Ehud Galili · Baruch Rosen

ONE ARMED ANCHORS FROM ISRAEL

Introduction

Forty years of underwater research in Israeli waters (the Mediterranean, Sea of Galilee, the Dead and the Red seas) revealed numerous anchors from periods starting at the Bronze age, many well preserved. They are of numerous types: stone, wood and metals, or composed of various combinations of these materials (Fig. 1).

One of the relatively rare and little studied anchor type is the OAA. Based on anchor parts from Sicily (two holes lead assembly-pieces) Papo (1966) and Kapitan (1971) suggested the existence of antique OAA in the Mediterranean. Kapitan (1971) predicted that more such anchors will be found. Dangreaux (1996) reported on an OAA recovered from a classical wreck at Hyeres which consisted of a broken wooden sank and a whole wooden arm with no lead assembly-piece.

This article describes OAA from several periods recovered off the coasts of Israel (Fig. 2) and discusses their possible evolution and functions. In describing the anchors the terminologies of Haldane (1984) and Nelson-Curryer, (1999) are used.

One armed anchor (killick) from the Dead Sea (Table 1 No.1)

In 2004 a simple OAA (Killick-anchor) was found on dried sea bottom near Ein Gedi, on the Dead Sea shore (Fig. 2), At elevation of 415 m. below sea level (Hadas *et al.*, 2005). It is a simple artifact made of little worked, easily available local materials: tree branch, plant fibers and local stone. A major branch of a tree formed the shank and a branch protruding from it formed the single arm which joined the shank at about half a meter above its lower end. The bottom part of the major branch was kept and protruded below the arm. An elongated stone stock was joined by rope to the shank in the side facing the arm. Unusually the stock was placed not at the top of the shank but just below the arm. The minimally worked wood is still covered by bark in many places (Hadas *et al*, 2005).The anchor was dated by C14 to 8^{th}-5^{th} centuries B.C. E (Hadas *et al.*, 2005), another laboratory dated it to a later Persian period (Boaretto, 2004).

One armed anchor from Ma'agan Michael wreck (Fig. 3;table 1 No. 2)

A practically intact OAA carved from a single timber and a stock was recovered in 1989 during the final excavation season of the 13 m. long wreck off Ma`agan Michel (Fig. 2) (Linder, 1989; Rosloff, 1991, 2003). The 1.89 m. long OAA weighing about 55 – 60 kg. was found beside the wreck starboard bow with the single arm pointing down. The stock (1.55 m. long, weighing 45 kg.) was made from a single timber and its weight was increased by two lead cores. The stock was asymmetric in its longitudinal axis and the center of mass was placed in a position that caused it to land with the single arm pointing down. The stock joined the shank on the side facing the one arm by a single cotter pin secured by inserting a smaller pin. The bill (tooth) was sheathed by cooper. The wreck was dated to about 400 BCE.

Table 1

comments	location	Rope traces	Arm angle (deg.)	Identification, IAA no. or diving report	Weight Kg	material	Anchor/ Anchor part	
Persian period?	Dead Sea, En-Gedi	+	45~	2004-154	~ 35	Tree branch & stone	Killick	1
400 bc	Ma'gan Michael Wreck	+	25	-	Stock -45 Total ~ 55	Wood + Lead core	Complete OAA + Stock	2
Unknown	South Israel	-	-	4/2000 M12/2	8.2	Lead + Wood core	Fixed stock	3
-	Yavneh Yam	-	-	4/2000 M/12/2	18.5	Lead	Removable stock	4
Roman	Yavneh Yam	-	30-40	13/99 M122/1	9.4	Lead	Assembly piece	5
Roman	Yavneh Yam	-	38	21/94 26/10	5.7	Lead	Assembly piece	6
Roman	Atlit North Bay	-	25-30	Galili 1994	3.5-4	Lead	Assembly piece	7
Roman?	South of Appolonia	-	25	37/96 64/1	~10 -15	Iron	Complete OAA + stock	8
Roman Assemblage	Ashkelon North	-	30	-	3.3	Iron	Complete OAA + stock	9
	Yavneh Yam	-	40	2003/84 10	0.029	Lead	Miniature Model	10
Broken Stock	Yavneh Yam	-	33	21/94 83/06	0.070	Lead	Miniature Model	11

Wood and lead OAA from Atlit (Figs. 4, 5/a; table 1 No. 7)

The OAA assembly piece weighing 3.5-4 kg. with an inserted single wooden arm, was discovered in 1985 in Atlit North Bay anchorage (Fig. 2) at 5 m. depth, 180 m. off shore (Galili, 1994). It was a part of OAA probably lost to a water craft using the anchorage. The assembly piece has a rectangular shape with two square perforations, in one of them a complete wooden arm survived. The arm angle relative to the stock is about 25-30°. This anchor supplies information on the arm-shank junction, a critical structural point in all anchors. Judging by a remaining mortise, the arm was joined to the shank by a wooden tenon with a round dowel passing through it and protruding on both sides. The bill was covered by remains of an iron sheathing fixed by an iron nail. Using Haldane`s typology (1984) this composite (lead, wood, iron) anchor can be dated from 2nd century B.C.E. to the 3rd century C.E.

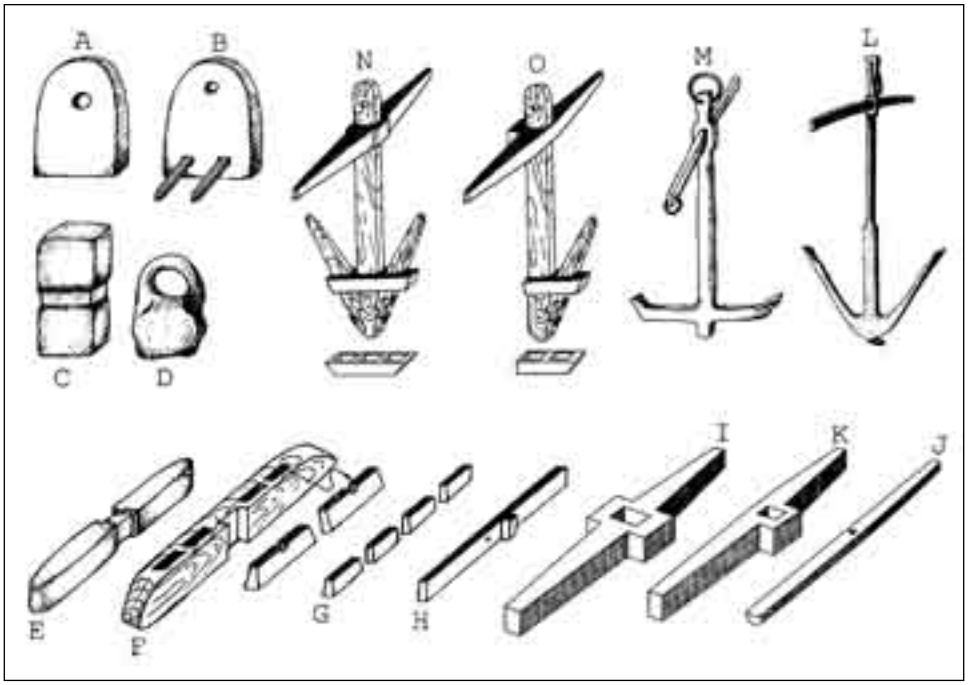

FIG. 1. General typology of anchors recovered from Israel waters.

FIG. 2. Location map of sits mentioned in text.

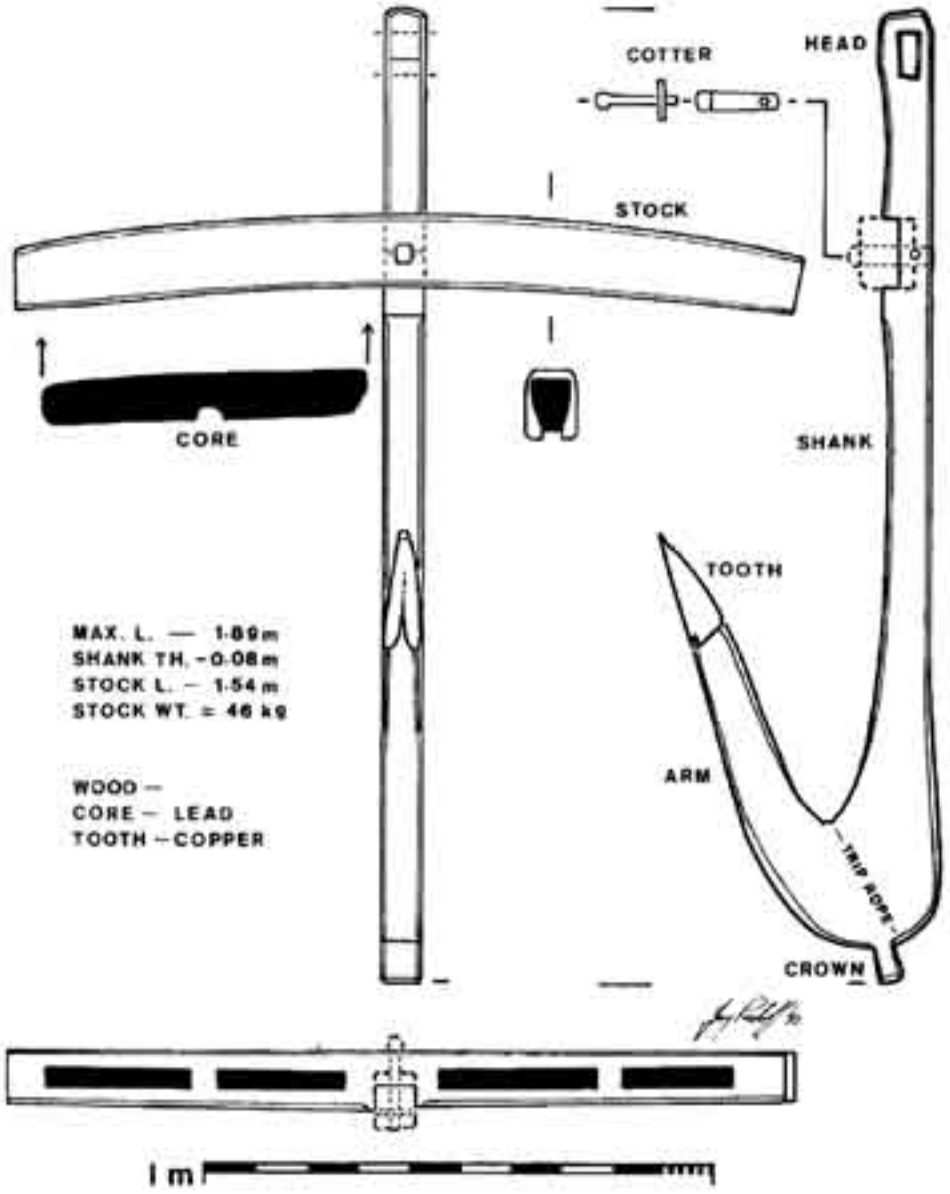

Fig. 3. One Armed Anchor from Ma`agan Michael Wreck (after Rosloff, 2003).

Lead assembly pieces of OAA from Yavneh-Yam (Fig. 5/b, c; table 1 No. 5 & 6)

Two lead assembly pieces belonging to OAAs were recovered from the Yavneh-Yam anchorage between 1994-2000 (Fig. 2). Assembly piece No. 5, weighing 9.4 kg., was

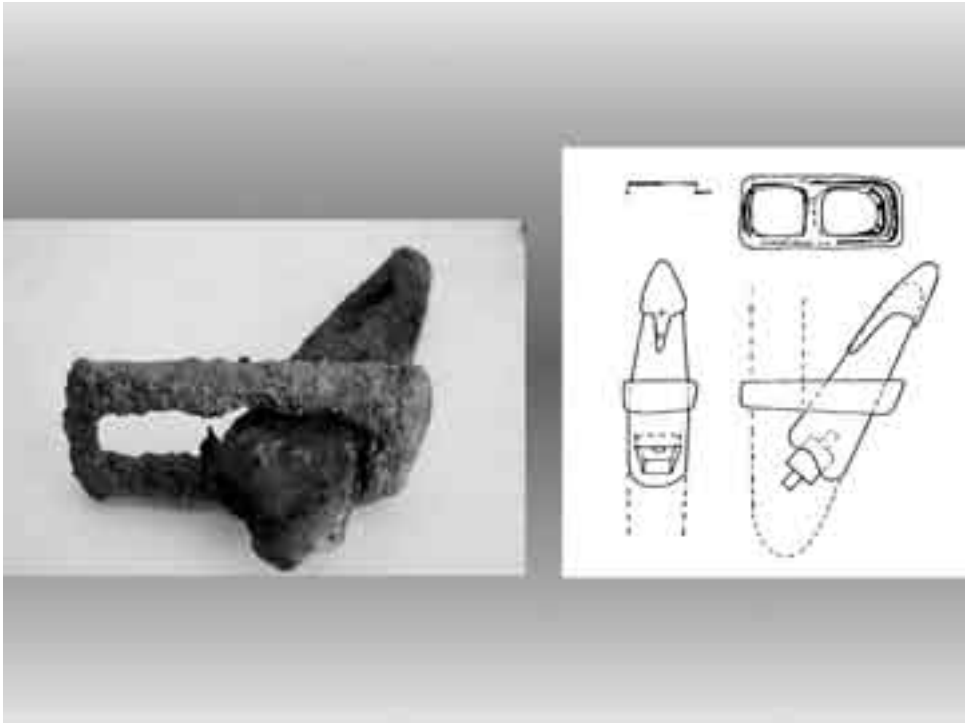

Fig. 4. Roman Wood and Lead OAA from Atlit.

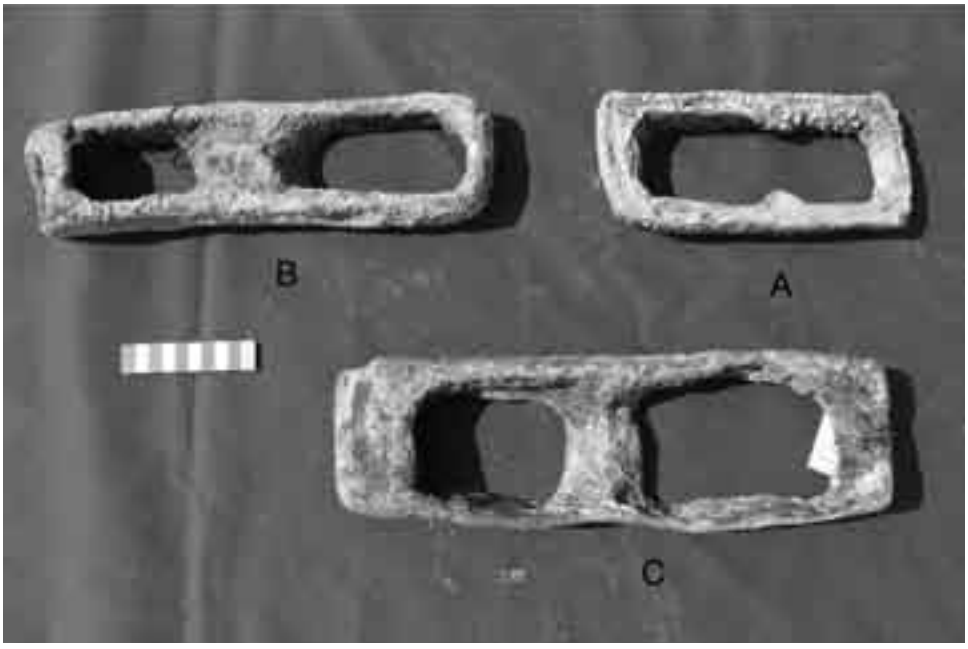

Fig. 5. Lead Assembly Pieces of OAAs : a -Atlit , b, c- Yavneh Yam.

recovered inside the anchorage at a depth of 5 to 6 meters. Its reconstructed arm angle is about 35°.

Assembly piece No. 6 weighing 5.7 kg. was recovered inside the anchorage at a depth of 4 to 5 m. Its reconstructed arm angle is about 40°. It was found in the lee (sheltered) side of a submerged kurkar ridge, and probably belonged to a ship which sheltered in the anchorage.

Fixed Lead stock of wooden OAA from southern Israel (Fig 6/a; table 1 No. 3)

This lead stock, weighing 8.2 kg, originated in the sea in south Israel. This stock is asymmetric in its longitudinal axis and has a slightly tapering rectangular cross section. The hole in the "box", which holed the vanished shank, is square (6.5 cm. by 6.5 cm.). Traces of elongated, rectangular wooden core (1.5 × 2 cm.) survived inside the stock. The wooden core was fixed asymmetrically to the shank side before the lead was cast. This construction caused the center of stock's mass to be on the side of the shank facing the one arm and assured proper functioning of the OAA as described above.

Removable Lead stock of wooden OAA from Yavneh –Yam (Figs. 6/b, 7; table 1 No. 4)

This lead stock (weighing 18.5 kg.) was found on a rocky bottom at the exposed south edge of the Yavneh – Yam anchorage (Fig. 2). It has a rectangular tapering cross section and a round hole in the middle (diameter 30 mm.). This hole housed a pin joining the stock to the shank's side. The square shallow open groove (width 75 mm.,

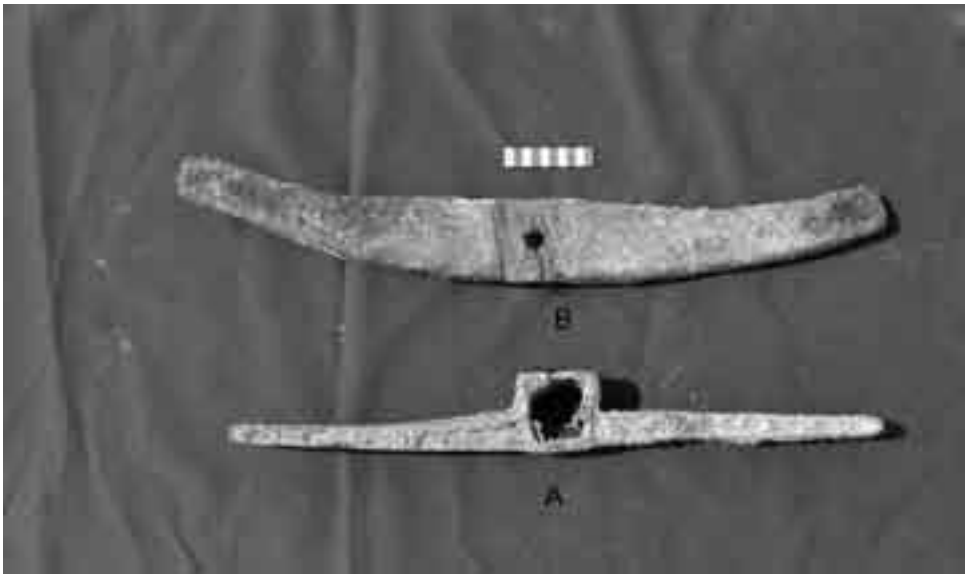

Fig. 6. Lead Stocks of OAA from Southern Israel: A- fixed stock from unknown source, B- Removable Stock from Yavneh- Yam.

FIG. 7. Removable Stock from Yavneh- Yam- detail.

depth 10 mm.) in the middle of the stock, held the vanished wooden shank. This OAA probably belonged to a wrecked ship, less probably it was lost to a sheltering ship. Somewhat similar, non symmetric stocks, were described by Kapitan (1971)

IRON OAA RECOVERED OFF ASHKELON (FIGS. 8, 9; TABLE 1 NO. 9)

Two OAAs were found north of Ashkelon (FIG. 2) at, about 1000 meters off shore at a depth of approximately three m. (Galili and Sharvit, 1998; Galili *et al.*, 2001), only one was recovered. The OAA were found adjacent to a Roman shipwreck's assemblage. This assemblage contained: two iron anchors (with two arms) concreted together, with their stocks beside them (in a stored non-functional position), a set of bronze balance weights, a trumpet, a bronze ladle, a bronze fire shovel, bronze nails, sounding lead and additional small items.

The OAA, that lost much material through corrosion, weighs about 3.3 kg. and consists of one arm and a shank, to which a detachable or moveable stock was fixed by a pin. The angle of the shank to the arm is 30°. The shank (rectangular cross section in the lower part, tapering to a square section in the thinner, upper part) and the arm (rectangular cross section all over) were forged together forming one piece. A round hole in the upper part of the shank retained the remnants of an iron ring, eleven cm in diameter. Below the ring, an elongated stock, having a rectangular section, was attached to the shank by a round rivet. The stock was placed asymmetrically with the

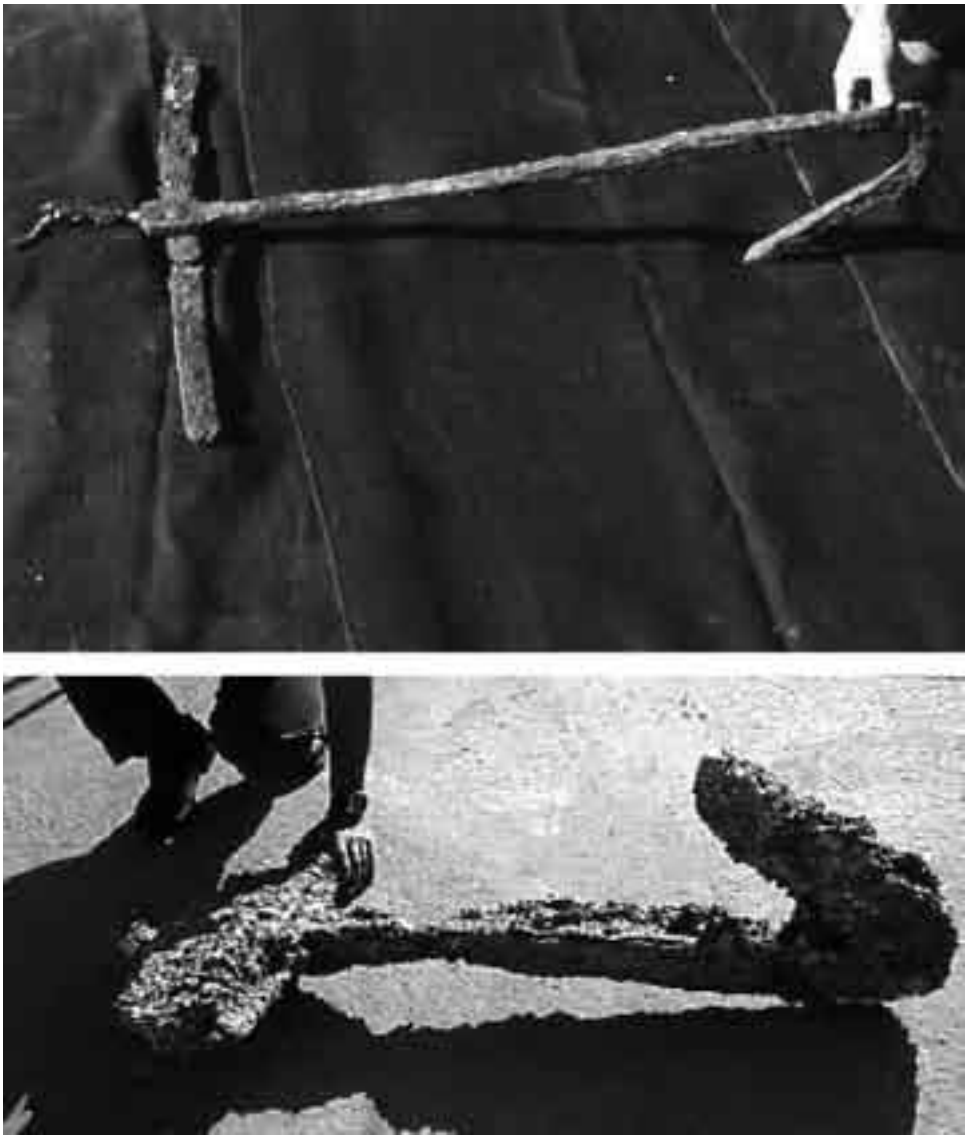

Fig. 8. One Armed Iron Anchor from Ashkelon, as recovered and after cleaning.

mass facing the arm. In the lower part of the shank there is a hole to which a salvage rope was once attached, perhaps by a vanished ring.

Iron OAA recovered off Apollonia (Fig. 10; Table 1 No. 8

This OAA was recovered about 1000 m. south of Apollonia at a water depth of about four m. (Fig. 2). The anchor was located about 150 m. south-south west of a cargo of Roman mill stones made of Basalt which may belong to the same ship

(Galili and Rosen, in press). The OAA was exposed as a result of sediment shifting

and sea-bottom erosion caused by the building of a local marina. Because severe corrosion, the OAA original weight was roughly estimated at 10-15 kg. The OAA (105 cm. long) consisted of a single arm and a shank forged in one piece, a stock and a ring. The shank had a rectangular cross section in the lower part, 35 × 20 mm. and was square in the central part 23 × 23 mm. About 15 cm. bellow the apex, in the place where the stock was joined, a 7 cm. long section of the shank was widened (cross section 4. 7 × 2.5 cm.). The stock (65 cm. long, 45 × 22 mm. in the center) had a rectangular cross section all along and tapered toward the ends. It was asymmetrically joined to the shank by a round pin (17 mm diameter) with the mass facing the arm. Pos-

FIG. 9. One Armed Iron Anchor from Ashkelon, Details.

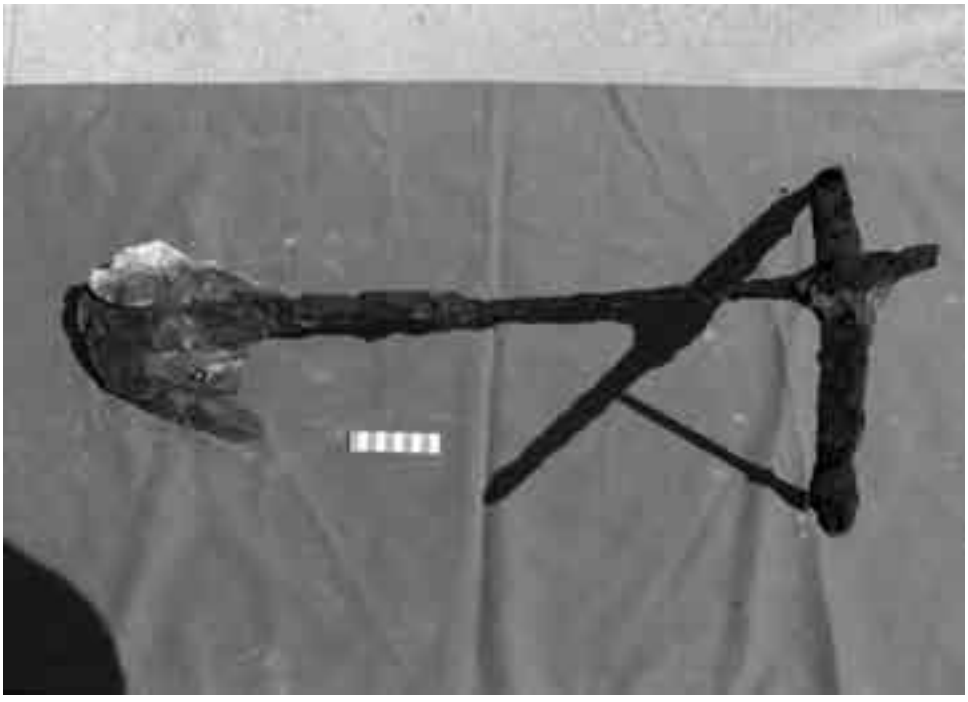

FIG. 10. One Armed Iron Anchor from Apollonia.

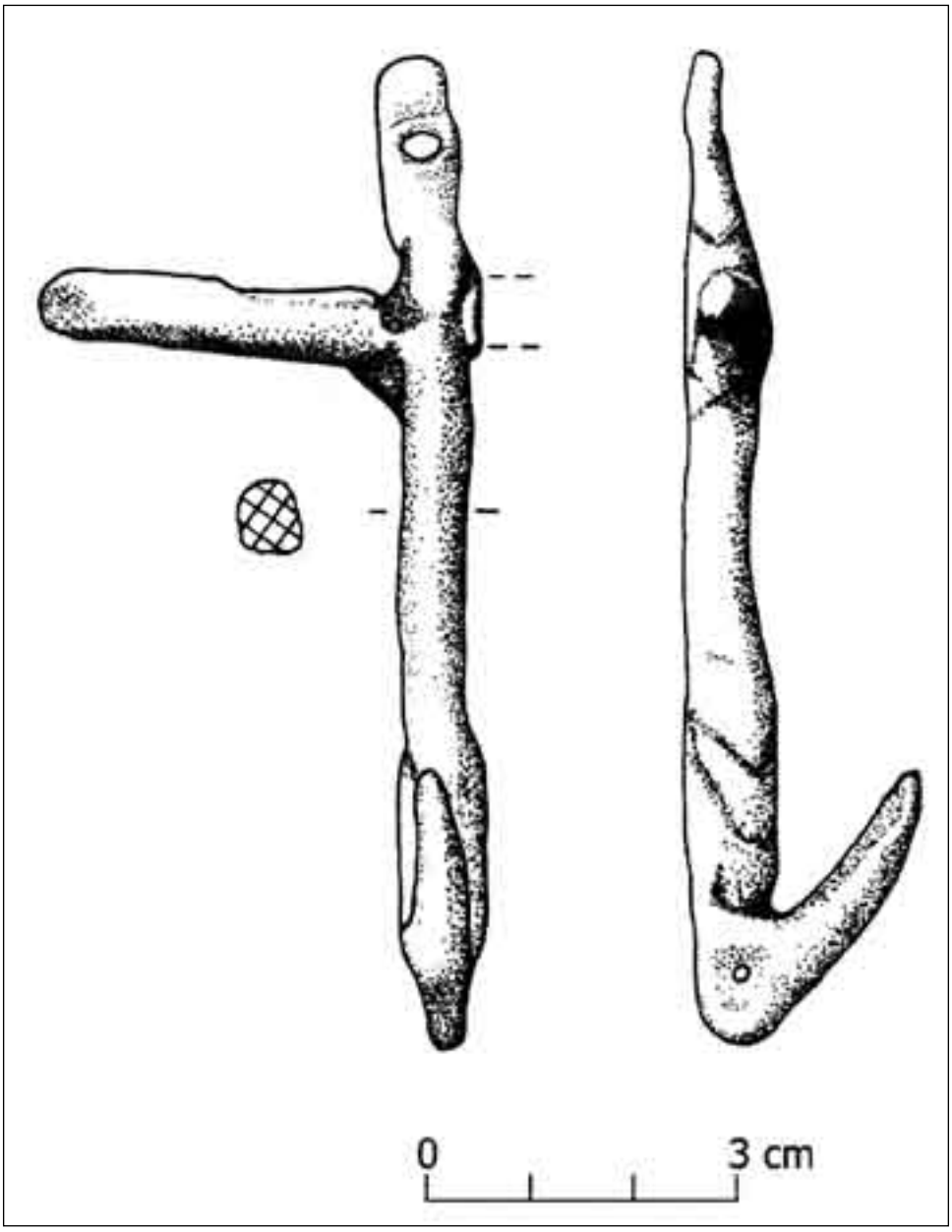

Fig. 11. Miniature Lead Models of OAA from Yavneh-Yam.

sibly the stock was detachable but the heavy corrosion makes such assumption tentative. The shank and the arm (rectangular cross section all over, 60 × 25 mm in the lower widest part) formed an angle of about 25°. In the upper part of the shank (25 mm. below the apex) there were remnants of a hole holding an iron ring, whose diameter was 130 mm. The ring was made of a round iron bar 12 mm. in diameter. The

hole, where the ring was inserted, was in parallel to the stock and in right angle to the plane of the single arm.

Miniature lead models of OAA from Yavne-Yam (Fig. 11)

Two miniature lead models of OAA (Table 1 no. 10, 11) were recovered from Yavneh-Yam anchorage (Galili and Sharvit, 2005). In both anchors the right side of the stock is missing and a vestigial base of the missing stock arm can be observed. It may have been intentionally (symbolically?) omitted or cut in antiquity.

Anchor no. 10 weighs 29 g. The arm to shank angle is about 33°. Twisting marks on the shank may indicate that to simplify its production the anchor was first cast in one plane in a shallow mold and then twisted to simulate a functioning anchor. Anchor no. 11 weighs 70 g. The arm to shank angle is about 40°. In the upper part of the shank, both anchors possess a small hole imitating the connection point of the anchoring hawser. A hole on the lower part probably represents the tying place of the salvaging rope. These soft lead artifacts can not function as hooks or weight bearing devices. Seemingly they served some symbolic or ritual purpose.

Discussion

One armed anchors were mentioned in Egyptian papyri thus their presence was known in the Roman and Byzantine periods prior to their discovery by underwater archaeologists. Casson (1971) suggested that the OAA mentioned in the papyri were carried by boats sailing the Nile and were used to moor water craft to the beach. According to Casson (1971), the anchors were manually places on the shore, and substituted for the mooring stake or stone.

The earliest OAAs discovered in Israel are the Dead Sea OAA (killick) which was dated to the Iron or Persian periods and the Ma`agan Michael OAA which was dated to about 400 B.C.E. (Rosloff, 1991; 2003). However it is likely that along the coasts of Israel, as elsewhere, primitive proto-types of OAA fabricated of tree branches or of combination of stones and tree branches (killick), were used earlier. Such devices are known from traditional and conservative contemporary cultures. Traditional natives of South East Asia use one armed anchors and killicks till modern times (Kapitan, 1971; Van Nouhuys, 1951; Ucelli, 1951). In the Philippines such anchors, produced by the local fisherman from Mangrove branches, are combined with a stone stock attached to the shank side facing the arm (Fig. 12).

A major aim of a designer-fabricator of anchors with arms, in contrast to weight, arm-less, anchoring and mooring devices, is to ensure that after the anchor is cast at least one arm will penetrates the sea-bottom and will keep hold. In admiralty-like, two armed anchors, a stock is inserted on the upper part of the shank perpendicular to the plane of the arms. The stock is positioned horizontally on the sea-bottom and causes one of the arms to penetrate the seabed and secure hold. Grapnel anchor needs no stock as one or two of the several arms are always pointing downwards toward the bottom. Designers of modern two armed anchors eliminated the need for a stock by adjusting the centers of mass and effort and using moving arms or flukes. Examples of such modern anchors are: Hawkins and Martin; Francois Martin, Hall "unhokeable anchor", Taylr`s anchor, Halls Improved Patent anchor and the Danforth anchor (Nelson-Curryer, 1999: 113-156).

FIG. 12. Traditional Killick –made of mangrove branch from the Philippines.

As predicted by Kapitan (1971), finds from Israel indicate that already during antiquity the stock of the OAA was fixed on the side of the shank facing the arm. This tended to tilt the OAA in such way that it reached the sea bottom with the arm pointing towards the bottom. The shifting of the center of mass is typical to all OAA including the most primitive Killicks (Van Nouhuys, 1951).

There are numerous modern single arm and single fluke anchors, which are designed sophistically so that there is no need for a stock. The findings from Israel demonstrate an early understanding of the working of the OAA, However, the technological achievements of modern designers were most probably beyond the capabilities of ancient anchor producers.

Iron OAA are used in modern times for heavy duty mooring systems (Nelson- Curryer, 1999: 134-149). These type includes Admiralty Mooring Anchor Type One (Tombstone), Admiralty AM 7 (FIG. 13), The Bruce Anchor and the Delta Anchor. Like the ancient OAA these do not have moving parts.

Gigantic OAA with fixed arms and flukes are traditionally used to anchor buoys used for permanent mooring. Recent "archaeological" recoveries of such OAA, used to anchor Sea-Planes, in the Dead Sea and in the Sea of Galilee, at the beginning of the 20th century, symbolize a continuation of a long tradition.

Disadvantages of multi armed anchors

Stone anchors (without arms) used during the Bronze Age were lying flat, horizontally, on the bottom. Nothing extended from these anchors into the seabed or above the anchor.

The composite stone anchors with protruding wooden arms can be seen as an evolution of the kellick. They improved the hold in the sea-bottom but introduced

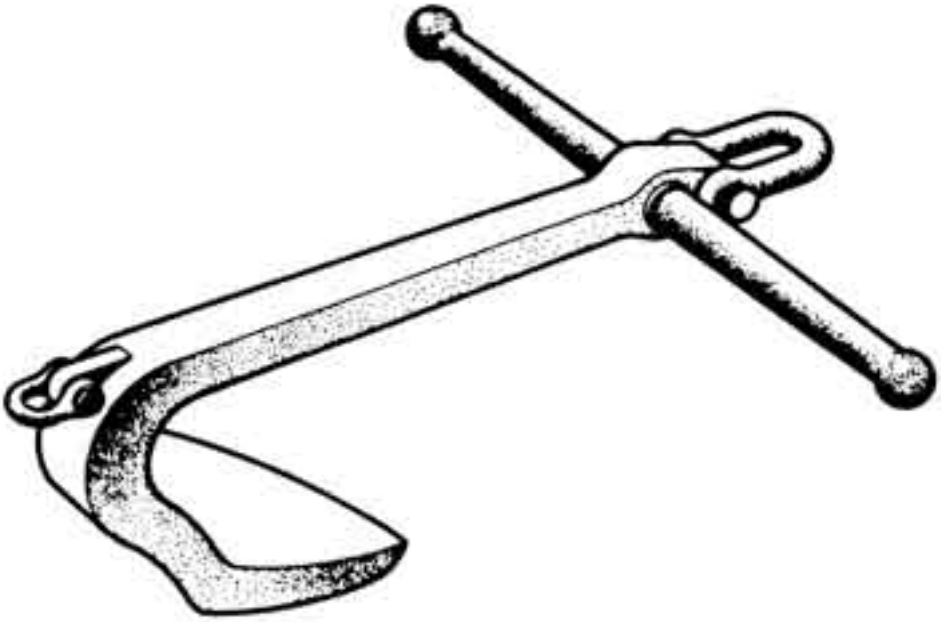

Fig. 13. Admirality A M 7 OAA used for Heavy duty mooring.

problems. The part digging into the seabed performed an essential task, while the other was a waste of construction material, deck space and carrying capacity. It's protruding sharp parts endangered the wooden hall of the ship carrying the anchor and/or adjacent ships. When anchoring, the unused arm, or arms, protruded above the seabed and created objectionable obstacles. Anchoring watercraft shifts and change position with wind and current. The anchor line could thus have looped around the protruding arm. This could have twisted the anchor, break it or disengage it and endanger the anchoring ship. The protruding arms could have also interfered with neighboring ship and fishing gear.

The Advantages of the OAA

The OAA is more economical than the multi-armed anchors as the one arm is always in use, no material and/or weight are thus wasted. The absence of protruding parts above the seabed prevents possible problems to the ship itself or to neighboring vessels. The OAA reduces the risk that the anchoring lines of a ship will entangle the anchor, lift it, or damage it. Relative to the multi-armed anchor, the OAA creates less on-deck storage problems and demands less deck space. Also, while hanging overboard it is less dangerous to the ship and to its neighbors.

The Disadvantages of the OAA

The advantages of the OAA explain why it was used continuously from early cultures to the present. However it was always rare relative to the multi-armed anchors, be-

cause there was always a chance that at the critical point of time, when the safety of the ship, the cargo and the crew depended on the anchor catching ground, the OAA will reach bottom with the only arm pointing up. Such an event, even if rare, could have caused the loss of the ship and everything in it.

Symbolic Miniature OAA

Anchors were traditionally associated with hope and safety of ships and thus became symbols. Consequently anchors and artistic depictions of them were used to symbolize safety and hope since antiquity. Already during the Bronze Age stone anchors were incorporated into temples and holy sanctuaries (Frost, 1969). Around the Sea of Galilee, huge, anchor-like megaliths were erected as symbolic structures (Wachsmann, 1985). As if to strengthen their positive power, anchors themselves were often decorated by symbolic figures. Among the decorative elements were symbols, letters and words, sea shells, astragalli, and dolphins (Galili, et al 1994; Raban and Galili, 1985; Magon, 1894; Zemer, 1981). The two miniature models of OAA recovered from Yavneh-Yam (reported above) were probably intended to assure a ship or a crew member or a passengers safety, or to ascertain a successful sailing and fast anchoring. The two artifacts probably imitated a functional OAA carried by a Roman sea-craft. Miniature lead models, imitating two armed Byzantine anchors, were recovered recently off the north coast of Ashkelon (Galili *et al.*, 2001). These finds indicate that the tradition of good luck charms in the form of miniature anchors was well known to ancient seamen of the East Mediterranean. This tradition was probably transferred from one generation to the next and prevailed for a long time.

Conclusions

The most significant marker of the OAA is the stock or the way in which it is joined to the stem. Stocks of OAA are placed on the side of the shank facing the one arm. Consequently the stone, lead, or iron stocks of OAA can be identified because the shank is placed none symmetrically in respect to the middle of the stock.

The stock often survives, and since it is always fixed asymmetrically on the shanks side facing the arm, it is usually non- symmetric and easy to identify.

Identifying wooden stocks of OAA by the lead cores alone is not possible because the lead cores are usually symmetric and can not indicate the existence of none-symmetric wooden stock. This can be observed in the Ma`agan Michael OAA. It has a non symmetric wooden stock that is filed with lead cores which are symmetric.

Additionally Roman composite OAA made of wood may be identified by the two holed non-symmetric lead assembly pieces (Kapitan, 1971).

Thus stocks, and some times the assembly pieces, may be very useful in identifying ancient OAA made of perishable materials. Using these markers, the ancient OAA can be identifies even if only few parts remained. The variety of OAA or remnants recovered from the coasts off Israel alone indicates that this anchor type was more frequently used in the Mediterranean than previously thought.

Archaeologically the OAA is relatively rare type of anchor, perhaps because its use is somewhat complicated and risky. However, despite these disadvantages, the OAA was used continuously starting in antiquity up to our own times. The use of innovative technologies and modern materials created sophisticated OAA with moving

parts. These OAAs are the most common anchors in modern yachts. These modern OAAs reduce the inherent risks and incorporate the unique advantages of the OAA that ancient anchor designers tried to apply with the materials and the technologies of their own times.

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Abstract

Hundreds of stone, wood and metal anchors, from numerous periods were recovered along the Israeli coast. Among them are one armed anchors, (OAA) including wooden anchors with stone or lead parts, iron anchors and miniature symbolic models of one armed anchors. OAA are relatively rare and little studied. This study summarizes the finds of OAA recovered off the Israeli coasts and discusses the advantages and problems of the practical use of these anchors compared to other anchors.