These last two authors also mention a Deep Sea Lead or Coasting Lead weighing from 30 to 100 lb (13.6–45.4 kg), which was tethered to a 100-fathom (182.9 m) line. The official Navigation Dictionary issued by the US Naval Oceanographic Office records the following weights: hand lead, 7–14 lb (3.2–6.3 kg), usually tethered to a line of not more than 25 fathoms (45.7 m); deep-sea lead, 30–100 lb (13.6–45.4 kg), usually tethered to a line of 100 fathoms (182.9 m) or more; coasting lead, 30–50 lb (13.6-22.7 kg), used for sounding depths of 20–60 fathoms (36.6–109.7 m); drift lead (no weight given) which is placed on the bottom to indicate undesired drifting of an anchored vessel.[31] The drift lead was generally dropped from the bow of a ship at anchor. The line was tightened (with no slack) so that the weight was just touching bottom. Every so often a sailor on watch would feel this line. If the line provided slack the vessel was drifting toward shallower water. If, on the contrary, the weight was hanging free in the water, the ship was drifting toward deep water. The coast of Israel is too open for the routine anchoring of ancient ships close inshore, so our group of heavy leads is unlikely to have served this purpose except in emergencies.

Coasting leads and their use are not well defined in the relevant literature. It seems that they were lighter, more convenient, and easier to handle than the heavy and clumsy deep-sea sounding leads. Speed of deployment or retrieval was not a decisive factor in the characteristics demanded of a sounding lead employed a deep-water navigational instrument used when approaching the continental shelf. From the late nineteenth century onward the heavy deepwater leads were recovered with the assistance of a steam-powered windlass.

Judging by the criteria specified in modern seamanship manuals, the heavy sounding leads catalogued above might be interpreted as deep-sea leads or coasting leads. Although we have no evidence for such a use, when attached to the anchor cable, lead weights could have improved the holding power of anchors by 'flattening' the cable, much like the few metres of iron chain connecting the anchor rope to the tethering ring of modern anchors. The fact that some leads were found with a lighter companion lead implies a diversity of function: the heavier of the pair may have been deployed for deep water navigation in little-known waters or when approaching not well known but expected steep shores, in coasting, or in anchoring. The lighter could have been deployed for shallow water coastal navigation and for entering harbours or locating anchorages.

The hypothetical function of our group of heavy leads fits in well with what we know of ancient seafaring routes along the Levant. Cargo ships leaving Alexandria, Caesarea, or Beirut for the Western Mediterranean, against the prevailing winds, generally had to follow a port tack up the coast of the Levant, often as far as Antioch, before finding a starboard tack that would carry them along the north or south shore of Cyprus and Crete and on to the West.[32] The voyage of Saint Paul from Caesarea to Puteoli in AD 60, including a shipwreck event during which sounding leads were deployed, is one of the best-known accounts of such a voyage (*Acts* 27: 13–20, 27–32).

The navigators on square-rigged ships coasting up the practically shelter-less lee shore of the south Levant with a west or northwest wind must have had to use all their skills. Given the frequent use of this route by the largest cargo ships in the ancient world, especially the carriers of Egyptian wheat to Rome, and the dangerous

character of the lee shore, it is no surprise that deep-sea sounding leads should be found here in larger numbers than elsewhere. The absence of clear and easily identified landmarks on the coast of Sinai and south Israel was a further inducement to navigate by means of sounding leads. The depth contours of the deep sea from Alexandria to opposite the head of Mount Carmel run parallel to the coast, and making a course along this feature with the aid of a deep-sea sounding lead provided the navigator with a margin of safety.[33] All the sounding leads from Israel catalogued above were found in shallow water (3–6 m. deep). It is likely that they originate from ships that were driven ashore during storms while sailing along the coast. If these particularly massive sounding leads belonged to wrecked Alexandrian wheat transports, they hint at the importance of the shelter offered by the construction of Caesarea harbour on such a dangerous coast. The Mahdia lead (no. 6 above) was found in association with a wreck carrying marble architectural elements and art works, but the other seven leads were associated with only miscellaneous artefacts. None was associated with an amphora wreck. The absence of large surviving cargoes in association with the leads in this class suggests that the cargoes were biodegradable, such as wheat. The chronology of the Alexandrian grain trade fits well enough with the chronological range of the leads catalogued above.[34]

Once the dangerous Levantine leg of the journey was finished, the rest of the voyage to Rome or other western ports for the most part involved deeper waters, where the discovery and investigation of ancient shipwrecks has only just begun. The pair of leads from the Mahdia Wreck are welcome, although scanty, testimony to the use of deep water leads farther along the route to the west, and it is likely that more evidence for deep water leads will come to light in the future once deep-water wreck sites can be examined in more detail, or excavated. In the meantime, we may have some new archaeological evidence for the otherwise poorly documented passage of grain freighters along the Levantine coast.

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