

Article

The Unseen Record: Ninth–Seventh Millennium Cal. BP Wooden and Basketry Objects from Submerged Settlements off the Carmel Coast, Israel

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Abstract: Wood and basketry artefacts rarely survive in the prehistoric record since they require exceptional conditions for preservation; as a result, the current knowledge about when and how prehistoric societies used these basic organic raw materials is limited. Focusing on the southern Levant, we discuss for the first time a collection of 16 late prehistoric organic artefacts found in underwater research conducted in the last forty years off the coast of the Carmel Ridge (Israel). The waterlogged finds, including bowls, shafts, a wedge, a trough, a pitchfork, logs, a mat, and a basket, were found at sites spanning from the Pre-Pottery Neolithic to Middle Chalcolithic periods (ninth–seventh millennia cal. BP), constituting an unprecedented record of prehistoric wood and other perishable materials, providing us with new information about raw material preferences and manufacturing technologies.

Keywords: wooden objects; organic materials; waterlogged wood; Neolithic; Chalcolithic; underwater archaeology



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1. Introduction

Wood and other organic materials were an essential part of the daily life of almost all human societies. Yet, in many cases, these materials are not preserved in the archaeological record due to their tendency to rapidly decay in most environments, resulting in their omission from scholarly discourse [1]. So far, the earliest known wooden artefacts in the world were reported from the southern Levant at the 780 ka Acheulean waterlogged site Geshar Benot Ya'aqov [2,3]. A recent discovery of the earliest structural use of wood originated from a slightly less than 500 ka waterlogged site in Zambia [4]. Other Paleolithic wooden artefacts were found in China [5] and Europe (e.g., [6–11]). These perishable artefacts speak for a rich and versatile array of functions as well as technical cognition. As such, they can be used to study a variety of themes: raw material preferences, wood carving technologies, ecological and environmental circumstances, provenance, and skeuomorphs (e.g., [12,13]).

In the southern Levant and Israel in particular, wooden artefacts are infrequent in late prehistoric (Epipaleolithic to Chalcolithic periods) sites, and therefore the archaeological record is predetermined against the preservation of organic materials. Some perishable waterlogged artefacts were recovered from the 23 ka cal. BP Ohalo 2 submerged site in the Sea of Galilee [14], and several other finds were discovered at the Chalcolithic Judean Desert caves in a desiccated form (e.g., [15–19]). The scarcity of wooden artefacts inevitably produced a skewed prehistoric record, biased towards lithic, pottery, and, to some extent, ground stone tool assemblages (e.g., [20]).

Nonetheless, some depositional environments provide conditions favourable to the survival of organic materials (e.g., anaerobic and dry), leading to better preservation of otherwise perishable artefacts [1]. The seabed is such an environment, and submerged archaeological sites near the Israel Mediterranean Coast often offer good conditions for preserving wooden artefacts and other organic materials (e.g., [21]). Over the past decades, a series of submerged late prehistoric settlements flooded as part of the Holocene sea-level rise were discovered along a 15 km strip of the northern Carmel Coast (Figure 1) [22–30]. The earliest of these sites is dated to the Pre-Pottery Neolithic C (ca. 9300–8500 cal. BP), but most are assigned to the Early to Middle Chalcolithic (ca. 8000–6600 cal. BP). Following their inundation, the sites were covered by a 1–2 m thick layer of sand that prevented disturbance and intrusions and produced anaerobic conditions. In recent decades, the combination of human activities—mainly sand quarrying and construction of marine structures—and seasonal sea storms have removed this sand layer and exposed these submerged settlements.

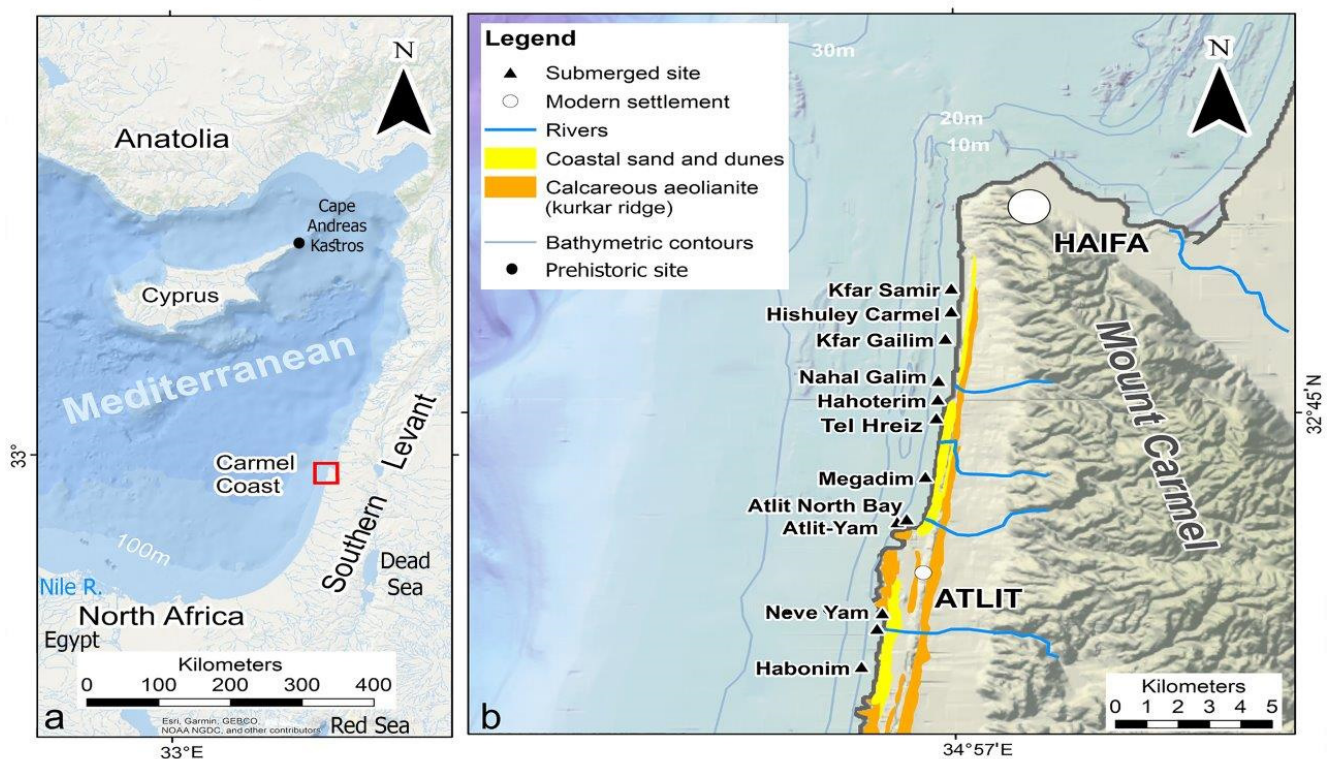


Figure 1. A map of the study area and the sites mentioned in the text; (a) general regional map with the study area marked by a red square, and (b) the Carmel Coast and the submerged settlements (modified after [30]).

The aims of the current study are to explore the characteristics of 16 wooden, matting, and basketry artefacts and other plant materials recovered from the submerged sites along the Carmel Coast. Next, we discuss their significance for understanding how organic artefacts were used, their manufacturing procedure, and their contribution to the reconstruction of the early Holocene environment of the Carmel Coast.

2. Methods

2.1. Field

The Neolithic sites off the Carmel coast, where the wooden and basketry artefacts were recovered, are submerged in the surf zone at 1–12 m depth. The sites are embedded in clay paleosol and are usually covered by a protective layer of sand, up to 2 m thick. Storms often remove the sand and expose the prehistoric remains. Soon after exposure, site features and artefacts can be damaged by rapid erosion.

Underwater surveys aimed at locating, rescuing, and documenting the archaeological remains were carried out following storms. The surveyors were using standard scuba diving equipment and often, in shallow water, free diving (snorkelling). The exposed features and artefacts were mapped, documented, and photographed using underwater cameras and measuring devices used in underwater archaeology. Finds at risk of erosion (e.g., wooden artefacts) were retrieved.

Underwater excavations were carried out in structures and installations that were at risk of destruction due to the action of waves and currents. During excavation, a dredging system operated by a water pump was used. The pump was mounted on a boat, pumping water to the dredger on the sea floor. On one side of the dredger, material was suctioned up from the site, and on the other end, the suctioned material was ejected into a collection box. Sand and loose material that covered the excavation area were sucked up through the hose, until the clay paleosol layer containing the archaeological remains was reached. The archaeological material was excavated in 0.5×0.5 m squares, in spits 5–10 cm thick. The material excavated manually or by the dredger was removed whenever excavation of a sub-square or a layer of 10 cm was completed. The excavated material from each sub-square was placed in a marked plastic bag. The bags were transferred to a laboratory on land. Organic materials were placed in plastic containers with sea water.

The waterlogged wooden objects are currently stored in the IAA (Israel Antiquities Authority) treasury facilities, kept in sea water or freshwater, at a temperature of 4° Celsius. The wooden bowl from Kfar Samir South (KS4) was soaked with polyethylene glycol solution to replace the sea water and was dried. It is currently displayed in the Israel Museum in Jerusalem under controlled temperature and humidity conditions.

2.2. Wood Identification and ^{14}C Dating

Analysis of wood was performed on the basis of the tissue structure examined beneath a Zeiss SteREO Discovery V20 epi-illuminated microscope and a Scanning Electron Microscope (SEM; Tescan Vega 3, TESCAN, Brno, Czech Republic). Samples were cut using razor blades and examined along three axes (transverse, radial, and tangential), and the arrangement, size, and abundance, along with a number of other characteristics of certain diagnostic features of a wood sample's anatomy, were noted. In order to make a determination to the most detailed systematic level, the samples were compared with a wood reference collection of the southern Levant (provided by the Steinhardt Museum of Natural History, Tel Aviv University), as well as wood anatomy atlases [31–36] and the "InsideWood" database [37].

Because of the possibility of the samples being analysed for ^{14}C dating, the samples were carefully handled with plastic gloves and set on aluminium foil to prevent carbon cross-contamination. The waterlogged samples were returned to the source waters to maintain consistent pH and chemical balances and to avoid hastened deterioration or the introduction of fungal spores. The samples that were chosen for ^{14}C dating were sent to the Beta Analytic Laboratory (Miami, FL, USA), following the laboratory instructions for the preparation and delivery of waterlogged archaeological materials. The dates were generated by Accelerator Mass Spectrometry (AMS). The radiocarbon ages were reported in conventional radiocarbon years (before present = 1950), calibrated to calendar years (cal. BP; with the OxCal 4.4 program IntCal 20) [38,39].

3. Results: The Sites and Their Wooden and Other Organic Artefacts

So far, five submerged sites off the Carmel Coast yielded 16 wood or braided twig objects (Table 1, Figures 1–16). Below, we offer a concise description of the sites and their associated artefacts.

Table 1. The artefacts included in the study. *Italicised* dates were obtained from the artefact directly.

#	Object	Site	Artefacts	Laboratory and Sample Reference No.	Taxa	References	Date Cal. BP*	Figure
1	AY1	Atlit-Yam, Well S. 11	Bowl	RT 1431, RT 2477, RT 2478	<i>Quercus</i> spp. (oak)	[27] (pp. 127–128), [29,40]	Dated according to the well's fill: ~8374–7933 to 8336–8540 (2σ range, 95.4%)	Not available
2	AY2	Atlit-Yam, Well S. 11	Bowl	RT 1431, RT 2477, RT 2478	<i>Quercus</i> spp. (oak)	[27] (pp. 127–128; Figure 130: 1), [29,40]	Dated according to the well's fill: ~8374–7933 to 8336–8540 (2σ range, 95.4%)	Figure 3a
3	AY3	Atlit-Yam, Well S. 11	Shaft	RT 1431, RT 2477, RT 2478	<i>Quercus</i> spp. (oak)	[27] (pp. 127–128; Figure 130: 2), [29,40]	Dated according to the well's fill: ~8374–7933 to 8336–8540 (2σ range, 95.4%)	Figure 3b
4	AY4	Atlit-Yam, Well S. 11	Shaft	RT 1431, RT 2477, RT 2478	<i>Quercus</i> spp. (oak)	[27] (pp. 127–128), [29,40]	Dated according to the well's fill: ~8374–7933 to 8336–8540 (2σ range, 95.4%)	Not available
5	AY5	Atlit-Yam, Well S. 11	Wedge	RT 1431, RT 2477, RT 2478	<i>Quercus</i> spp. (oak)	[27] (pp. 127–128; Figure 130: 3), [29,40]	Dated according to the well's fill: ~8374–7933 to 8336–8540 (2σ range, 95.4%)	Figure 3c
6	AY6	Atlit-Yam, Pit S.32/A	Shaft	RT 2681	<i>Styrax officinalis</i> (storax)	[This study]	Dated by charcoal extracted from Pit S.32: 7563–7427 (2σ range, 95.4%)	Figure 4
7	KS1	Kfar Samir, central sector	Bowl		Undetermined	[21,41]	Dated by the general range of dates from the site: 7964–7431 to 6531–6299 (2σ range, 95.4%)	Figure 6
8	KS2	Kfar Samir, central sector	Basket	BETA 3821, RT 1929A	Undetermined	[21,41]	Dated by the general range of dates from the site: 7964–7431 to 6531–6299 (2σ range, 95.4%)	Figure 7
9	KS3	Kfar Samir, central sector	Mat	RT 855	Undetermined	[41,42]	7568–7027 (2σ range, 95.4%)	Figure 8
10	KS4	Kfar Samir, southern sector	Bowl	RT 1360	<i>Ceratonia siliqua</i> (carob)	[42,43] (p. 152), [44] (p. 147)	8275–7872 (2σ range, 95.4%)	Figure 9
11	KS5	Kfar Samir, southern sector	Trough	RT 2499	<i>Pistacia palaestina</i> (terebinth)	This study, [45]	Dated wooden sample taken from the artefact to 6750–6490 (2σ range 95.4%)	Figure 10
12	KS6	Kfar Samir, southern sector	Pitchfork	RT 2498	<i>Quercus calliprinos</i> (kermes oak)	[45]	6680–6400 (2σ range 95.4%)	Figures 10 and 11
13	HC1	Hishuley Carmel	Bowl	Beta—657406	<i>Quercus calliprinos</i> (kermes oak)	[30]	6797–6665 (2σ range 92.3%)	Figure 12
14	KG1	Kfar Galim	Worked log	Beta—657407	<i>Tamarix</i> spp. (tamarisk)	[This study]	Dated wooden sample taken from the artefact to 7002–6845 (2σ range 88.8%)	Figures 13 and 14
15	TH1	Tel Hreiz	Bowl	Beta—657405	<i>Quercus ithaburensis</i> (Mt. Tabor oak)	[46]	7159–6937 (2σ range 94.4%)	Figure 15
16	TH2	Tel Hreiz	Braided circle	RT 799A, RT 799	Unidentifiable	[46]	Dated by the general range of dates from the site: 8379–7952 to 7440–6791 (2σ range, 95.4%)	Figure 16

3.1. Atlit-Yam

Atlit-Yam is a ca. 4 ha Pre-Pottery Neolithic C site located in the north bay of Atlit, ca. 10 km south of Haifa (Figures 1 and 2). The site is located 200–400 m offshore, 8–12 m below sea level [27], and is dated to ca. 9100–8500 cal. BP. Architectural remains include stone foundations of rectangular dwellings, hearths, megalithic structures, circular stone-lined water wells and pits, straight walls up to 60 m long, concentrations of burnt mudbricks, and stone-paved surfaces [27,47–51].

Well S.11 (Figure 2) was fully excavated. It is a stone-lined cylindrical shaft, 5.7 m deep and ca. 1.5 m in diameter. Its fill contained numerous faunal remains, flint and other stone artefacts, and considerable amounts of waterlogged and charred plant remains. Significant for our concerns, it also produced five wood artefacts: two bowl fragments, two shafts, and a wedge (AY1–AY5; Table 1) (see [27] (p. 127–128; Figure 130), [52]). All five were found

at the lower parts of the well, and preliminary analysis indicates that they were made of oak [53]. A sixth specimen is a storax shaft (AY6) recovered from a 1 m deep and 0.95 m wide round pit (S.32/A; Figure 2) (see [27] (pp. 55–63, 367–368)). The pit was lined with fieldstones and contained large quantities of botanical remains, mainly herbaceous species and tree branches.

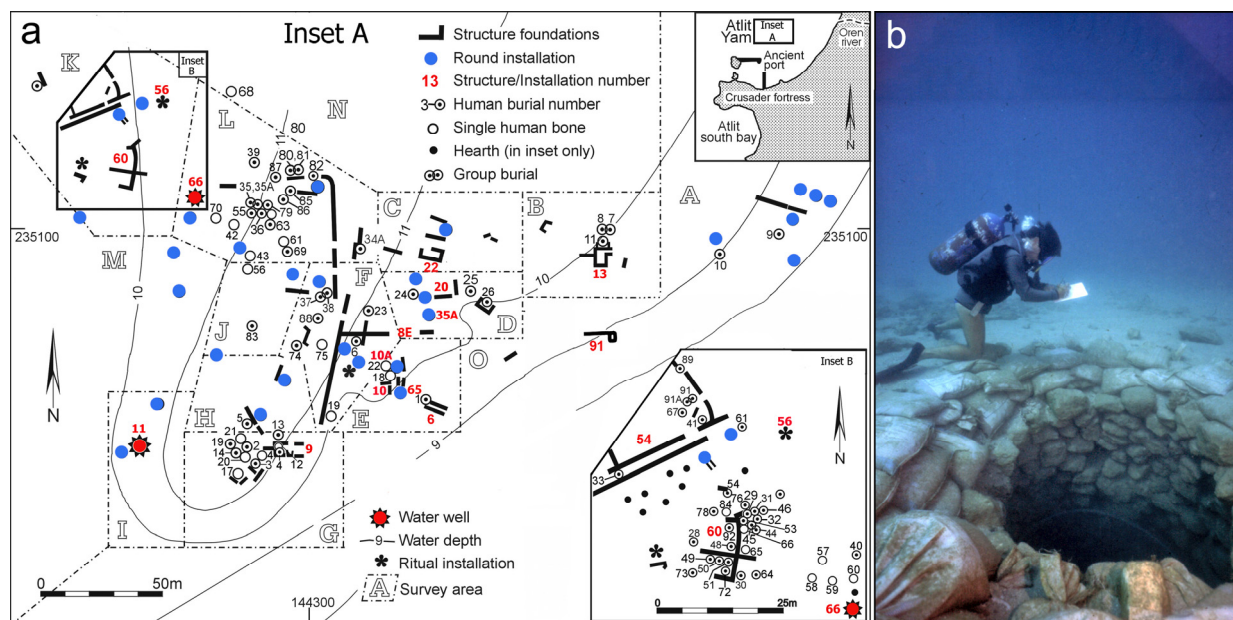


Figure 2. (a) A plan of Atlit-Yam and the location of Well S.11 and Pit S.32/A; (b) Well S.11 (E. Galili and I. Grinberg).

AY 1 (a wooden bowl fragment) is a broken, partly charred oak bowl fragment recovered from Well S.11. It comprises a small section of the bowl's flat base. About 30% of the fragment's surface is covered with parallel striations, probably the result of surface smoothing or polishing. Additionally, a few sets of parallel scratches are observed on the outer surface.

AY 2 (a wooden bowl fragment) is a broken oak bowl found in Well S.11. The item consists of the bowl's upper part, including the rim, which is estimated to have been 12 cm in diameter (Figure 3a). The rim's inner face is curved, while the outer is straight. Parallel lines cover its surface, probably polish marks. The item was analysed as for AY 1 above.

AY 3 and 4 (wooden shaft fragments) are oak shaft fragments recovered from Well S.11 (Figure 3b). They have round sections and are broken on both ends. AY3 is 7.0 cm long and 1.5 cm across, while AY4 is 6.5 cm long and 2.5 cm across. Both are thoroughly polished and feature longitudinal planning marks 3–4 cm long and 0.4–0.8 cm wide, suggesting that the bark was removed with a sharp flint blade. The two specimens may be parts of a single object.

AY 5 (a wooden wedge) is an oak wedge recovered from Well S.11. It is broken at the middle and measures 8 cm long, 2 cm wide, and 1.5 cm thick (Figure 3c,d). It has a triangular cross-section and features no shaping or modification marks on its surface, probably due to its poor state of preservation. While this item is undoubtedly modified, it is unclear whether it is a by-product of wood processing or an intentionally produced wedge (e.g., for splitting purposes).

AY 6 (a wooden shaft) consists of eight 1 cm thick storax shaft fragments (Figure 4) found in Pit S. 32/A, 50–60 cm below the site surface. Their similarity in dimension, material, and context of recovery suggests that they derived from a single ca. 50 cm long shaft. Notably, besides the shaft, the installation produced only vegetal materials, indicating that it may have served as a storage place for herbal substances (e.g., fodder for domestic animals, straw left over after threshing, or hay brought to the site). Perhaps the shaft was part of the pit's cover or a broken object (an arrow or other type of shaft) that was thrown or fell into the pit.

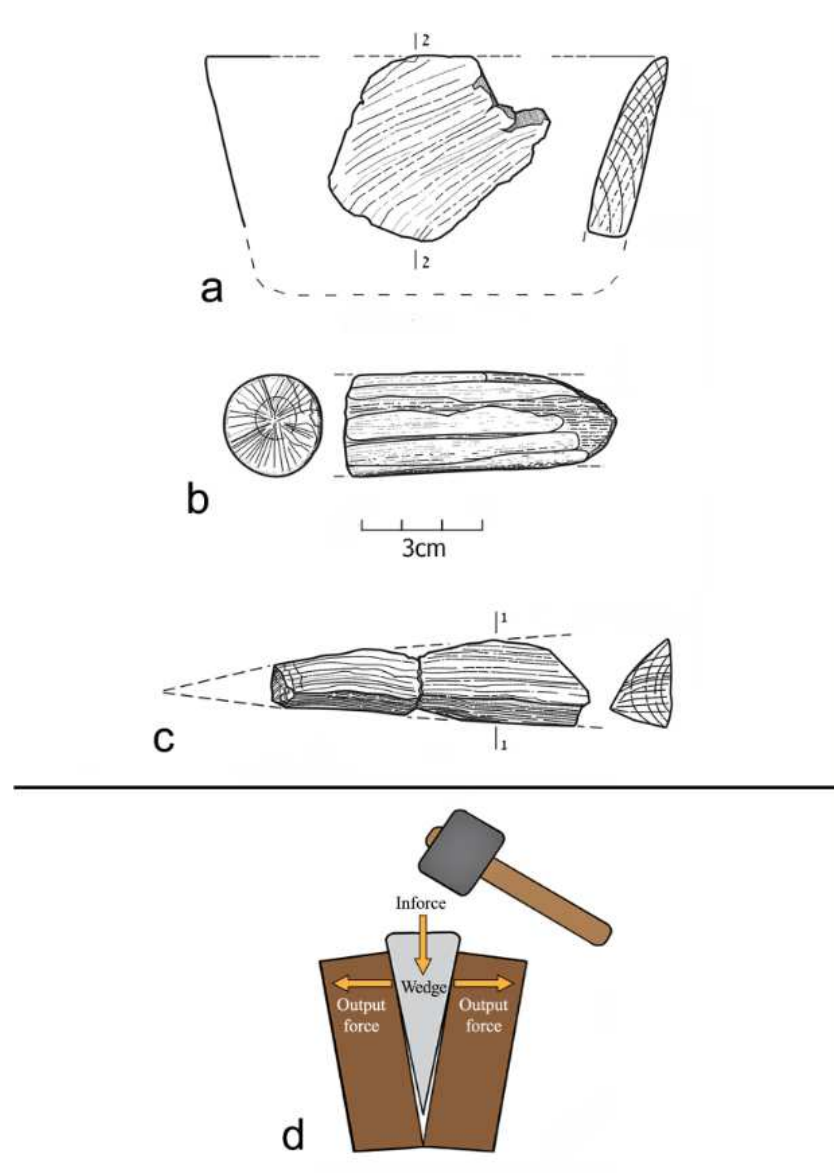


Figure 3. Wooden artefacts recovered from Well S.11: (a) bowl fragment AY 2, (b) shaft fragment AY 3, and (c) wooden wedge AY 5, and (d) a schematic depiction of the use of a wedge to split a wooden log (E. Galili and IAA).



Figure 4. Fragmented wooden shaft AY 6 from Pit S.32/A (E. Galili).

3.2. Kfar Samir

Kfar Samir (Figure 1) is an elongated concentration of artificial features scattered over 2.5 km along the shallow breakers zone (ca. 200 m wide) of the southern municipal beaches of Haifa. Given its length, the site was randomly divided into three sectors: north, centre, and south [21] (Figure 1). Three water wells were found in the central sector, 5.5 m below sea level and some 200 m offshore. Their walls were constructed of alternating

courses of wooden beams and undressed stones, mostly limestone pebbles (Figure 5). These wells are among the earliest known wooden structures in the world [21]. The site's central and southern sectors also produced pits in the clayish ground, containing sizeable concentrations of olive stones. Many of them were crushed and interpreted as representing various stages of olive oil extraction [21,30,41,51,54,55]. Large stone basins and weaved strainers (see below) were also recovered and are thought to have been part of the olive processing industry at the site. The wooden artefacts presented below derive from a ca. 50 × 50 m area in Kfar Samir's central sector (KS 1, 2, and 3) and a much smaller 3 × 3 m area in the site's southern sector (KS 4, 5, and 6).

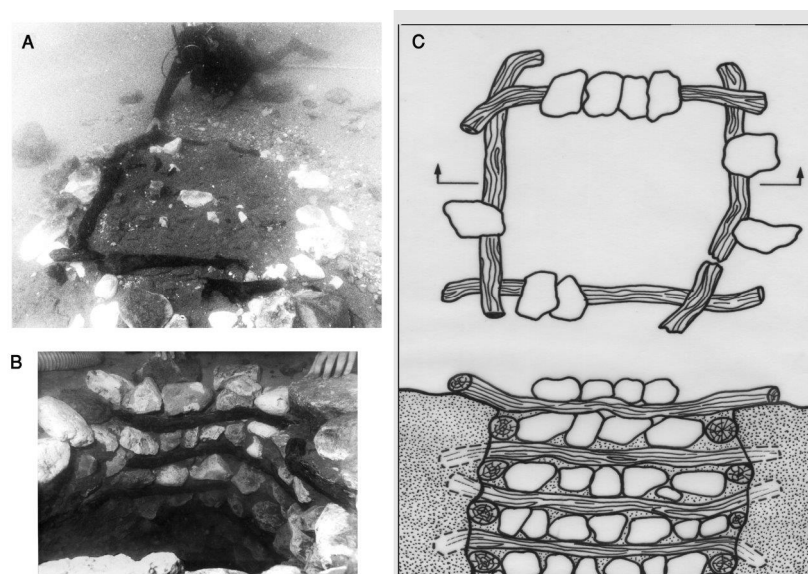


Figure 5. A well in Kfar Samir lined with alternating courses of wooden branches and stones: (A) the well before the excavation, (B) The well during excavation, and (C), a schematic drawing of the well (E. Galili).

KS 1 (a wooden bowl with a pierced, elongated, vertical handle) (Figure 6a,b) was found in Kfar Samir's central sector, some 15 m from the coast, at a water depth of 0.5 m below sea level (32°47'36.19" N, 34°57'19.42" E). It was embedded in a pavement of small, undressed stones (Figure 6c). The bowl has slightly concave walls, and its inner space widens toward the rim. The base is thick and slightly convex. The recovered specimen is 22 cm high and 20 cm wide and constitutes ca. 30% of the original vessel. Originally, the bowl is likely to have been 22.5 cm high and 26 cm across the rim. A vertical, elongated, and pierced handle on the outer wall may suggest that there once was another across from it. This handle is 12.5 cm long, 2 cm wide, and perforated with a 0.5 cm hole. No production traces were noted on the bowl (see [41]). Based on the general chronological framework of the site, the date of the item is suggested to be between the early eighth to the late seventh millennia cal. BP [21,41].

KS 2 (basket braided fragments) comprises three fragments of a braided basket made of twigs of an unidentified plant (Figure 7). They were recovered in Kfar Samir's central sector, 2.5 m below sea level and ca. 80 m from the coastline (65 m west of wooden bowl KS 1). The fragments were deposited in a pit (0.90 m in diameter, 0.55 m deep) dug into the clayish paleosol and filled with soft grey clay. Besides the braided basket, the pit also contained dozens of olive pits and fragmented tree branches. KS2 is indirectly dated by the range of dates from the site as KS 1.

One of the fragments is round and probably derives from the basket's base, while the other two probably originate from its walls. The vessel was braided by the alternate pair-twining method. The warps emerge from the centre of the base and extend outwards perpendicularly to its rim. The wefts are alternately twined around two warps and cross

over after each pass (Figure 7b,c). Usually, the wefts are twined around warps made of a single twig. However, in a few places, the warps consist of three twigs or a pair of twigs next to each other. The complete basket was likely over 30.0 cm in diameter and may have been used as an *aqal*, a woven container for holding and pressing olives during oil production [55].

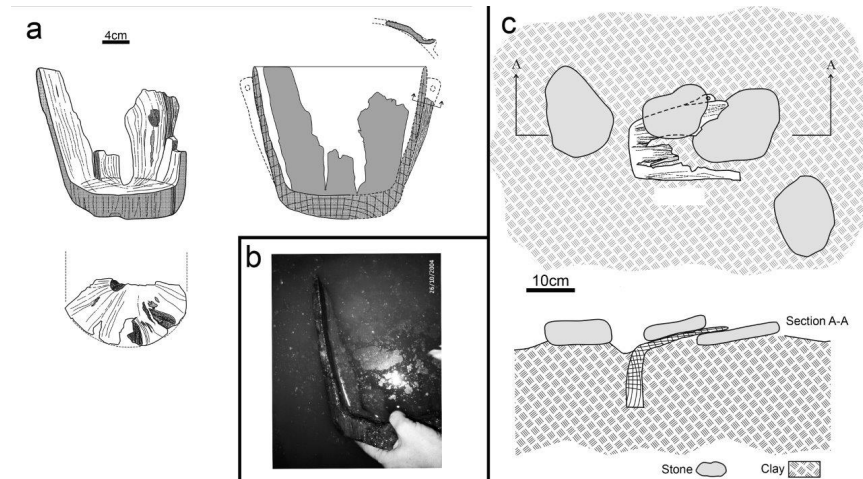


Figure 6. Wooden bowl KS 1 with a pierced handle from Kfar Samir's central sector: (a,b) the bowl and (c) a schematic illustration of the bowl's context of recovery (IAA).

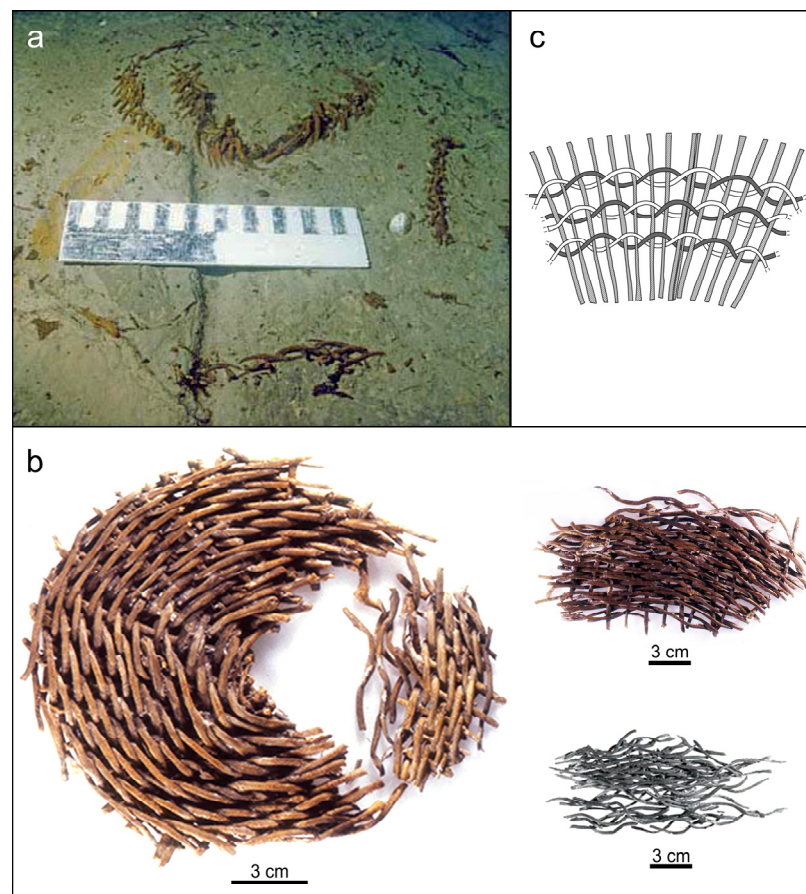


Figure 7. Fragments of basket KS 2 from Kfar Samir's central sector: (a) the basket in context, (b) the basket after cleaning, and (c) a schematic drawing of the basket's braiding technique (E. Galili and IAA).

KS 3 (a mat/basketry fragment) is a fragment of a mat or basket (Figure 8a,b) made of straw of an unidentified plant. It was found in a pit in Kfar Samir's central sector [29,32,33], 1.5 m below sea level and some 35.0 m from the coastline (32°47'33.79" N, 34°57'19.19" E). The pit was 0.6 m in diameter and 0.5 m deep; it was dug into the site's clay paleosol and filled with soft grey clay.

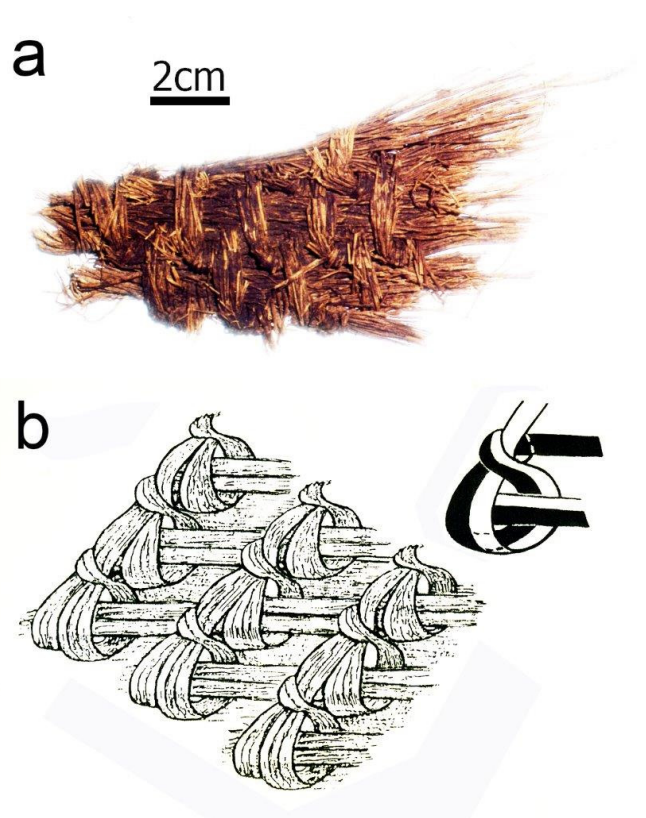


Figure 8. Mat fragment KS 3 from Kfar Samir's central sector: (a) the mat and (b) a schematic illustration of the mat's braiding technique (IAA).

The specimen measures 12.0 × 22.0 cm. The stitches are ca. 2.5 cm long and 0.6 cm wide, and the intervals between them are 0.8–1.2 cm. The fragment consists of four longitudinal bundle foundations (Figure 8b). The stitches are wrapped in a flask knot around its standing portion [56] (Figure 64) and then incorporated into the foundation (Figure 8b). The foundation bundles and the stitches are made of the same raw material (straw of an indeterminate species). While this method may be described as “coiled basketry with an intricate stitch” [56] (Figure 62), the knobs of the Kfar Samir specimen do not separate the bundles as usually the case with this category of production. Instead, it may be classified as Type 4 of the coiled basketry subclass as defined by Crowfoot [57] (p. 416, Figure 258D).

KS 4 is a wooden bowl (Figure 9a–d) recovered in Kfar Samir's southern sector, 2 m below sea level and some 50 m from the coast (32°47'4.6" N, 34°57'10.6" E) (see [33]). It was found in a shallow pit containing grey clay with other waterlogged finds, including tree branches, olive pits, and straw.

The bowl is made of a carob tree trunk or bough cut perpendicular to the fibre's direction [42]. Carob is relatively uncommon in the south Levantine Mediterranean maquis/forest. Nevertheless, carob remains were also identified at Atlit-Yam [53], and carob pollen grains were reported from sediments retrieved from other submerged settlements nearby [21]. The bowl is 12.5 cm high, and its maximum diameter at the top of the rim is 22.5 cm; it has a flat 12 cm wide base and straight diverging walls.

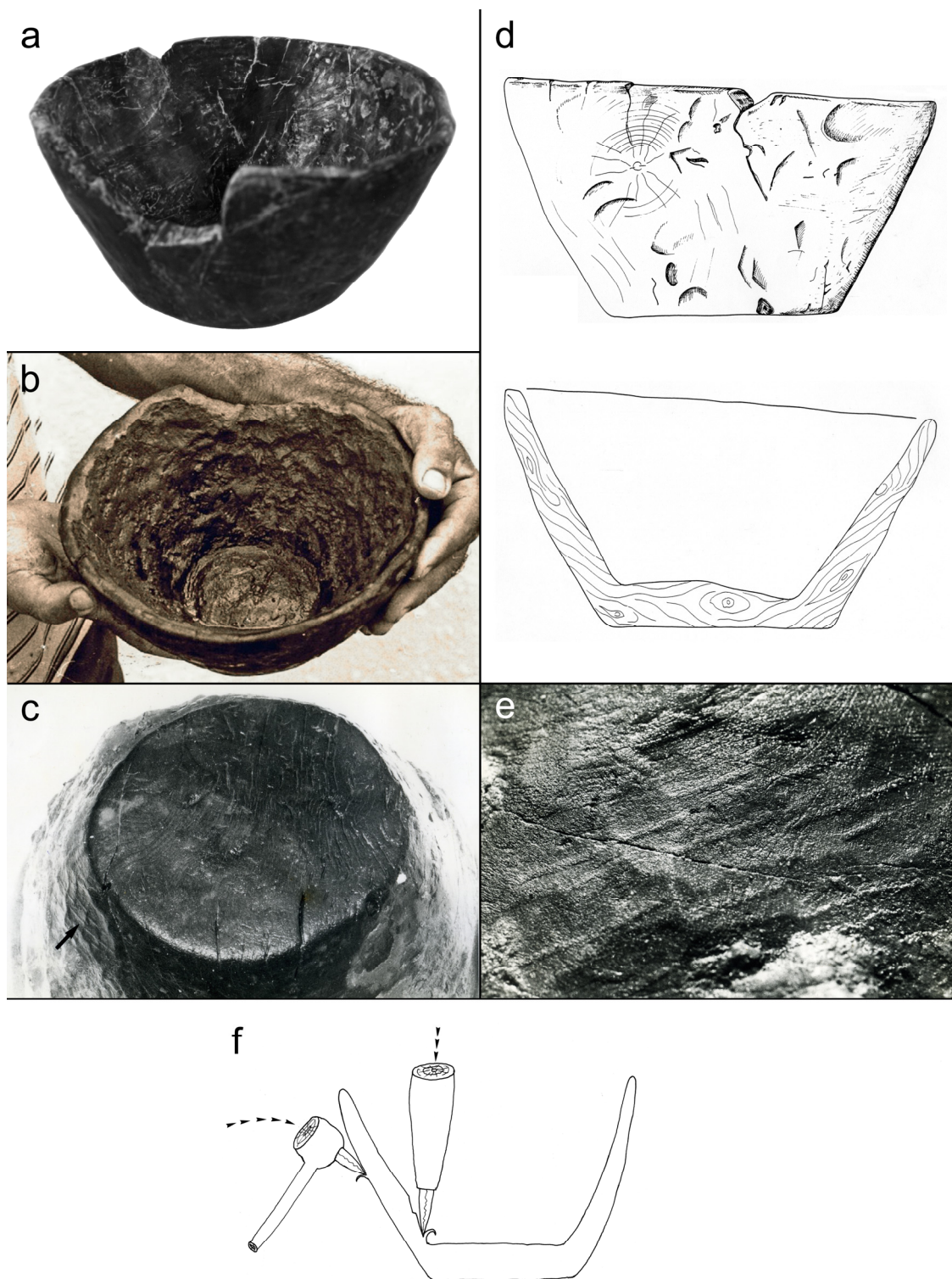


Figure 9. Wooden bowl KS 4 from Kfar Samir's southern sector: (a,b) the bowl, (c) the outer face of the base with production marks on the wall (marked in arrow), (d) a drawing of the bowl, (e) tool mark scars on the bowl's exterior, and (f) a proposed reconstruction of the bowl's shaping (E. Galili and IAA).

The bowl's surfaces feature production traces in the form of carving-tool scars (Figure 9b–d). The scars on the outer surface are shallow, produced by a sharp flint tool with a curved working edge, probably an adze. It was operated in arc-like motions to achieve a smooth face. Thin ridges inside the scars (Figure 9e) indicate that the tool's working end had a small fracture. The scars on the inner walls suggest that a different tool

was used for this part of the bowl, producing rough marks and steps. As the space was too narrow to operate an adze whose blade is perpendicular to the haft, a chisel could have been used linearly to hollow out the vessel (Figure 9f). The use of different tools resulted in the inner and outer faces' distinct finishing qualities. Unlike the walls, the base and the rim are thoroughly smoothed and bear no marks of production. They may have been polished with fine sand to achieve a perfect finish.

KS 5 (a wooden trough) is a concentration of three flat terebinth pieces found in a shallow pit filled with soft grey clay at Kfar Samir's southern sector, 1.0 m below sea level and some 50 m from the coastline (32°47'1.85" N, 34°57'12.78" E; Figure 10a,b; see KS6 below). The three pieces fit together and seem to belong to a single artefact, probably a trough. It is 67.5 cm long, 17.5 cm wide, and 3 cm thick (Figure 10c) and features a slightly curved section. The complete trough seems to have been much larger and may have been used as a container for feeding livestock or various household uses. Alternatively, it may have been a fragment of a log-made canoe.

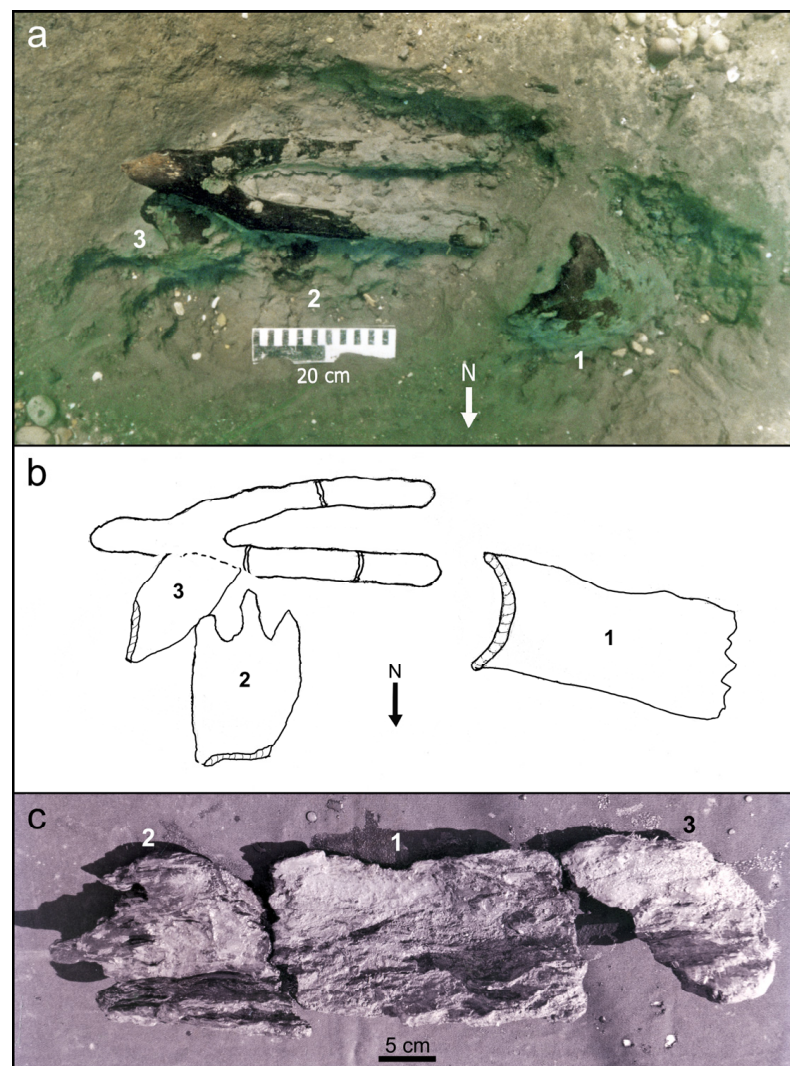


Figure 10. Wooden trough KS 5 and two-pronged fork KS 6 from Kfar Samir: (a) the trough and the two-pronged fork in situ, (b) a schematic depiction of their position at the time of recovery, and (c) trough KS 5 (E. Galili).

KS 6 (a two-pronged wooden fork) is a two-pronged kermes oak fork found in the same pit as wooden trough KS5. It is 50 cm long, 17 cm wide, and 5 cm thick (Figure 11a); it features no use wear and could have been used for various purposes (e.g., Figure 11b).



Figure 11. Two-pronged fork KS 6 from Kfar Samir: (a) the fork after recovery and (b) a possible function as part of a fishing net (Alexandria, Egypt) (E. Galili).

3.3. Hishuley Carmel

The Hishuley Carmel site is located ca. 1.0 km south of the Haifa municipal beach (Figure 1), 0–100 m from the shore and 0.0–4 m below the present sea level [21,30]. A survey of the site's shallow sector discovered two elliptical structures constructed of upright stone slabs and containing thousands of waterlogged olive pits. Additional round stone structures were documented some 100 m offshore in the site's deeper sector (2–4 m deep; [30]).

HC 1 (a wooden bowl) is a wooden kermes oak bowl (Figure 12) found some 50.0 m northwest of the elliptical structures, 1.5 m below sea level [21] (Figure 1), [30]. The recovered specimen is 13.5 cm long, 10 cm wide, and 0.6 cm thick, constituting ca. 60% of the original artefact. The bowl is heavily worn, and no production marks are discernible on its surface.

3.4. Kfar Galim

Kfar Galim is located west of the eponymous modern settlement, ca. 2.0 km south of Haifa (Figure 1), some 30–100 m offshore and ca. 1.5–4 m below sea level. Two rows of undressed stones, forming a right angle, suggest the existence of at least one rectangular structure. Other architectural remains include stone-lined pits, probably wells, 1 m in diameter. The other six pits, probably water wells as in Kfar Samir, are lined with stones and tree trunks. Excavations in two revealed fills containing sherds, flint, waterlogged plant remains, and animal bones [26].

KG 1 (a worked wooden log) is one of three shaped wooden logs found in one of the wooden structures (32°46'3.16" N, 34°57'5.77" E), each measuring ca. 25 cm long and ca. 15 cm in diameter (Figure 13); two were left in their original location. The retrieved wooden log is 24 cm long, 14 cm wide, and 12 cm thick; it is made of tamarisk and is roughly oval in cross-section (Figure 14).

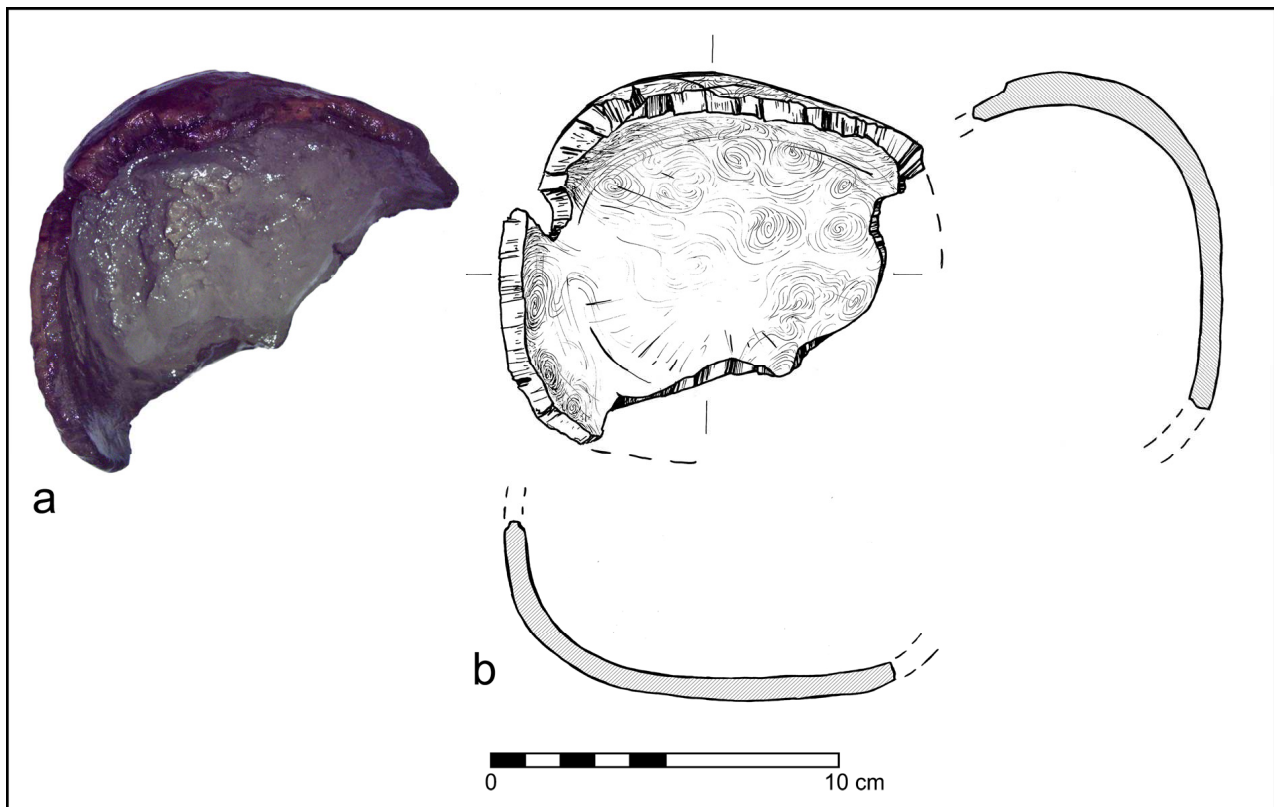


Figure 12. Wooden bowl KC 1 from Hishuley Carmel (K. Alaverdian and E. Galili). (a) a photo of the bowl and (b) drawing of the bowl and sections.



Figure 13. A structure in Kfar Galim made of wooden branches (possibly a water well) containing three wooden logs. The retrieved log (KG 1) is marked with an arrow (E. Galili).

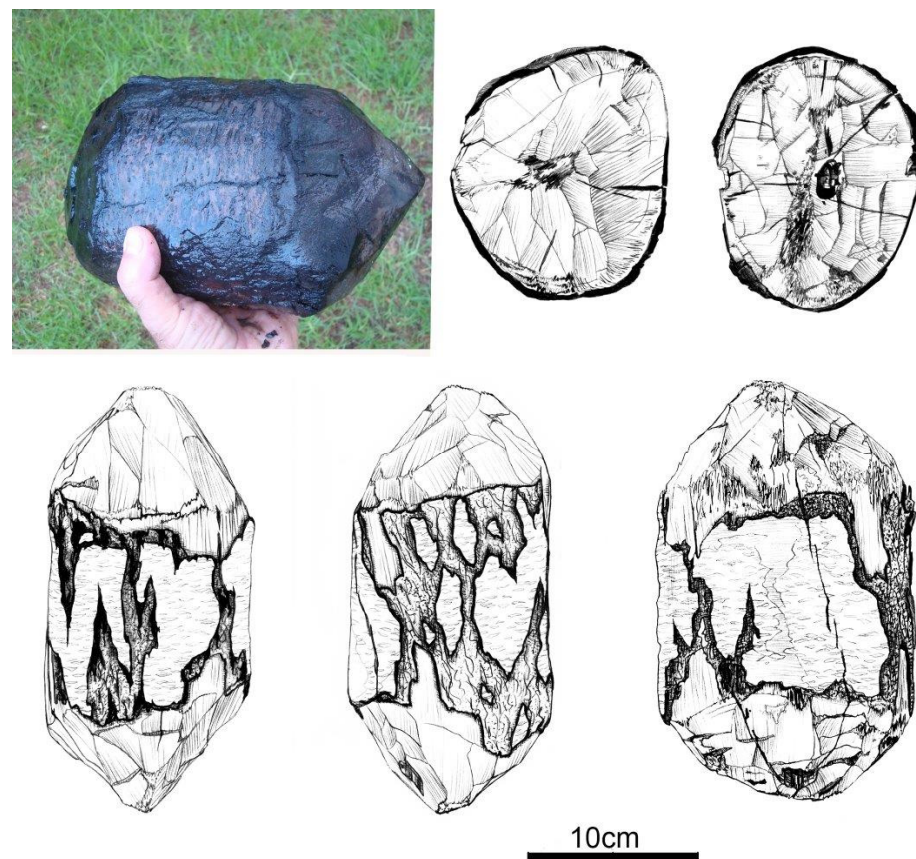


Figure 14. Worked wooden log KG 1 (K. Alaverdian and E. Galili).

The original bark still covers the central part of the log, while its two ends are worked into points, which clearly feature traces of cutting. Wooden logs intended for building and construction are usually longer. Firewood is broken or split with the minimal investment required to fit an open fire. The three logs are incommensurable with either. Perhaps they constitute an early preparatory stage in the production of wooden tools, vessels, or other objects.

3.5. Tell Hreiz

The site of Tel Hreiz (Figure 1) is located ca. 4.5 km south of Haifa. The site revealed evidence of rectangular structures, rectangular stone-built boxes (installations or graves?), human burials, stone paving, and hearths containing charred remains of wood and animal bones. An over 100 m long stone wall was discovered parallel to the present coast, 3–4 m below sea level. It was built of boulders, up to 1 m across, and may have served as a seawall to protect the village from wave action and rising sea levels [46]. Two concentrations of vertical wooden poles made of tree branches were recovered, probably representing fence or hut foundations.

TH 1 (a wooden bowl) is a Mt. Tabor oak bowl (Figure 15) found in a small round hearth, 60.0 cm in diameter, west and immediately adjacent to the seawall, 3.5 m below sea level [46] (Figure 2A: 2). The recovered specimen is 16 cm long, 14 cm wide, and 1–1.5 cm thick, comprising ca. 35% of the complete bowl. A long flint blade was found inside the bowl (Figure 15). The bowl's surface is eroded, and no production marks are discernible.

TH 2 (a braided circle made of twigs) is a circular element made of twigs of an unidentified plant. It is 18.0 × 17.0 cm in size, and the twigs are 0.6–0.8 cm thick, twisted on each other (Figure 16) (see [46]). It was found in the northern parts of the site, 2.5 m below sea level [46] (Figure 2A: 14).

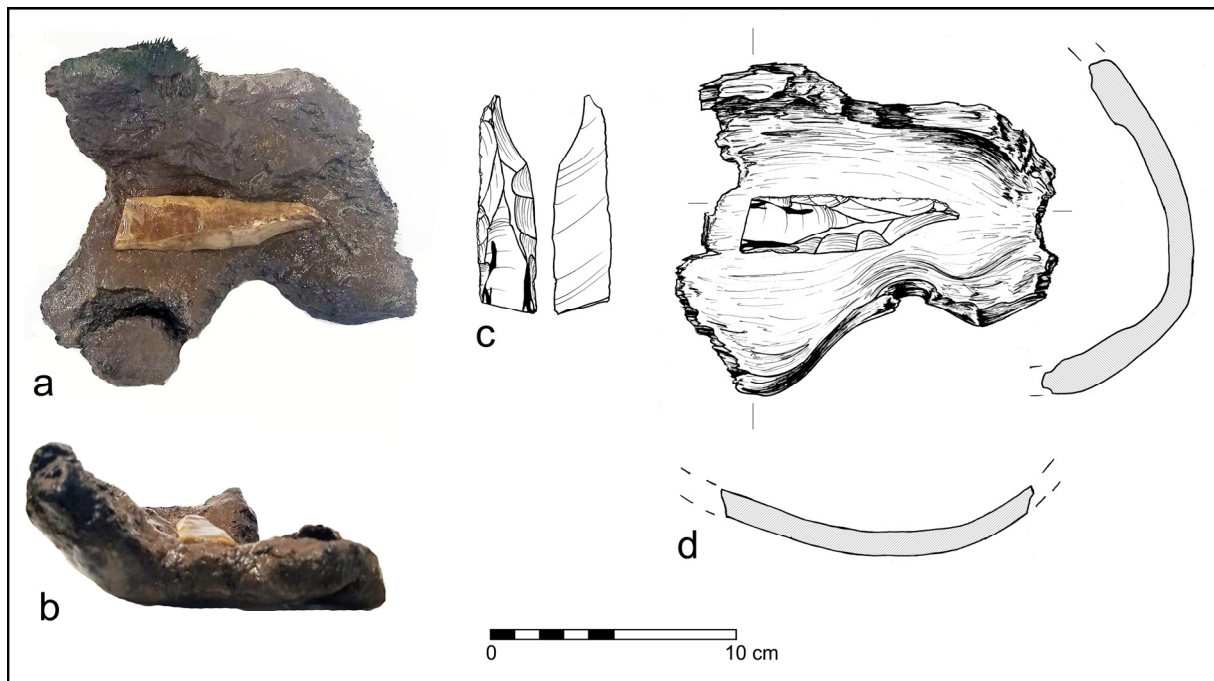


Figure 15. Wooden bowl TH 1 from Tel Hreiz: (a,b) the bowl and the flint blade found in it; (c) the flint blade; and (d) a drawing of the bowl and the flint blade in it (K. Alaverdian).

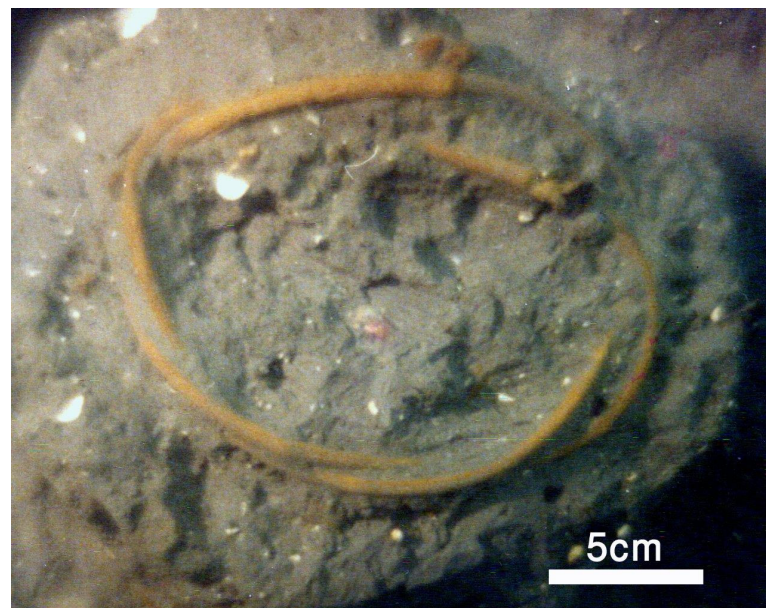


Figure 16. Braided circle TH 2 from Tel Hreiz in situ (E. Galili).

4. Discussion

Vegetal resources were among the earliest raw materials used by humans for the production of implements, tools, matting and basketry, cloths, and containers. They occur in the archaeological record as early as the Palaeolithic period (e.g., [4]) and in increasing frequencies from the Neolithic period onwards [12,58,59]. Nevertheless, these materials are highly vulnerable and susceptible to decay in most depositional environments and are, therefore, relatively rare. Consequently, many scholars avoid incorporating them in their discussions of early material culture, although they acknowledge that artefacts made of wood and other perishable materials were central to past daily life [1,60].

While south Levantine sites produced some wooden artefacts and braided objects (e.g., [14–19,61,62], [63] (p. 197), [64–67]), the number and variety of finds retrieved from the submerged sites off the coast of the Carmel Ridge are unprecedented. Thus, they significantly contribute to our understanding of how local communities employed organic materials, and specifically timber, for purposes other than fuel and construction, adding another layer to our understanding of their use of their environment.

4.1. Environmental Consideration

The arboreal taxa used to manufacture the abovementioned artefacts and the fossil pollen and wood remains recovered from the submerged sites along the Carmel Coast [21,25,68] suggest that the same arboreal components prevailed in the region during the Neolithic and Chalcolithic periods as today. Generally, wood for everyday use, including the production of wooden objects, was usually obtained from areas close to the settlements (e.g., [1,69]). Assuming that the wooden objects presented here indeed derived from vegetation in the sites' vicinity, it seems that the early Holocene Carmel Coast was characterised by a Mediterranean maquis/forest.

The two species of oak—kermes and Mt. Tabor (*Quercus calliprinos* and *Q. ithaburensis*)—and the carob (*Ceratonia siliqua*) and the terebinth (*Pistacia palaestina*) are faithful representatives of the Mediterranean maquis/forest, in general, and the area of the Carmel, in particular [21,25,47,53,68,70]. The tamarisk (*Tamarix* sp.) is somewhat equivocal in this respect. While ubiquitous in many south Levantine phytogeographic regions, it is especially prevalent in arid, saline, and wetland environments [70,71]. Accordingly, one might suggest that the tamarisk and bowl and trough were fashioned away from the Mediterranean Coast and only later brought to their respective sites. However, the log found at Kfar Galim is likely to have been brought from nearby. This shrub was also used for the preparation of Chalcolithic wooden objects recovered from the arid parts of the southern Levant (e.g., [19]).

4.2. Artefactual Consideration

The wooden objects described above represent different functions and uses, frequently unparalleled with other materials. They include a trough, various bowls, shafts, a wedge, a fork, and a shaped log, representing various functions.

Interestingly, the wooden bowls bear some similarities to pottery and stone containers (see [72,73]). At least two species of oak were used to produce most of them, while one was made of carob. Although similar wood vessels probably predate the Pre-Pottery Neolithic, the bowls from the submerged sites of the Carmel Coast are the earliest to be reported to date. Stone containers are known from the Upper Palaeolithic onwards (e.g., [74–76]); plaster-based white ware (*vaisselles blanches*) emerged during the Pre-Pottery Neolithic B period (e.g., [77–79]), and large pottery assemblages first appeared in the Pottery Neolithic period (e.g., [73,80]). The typological and morphometric relations between vessels made of clay, wood, and stone were probably tight, and they are likely to have influenced each other [73,80,81]. Interestingly, the use of several wood species is suggestive concerning the flexibility of production, the availability of wood, and, possibly, the vessels' functions.

Mats and baskets have a long history in the region, appearing mainly at sites dating from the Pre-Pottery Neolithic (e.g., [16,18,57,63]). Mat and mat impressions have been recorded on a clay product from Atlit-Yam [27] (pp. 142, 143: Figure 149) and on the bases of pottery vessels dating from the Pottery Neolithic and Chalcolithic periods (e.g., [80,82–84]). The current assemblage comprises three items: a basket, a mat, and a braided circle. While the mat is too small to reconstruct its original shape, size, and function, it features a specific coiling technique, which was unpopular compared to the simpler stitch variety. Although rare, this technique was used as early as the 8th millennia BP and lasted several thousand years, as indicated by funerary deposits from Tarkhan, Egypt, and the Cave of Treasure in the Judean Desert, Israel ([33], and references therein).

4.3. Dating Consideration

The new and old radiocarbon dates presented here (Table 1) (see [29]) (Table 23.2) suggest that four of the five sites discussed here—Kfar Samir, Hishuley Carmel, Kfar Galim, and Tel Hreiz—thrived during the Early to Middle Chalcolithic periods, which had begun at ca. 7800 cal. BP and ended at ca. 6700/6600 cal. BP (e.g., [80,85,86]). Thus, the occupational history along the Carmel Coast lasted from the Pre-Pottery Neolithic C period, through the Wadi Raba culture of the Early Chalcolithic period, and into the Middle Chalcolithic period, when sites such as Tel Tsaf, Tel Abu Habil, Qatart a Samra, and Tel a-Shuna (N) thrived in the Jordan Valley (e.g., [87,88]). Interestingly, some evidence for contact between the Jordan Valley and the Mediterranean Coast was noted based on Mediterranean Sea shells at Tel Tsaf (D. Rosenberg, pers. obs.) and Dead Sea bitumen on sickle blades from Atlit-Yam [89]. Furthermore, it was recently argued that evidence for olive horticulture in the vicinity of Tel Tsaf, where the tree does not occur naturally, speaks for the exchange of knowledge and genetic material between the Carmel Coast and the central Jordan Valley [90,91].

5. Conclusions

Objects made of wood and other vegetal materials are uncommon in the prehistoric archaeological record of the southern Levant. Against this background, the small assemblage of wooden and basketry objects from the submerged sites along the Carmel Coast acquires special significance. It suggests that the use of wood and other plants was common practice during the Neolithic and Early-to-Middle Chalcolithic periods in this area, augmenting finds from various sites in the Judean Desert and underscoring the range of artefact types and functions associated with wood and vegetal resources. Furthermore, the assemblage's wealth strongly indicates how severely underrepresented wooden objects are in the archaeological record and that under appropriate depositional environments (dry, waterlogged, or anaerobic conditions), they can be much better preserved than under others.

Finally, the data presented in this study demonstrate that wood was a widely accessible and amenable raw material. Thus, we should re-evaluate the place wooden objects occupied for past communities in the region. In this regard, the submerged sites off the Carmel Coast offer a unique opportunity to glimpse into the frequently invisible component of the region's archaeological record, assess its role, and incorporate it into the archaeological discourse of the Neolithic and Chalcolithic periods of the southern Levant.

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