Iron Age Shipwrecks in Deep Water off Ashkelon, Israel

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Abstract

In 1997, two shipwrecks were first discovered in the Mediterranean Sea west of Israel by the U.S. Navy's research Submarine *NR-1*. Further investigation in 1999 with the remotely operated vehicle system *Medea/Jason* found the wrecks to be from the eighth century B.C., the earliest known shipwrecks to be found in the deep sea. Both ships appear to be of Phoenician origin, laden with cargoes of fine wine destined for either Egypt or Carthage, when they were lost in a storm on the high seas. The ships lie upright on the seafloor at a depth of 400 meters in a depression formed by the scour of bottom currents. Their discovery suggests that ancient mariners took direct routes to their destinations even if it meant traveling beyond sight of land.*

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Introduction

During the summer of 1997, the U.S. nuclear research submarine *NR-1* participated in a major deep-water archaeology program in the Straits of Sicily north of Skerki Bank.[1] Following that expedition, the submarine moved to the eastern Mediterranean where it conducted a search effort for the Israeli Navy in hopes of finding the *Dakar*, and Israeli diesel submarine lost in the 1960's. Although this search effort for the *Dakar* was not successful, the *NR-1's* large area search sonar did succeed in finding three smaller shipwrecks in the area off Egypt and the Gaza Strip, 33 nautical miles offshore and in 400 meters of water (Figure 1). Since the submarine's primary mission was to locate a lost Israeli submarine, a thorough inspection of the three ancient shipwrecks was not conducted. A preliminary analysis of the black and white videotapes obtained while cruising high above the sites, however, did reveal some wreckage including, in two instances, large accumulations of stacked amphoras. Subsequent examination of those videotapes by archaeologists suggested that two of the shipwrecks might date from the Iron Age and, for that reason, merited further investigation.

1999 Expedition

In 1999, a follow-up expedition was conducted in the area in hopes of relocating the two amphora wreck sites to determine their exact age and origin. The support vessel for this effort was the *Northern Horizon*, a converted British deep-sea trawler. This vessel is equipped with a dynamic positioning system, and was previously used by the Authors and collaborators to survey the remains of the British luxury liner *Lusitania*.[2] Aboard the

Northern Horizon was the *Medea/Jason* remotely operated vehicle system and the *DSL-120* sidescan sonar.[3]

The *DSL-120*, developed by the Deep Submergence Laboratory of the Woods Hole Oceanographic Institution, is a phased-array 120 kHz side-scan sonar used to produce both sonograms of the ocean floor as well as bathymetric maps. The *Medea/Jason* ROV system has been used on a growing number of marine investigations and is equipped with advanced robotics and control technology ideally suited for deep-water archeological programs.[4]

Once the *Northern Horizon* reached the search area, the *DSL- 120* was deployed. A systematic series of survey lines was conducted, revealing the location of several possible acoustic targets. These targets had the same size and signature of the suspected shipwrecks although they were not located at the reported positions given by the *NR- 1*.

The *DSL- 120* was then recovered and the *Medea/Jason* was deployed to inspect two possible targets. Upon reaching the bottom, the *Jason* vehicle located the first target, which proved to be an 18th to 19th century sailing ship with a steel anchor and chain. The *Northern Horizon* and the *Medea/Jason* system then moved to the second target some 2.4 km away. The second target was acquired on *Jason's* scanning sonar system at a range of 150 m. It appeared as an oval shaped depression 18 m in length and 8 m wide with a highly reflective mass centered within the depression. As the target was approached, an elongated pile of amphoras about two meters high came into view. On closer inspection, the amphoras associated with the shipwreck appeared to be from the 8th century B.C., confirming earlier speculation.

After a preliminary visual survey of the site was conducted, a free-falling elevator was dropped from the surface, which landed fewer than 100 meters from the site.[5] Contained on board the elevator were two high frequency EXACT 300 kHz transponders, which were then deployed by the *Jason* ROV next to the wreck site. For future reference purposes, the wreck site was nicknamed *Tanit*.

Jason was then used to off-load and place the two transponders approximately 35 meters from the wreck site, about 50 meters apart. With these two transponders, it was possible to track *Jason's* position three times a second to an accuracy of about 2 centimeters.[6] With such a precise and rapid up-date rate, it was possible to place the vehicle in "closed-loop" control and conduct a series of survey lines one to two meters apart. The navigation suite used during this survey effort consisted of the bottom installed EXACT transponders, an attitude reference package, a precision depth sensor, and a 1200 kHz bottom track Doppler navigation sonar mounted on *Jason*.[7] The bottom transponders and the vehicle's Doppler navigation provided complementary information about the vehicle's horizontal position. The transponders provided a stable reference with high accuracy, but were susceptible to short-term dropouts. The Doppler navigation system, however, provided an excellent dynamic estimate of vehicle motion, but was prone to drift. By combining the two sensors, a very reliable and accurate position estimate was possible. Figure 2 illustrates the nature of Jason’s sensors.

As each survey line was made, a series of electronic images was collected, while simultaneously a 675 kHz digital sonar was scanned back and forth across the wreck site measuring its micro-topography.[8] Due to the limited scanning rate of the sonar, the speed along the trackline was set at 10 cm/sec. High quality color video and still images were also collected during these survey runs.

Until the precision mapping phase was completed, the vehicle constantly hovered over the site and did not land. Care was taken not to disturb the site with the vehicle's propeller wash by insuring the vehicle was trimmed for positive buoyancy, resulting in the propeller wash being directed upward instead of downward. The documentation runs were conducted at very low speeds over the bottom and at sufficient altitude, 1.5 to 3 meters, to avoid striking any objects. The photographic runs documented the exposed artifacts while a sub-bottom profiler penetrated the bottom sediments to a depth of a few meters.

Individual images obtained with a high-resolution electronic still camera were processed to remove the effects of the underwater environment. These images were normalized with respect to reference images for the camera and then histogram equalized to stretch the contrast and thereby reveal the details of the site. Since lighting conditions underwater make it virtually impossible to frame large areas on the sea floor within a single image, composites of smaller images (photomosaics) were assembled to permit archaeologists to gain a wider perspective of the site of interest.

An initial mosaic was made of the wreck site using a small number of images taken at high altitude. Although it lacked resolution, the resulting mosaic minimized the inherent distortion associated with mosaics composed of a large number of images. Using this crude mosaic as a template, a higher resolution mosaic was then constructed of images taken at low altitude covering a smaller area but having higher resolution.

The creation of a photomosaic involves picking common points in overlapping imagery to compute the relative transformation between the overlapping images. This transformation is then used to warp successive images into a composite mosaic while blending the boundaries between overlapping images to give the mosaic a continuous look.[9]

The mapping process continued until the entire area had been photographed with overlapping imagery and a dense concentration of sonar soundings. The result was the creation of a digital mosaic image (Figure 3) and a fine-scale bathymetric map of the wreck's upper surface (Figure 4).

The survey process proved highly efficient and was completed in **fewer** than twelve hours for each site. **The team of archaeologists then** had a complete photographic record of the site and a database, which showed the orientation, and size of each exposed object.

The acoustically derived bathymetric map of the same region (Figure 4) highlights the complementary nature of the imaging sensors. The optically derived photomosaics provide a vivid view of the shipwreck. However, due to incremental errors in building up the photomosaic, one is unable to make precise measurements over the entire mosaic. The bathymetric map, on the other hand, while not visually as appealing, provides a mechanism for making very precise quantitative measurements across the entire site of interest. After completing this precision survey, specific artifacts were selected by the archaeological team for recovery, based upon their ability to help determine the age, origin, and significance of each wreck. To avoid damage to the artifacts, important artifacts lying along the perimeter of the wreck site were initially selected for recovery. The recovery tool that proved most effective was a simple hydraulic device that consisted of two opposing horizontal tongs each having a webbed mesh net. With the tongs in a relaxed position, the vehicle operator slid the lower tong beneath the desired artifact, closed the upper opposing tong using the vehicle's hydraulic system, and then thrusted the vehicle up off the bottom until it was free of the site.

Using the search sonar on the vehicle, the pilot then drove over to the elevator, positioned the artifact above one of the elevator's net meshed compartments, and reversed the hydraulic pressure, gently placing the artifact within the selected and numbered compartment.

On some occasions, the artifact selected was nested within the site amongst other objects. To ensure that the artifacts were recovered without damage to themselves or the surrounding objects, *Jason* was moved in incremental steps while in closed-loop control in all degrees of freedom, (i.e. X, Y, Z, and heading) centimeters at a time.[10] Once in position, while hovering (automatically) above the object, the vehicle's mechanical arm was used to gently grasp the object. To avoid damaging fragile materials, the strength of the manipulator's grip could be regulated, applying just enough force to cradle and lift the object. Once properly cradled between the grippers, the vehicle thrusted upward and away from the site toward the nearby elevator. Once the elevator was full, a meshed lid was placed above the artifact compartments, an acoustical command triggered the release of the elevator's weight, sending it toward the surface where it was recovered back aboard ship, emptied, and sent back to the bottom.

After spending two days surveying, mapping, and recovering artifacts from the *Tanit* wreck, *Jason* then went to inspect the third acoustic target located in the initial side-scan sonar survey positioned 2 km to the north of the *Tanit* wreck site. This third target also proved to be an Iron Age shipwreck very similar to the *Tanit* although slightly larger. Nicknamed *Elissa*, it was also surveyed in detail using EXACT bottom mounted transponders. This survey produced a similar mosaic (Figure 5) and microtopographic map (Figure 6) of the site. The survey was followed by the recovery of selected artifacts, selected by the archaeologists to determine the age and origin of the ship.

Following this effort, attempts were made using the *DSL- 120* to locate additional shipwreck sites. Before conducting the new search effort, a series of lines was made at right angles to the *Tanit* and *Elissa* wreck sites using the *DSL-120*. The purpose of this effort was to obtain acoustic images of the two wrecks at different aspect angles to help guide the subsequent search program.

Since *Tanit* and *Elissa* wrecks lie on an east-west line connecting the ancient seaport of Ashkelon with Egypt and Carthage to the west, it was thought the two shipwrecks might define an ancient trade route along which other shipwrecks could be found.

For that reason, a series of side-scan sonar lines was made diagonally across this suspected ancient trade route. Very quickly several targets were detected with the same acoustic signatures as the *Tanit* and *Elissa* wrecksites. The *DSL- 120* was then recovered and the *Medea*/*Jason* was launched to investigate.

These new targets proved to be a series of hydrocarbon seeps characterized by an elongated depression in the center of which was located a hard reflective mound of seep deposits consisting of calcium carbonate.[11] Since these mounds were numerous and had the same acoustic signature as the wreck sites, it was judged that further search efforts in this area would not be productive.

<u>Archaeological Results</u>

General Introduction

The archaeological component of the Ashkelon Deep-Sea Project was comprised of terrestrial archaeologists from the professional staff of the Leon Levy Expedition to Ashkelon: Catherine Beckerleg, Susan Cohen, Daniel Master and Michael Press, all doctoral candidates (in 1999) in the Department of Near Eastern Languages and

Civilizations at Harvard University. In addition, the team included veteran maritime archaeologist Shelley Wachsmann, professor in the Institute for Nautical Archaeology at Texas A & M University and Lawrence E. Stager, Dorot Professor of the Archaeology of Israel, and Director of the expedition's deep-sea archaeology team.

The primary goals of the archaeological research were to survey, plan, and photograph the two oldest shipwrecks, the *Tanit* and the *Elissa*. The next goal was to collect samples of artifacts and other relevant material from their cargoes, while, at the same time, disturbing as little as possible of their remains in order to obtain the following information: 1) the size and date of the shipwrecks; 2) the nature and origin(s) of the cargoes; 3) the homeport of the crew; 4) their intended route and destination(s); 5) the cause of the shipwrecks; 6) relate the ships and their cargoes to the economic networks of the Mediterranean. After several days of research on each shipwreck, first *Tanit* and then *Elissa*, the archaeological team was satisfied that it had gathered sufficient data to meet most of its research goals.

Documentation

The Ashkelon Deep-Sea Project was an archaeological survey with limited artifact sampling. After locating each wreck, *Jason*, using the EXACT system, systematically flew over the wreck in programmed track lines covering the entire wreck. This information from *Jason* provided the raw information necessary to build detailed photomosaics and construct precise bathymetric maps. These plans became the primary recording devices for understanding the positional relationships of the artifacts.

After thorough recording of the wrecks, the archaeologists decided it would be extremely helpful to recover several artifacts from the wrecks. The fine details of the objects, details necessary for making precise stylistic connections, were not clear from the visual information provided by *Jason*. Further, the provenience of the objects, essential for understanding the origin of these ships, could only be determined through Petrography or Neutron Activation Analysis, both of which required physical fragments of the pottery.

The archaeologists on board chose objects that would not only demonstrate the total range of vessels visible on these ships but would also minimally disturb the delicate stacks of amphoras located in the middle of the wrecks. The location of each artifact was marked on the photomosaics, and the artifacts were further identified using time stamps linked to the video record of the recovery process. The artifacts were deposited in elevators to be lifted to the surface.[12]

In an attempt to fully document the alteration of this site, we recorded any artifact that was moved in any way by *Jason*. Artifacts that were moved but not recovered were numbered within the same sequence as the recovered objects but given an "M" suffix. Also, core samples taken at the margins of the wreck sites were numbered and recorded on the plans and marked with an "S" suffix.

Jason completed the final step in the recording process by re-flying the initial survey in order to record the final disposition of the wreck site for future investigators.

Microbathymetry provides the most precise measurements of the two shipwrecks, *Tanit* and *Elissa*. The contours of their cargoes are in the shape of a ship, outlining the forms of their long vanished hulls (Figs. 3-4, 5-6). The cargo of *Tanit* measures 4.50 m. wide by 11.50 m. long, for which we would estimate an overall width of ca. 6.50 m. and a length ca. 14.00 m. The cargo of *Elissa* is 5.00 m. wide and 12.00 m. long for an estimated size of the ship of ca. 7.00 m. wide and ca. 14.50 m. long.

<u>Tanit</u>

Inventory of Artifacts Retrieved from *Tanit*

(Shipwreck A) (Figure 8):

16 Amphoras:	004-006, 009, 011-012, 014-019, 042-045
2 Cooking Pots:	002-003
1 Bowl:	007

After the complete survey of *Tanit*, we decided to take several samples. First, we took core samples from the sediments surrounding the wreck. These were taken close to the wreck, but not so close as to endanger objects not visible on the surface. These samples provided a baseline against which to understand the sediments recovered from the various vessels. Then we sampled the various artifact types. We recovered two cooking pots and a bowl from the stern of the ship and enough amphoras to provide a broad sample for petrographic analysis. Of the 385 visible amphoras, we recovered 16 examples.

Elissa

Inventory of Artifacts Retrieved from *Elissa*

(Shipwreck B)   (Figure 9):

7 Amphoras:	031-032, 035-036, 038-040
1 One-Quarter Amphora:	021
3 Cooking Pots:	022, 028-029
1 Mortarium (Deep Bowl):	024
1 Decanter:	023
1 Incense Stand:	027
6 Ballast Stones:	026
1 Bowl (broken):	020

The survey of *Elissa* revealed a greater diversity of visible objects, and we designed our sampling accordingly. We recovered every type of artifact that we were able to see. We recovered four whole cooking pots, one small amphora, one broken mushroom-lipped decanter, six ballast stones, and one deep bowl, or mortarium. Further, in order to understand the cargo in similar ways to the *Tanit* wreck, we recovered eight amphoras. While we recovered a similar number of ceramic artifacts from *Tanit* and *Elissa*, the *Elissa* samples accurately reflect the greater visible diversity of artifacts on that wreck.

CARGO

Amphoras (Figure 8:4-5; Figure 9:5-6)

The most plentiful objects visible on the *Tanit* and *Elissa* were amphoras. *Tanit* contained 385 visible amphoras and *Elissa* contained 396. It must be emphasized that this represents just the top two tiers of amphoras and there may be many more below.

These amphoras are well known from land excavations in Israel and Lebanon. They have a slightly **wasp-waisted body**, a sharp shoulder, and a medium high-necked rim thickened at the top. There have been several significant studies of this form including work by Bikai, Gal, Gitin, Geva, and Lehmann.[13] On land, these vessels are commonly found in eighth century contexts such as Megiddo III, Hazor VI-V, Tyre III-II. While there may be some ninth century examples at Hazor and Megiddo, the distribution is heavily weighted toward the middle to end of the eighth century.[14]

Within the eighth century, there is a sharp distribution of these amphoras (Figure 10). Hazor and Megiddo have more than sixty whole forms, in addition to rim fragments. Tyre and Sarepta, while not possessing many whole forms, have hundreds of rim fragments. Apart from these four sites, no other site has more than ten preserved examples. This narrowly defined distribution plot shows the inland use of these containers in a very few places in proximity to the Phoenician coast. It also shows the presence of the containers in maritime trade both at the port and in transit on *Tanit* and *Elissa*. One possible destination for this cargo was the newly founded Phoenician colony at Carthage. The early Carthaginian colonists, many of them Tyrians according to founding legends, imported this type of transport amphora from the Levant. In archaic Carthage, complete jars have been found among mortuary offerings in tombs and graves as well as in habitations within the city. In one room alone the fill beneath the floor produced rim sherds representing 30 examples of this amphora.[15]

In a discussion of the terrestrial examples of this form, Geva argued that the "small size and clumsy manufacture" of the handles would argue that they were "seldom used".[16] In contrast, many other amphoras have larger, "functional" handles useful in terrestrial transport. Our discovery of these jars graphically demonstrates that these handles were perfectly designed for the guide ropes used to consolidate a ship borne cargo. While impractical for terrestrial transport and pouring, these amphoras were perfect as purpose-built maritime containers.

Our amphoras contained an average of 17.8 liters of liquid. They averaged 68.8 cm in height and 22.3 cm in width. But these averages do not do justice to the standardization of these amphoras. The complete amphoras that we recovered had a standard deviation of less than 2 cm in height and around 1cm in width. This narrow range indicates considerable standardization in manufacture, a characteristic typical of every aspect of these amphoras. These exacting tolerances were necessary for intricately stacking more than four hundred amphoras in the hold of a ship. If this standardization is representative of the hundreds of amphoras still on the wrecks, the picture of standardized production is even more remarkable.

In proposing a manufacturing center for this cargo of amphoras, we have considered several lines of evidence. First, these amphoras are purpose-built maritime containers. They are built to be easily stacked in the hold of a ship, to have consistent capacity, and to be easily tied down using special handles. This argues for a production facility familiar with the needs of maritime transport. Second, the ports at which many of these jars are found have a tradition of substantial pottery production. At Sarepta, several kilns have been excavated, and at Tyre, while no kilns were discovered in the extremely limited exposures of that excavation, Bikai uncovered kiln wasters from this very type of amphora.[17] Finally, the petrographic profile of these jars is consistent with the Phoenician coast.[18] We would argue that these jars were produced in one or more of the Phoenician port cities heavily involved with the maritime trade of the eighth century, Tyre being the primary port in Iron Age II.

Resin Linings

Dr. Patrick McGovern of the Molecular Archaeology Laboratory at the University of Pennsylvania Museum has reported that "torpedo" –shaped amphora (AS99.A.009), dated typologically to ca. 725 B.C. (plus or minus 25 years), had a dark, thin "lining" on its interior, which he determined to be pine pitch (from *Pinus halepensis*). Our inspection of the 21 amphoras recovered from *Tanit* and *Elissa* indicates that all of the jars had once been lined with resin. McGovern used three complementary analytical techniques – infrared spectrometry, liquid chromatography and wet chemical analyses – to determine whether tartaric acid, an organic acid that occurs mainly in grapes or grape products, such as wine, was present in the resin from Amphora A.009. It was. This analysis along with presence of resin lining in the other amphoras examined makes it clear that many, if not all, of the nearly identical amphoras on board the two shipwrecks contained wine. These, then, would be the oldest cargoes of wine amphoras lined with resin to prevent seepage.

GALLEY

Cooking Pots **(Figure 8:1-2; 9:7-10)**

The cooking pots on *Tanit* and *Elissa* were far less plentiful but no less important than the amphoras. Because we know that ancient ships had their galley at the stern, the location of the cooking pots was essential for determining bow from stern on both ships. In addition, unlike the amphoras which were brought on as temporary cargo, the cooking pots were probably a basic component of the ship, a type of pottery used voyage after voyage, for cooking one-pot stews, especially the fish chowders that were the constantly replenished staple of seagoing ships from antiquity to the present. These cooking pots have the same stylistic connections as the amphoras, reinforcing the idea that these were Phoenician ships. We recovered six cooking pots, two from *Tanit* and four from *Elissa*. The two cooking pots from *Tanit* were very similar and their closest connections are with eighth century cooking pots found on the Lebanese coast at 'Arqa.[19] This form has a wide chronological range from the mid-eighth through the seventh century. Similarly, two small cooking pots from *Elissa* had this same form in miniature.[20] Also on *Elissa*, there was a larger cooking pot with a clear connection to an eighth century vessel found at Hazor Stratum V.[21] All of these cooking pots belong to the stylistic family of vessels from the eighth century B.C. in Phoenicia and its hinterland.

Handmade Bowl (Figure 8:3)

At the stern of *Tanit* we recovered a coarsely made bowl. Given the rounded bottom and lack of symmetry of the bowl, we thought for a while that this might be some sort of lid. In our search for parallels at land excavations, we found only one matching object, an Egyptian bowl from the Phoenician site of Migdol.[22] Petrographically, our bowl is characterized by an abundance of straw temper. Mineralogically, there is a fair amount of biotite in the sand-sized fraction. This is a unique characterization within this assemblage, and it does fit with the use of Nile clay. This bowl is Egyptian in origin, a possible destination of the ship. In all probability, this was not the first time that this ship had made the run from Phoenicia to Egypt.

Mortarium (Figure 9:3)

In the galley at the port side of *Elissa*, we recovered a large, thick-walled bowl known as a "mortarium." This descriptive name accurately reflects the function of this bowl in which various foodstuffs would be ground. On land, this form is generally found in contexts dating to the seventh century B.C. and later. Mortaria are found over a time span lasting more than a millennium, and throughout this period, they appear to have been made at just a very few production sites. Lehmann charts the beginning of the evolution of this form as far back as the late eighth century.[23] Our eighth century B.C. exemplar closely matches the petrographic profile of the majority of later mortaria, a provenience most closely linked to the northeast corner of the Mediterranean, at sites such as Ras al-Bassit in northern coastal Syria.[24] The deep bowl used as a mortar for grinding condiments was known in Cilicia at Tarsus as early as the eight century B.C.[25]

Recently another eighth century mortarium has been found in a Phoenician site of Horbat Rosh Zayit in Galilee. There, too, it appears alongside our torpedo-shaped amphoras.[26] Our mortarium seems to be one of the rare examples of this early eighth century form, which marks the beginning of specialized mortarium production.

Small Amphora **(Figure 9:4)**

Also found in the galley of *Elissa* was a small amphora (B.021); its shape similar to the larger torpedo-shaped ones, but only half their height and a quarter of their capacity.   At Hazor in Stratum VI, where so many of the larger amphoras of torpedo-type were found, a much smaller version similar in shape and size to B.021 appeared.[27] This single item, most probably for wine, was set aside for the crew or for some special purpose. Our guess is that it stored the sacred wine to supply libations, which the captain poured out from the decanter upon departure and a successful arrival.

Mushroom-Lipped Decanter **(Figure 9:1)**

The mushroom-lipped decanter is a pottery type whose distribution is centered around the Phoenician sites of southern coastal Lebanon. It appears more rarely in those areas reached by Phoenician maritime trade, but Lehmann's plot of its distribution strongly associates it with its place of origin.[28] Our decanter has the sharp shoulder typical of forms from the last quarter of the eighth century. That it served as a carafe for wine, rather than for water, is clear from an inscription engraved on another decanter describing its contents as *yyn khl*, some kind of wine.[29] Further recent discoveries have provided an even more specific setting for at least some of the wine decanters. Expertly engraved on a decanter, 1.27 liters in volume, and dated to ca. 700 B.C., is an inscription that reads: “Belonging to Mattanyahu, wine for libation, one-fourth” (*lmtnyhw. yyn. nsk. rb*^{c}*t.*).[30] The term *nsk* is used for a cultic libation of wine several times in the Bible (Gen. 35:14; Exodus 29:40, 30:9; Lev. 23:13, 18; Num. 4:7, 15:5-7). Following the lead of Exodus 29:40 and Leviticus 23:13, we find that a typical cultic libation of wine equaled one-quarter of a *hin*, perhaps the quantity referred to elliptically in the *nsk rb*^{c}*t* (1/4 *hin*) of the decanter inscription. If the *bat* is equal to 32.5 liters, then a *hin* equals ca. 5.4 liters and ¼ hin equals 1.35 liters. The amount of wine, sacred or secular, held by our decanter is ca. 1.3 liters, quite close to the *nsk rb*^{c}*t* being offered in the Mattanyahu decanter.

The mushroom –lipped decanter provides an invaluable clue as to the cultural background of the crew. The mushroom-style rim, whether on jug, juglet, or decanter, was the “calling card” of Phoenicians from Tyre to the Pillars of Hercules.

***Incense Stand* (Figure 9:2)**

The small ceramic incense stand recovered from the galley of *Elissa* falls very much in the Late Bronze Age and Iron Age traditions of terracotta incense stands designed to be hand held. Typically they were used to offer aromatics to the gods.

The most commonly cited example of a Canaanite sea captain offering precious aromatics, such as frankincense, to the maritime deities comes from a 14th century B.C. Egyptian wall painting from the tomb of Kenamun.[31] There the captain holds a portable incense burner aloft in his right hand and an offering cup in his left, as he gives thanks for a successful voyage to Egypt from the Levant. An attendant who is steadying a Canaanite jar in front of the officer has just filled the cup with wine. The incense burner and the cup in the wall painting served the same purpose as the incense stand and wine decanter found in the galley of *Elissa*. Like their Canaanite ancestors, these Phoenician sailors were beholden to such deities as Ba^{c}l Saphon and Astarte for safe passage over the waters. Unfortunately for the crew of *Elissa*, the gods did not look kindly on this maritime venture.

ANCHORS

In addition to ceramic artifacts, we surveyed eight anchors on *Tanit* and *Elissa* (see figs. 3, 5). These anchors are of the most common ancient type, an apsidal stone with a single hole bored through it, a type found from the Bronze Age through modern times. While it is possible to make estimates about general length and width of these anchors by comparing them to other artifacts in the digital photos, this is inexact. Estimating the weight requires yet another approximation. As publications of anchors have shown, there is considerable variation in thickness.[32] Anchors of roughly the same length and width as our anchors vary between 80 and 400 kg. While the high relief of some of these anchors argues for considerable girth, we cannot make an exact measurement. We were unable to recover an anchor; they were too heavy to be lifted by *Jason*.

On *Tanit* there were four anchors visible at the surface level. Three of the anchors were located roughly amidships (2, 3, 4) and one was located about two meters off the bow (1).

On *Elissa*, all of the anchors were located at the midpoint of the ship, two on either side. The location of the anchors was probably due to the use of the mast to assist in lifting, running a rope over the yard near the mast and pulling down to maneuver the anchor.

Oceanographic Results

In addition to the archeological aspects of this expedition, much oceanographic insight was gained as it relates to the oceanographic conditions that favor the preservation of deep-water sites. How that knowledge might be used to find additional sites as this newly emerging field attempts to access the potential of the deep sea to archeological studies also was considered.

Unlike the Roman shipwrecks located in deep water north of Skerki Bank that were mostly buried, the *Tanit* and *Elissa* wreck sites were found resting in depressions, their contents well exposed. In many ways, they mimic the process observed in the Skerki Bank region for individual amphora. There, hundreds of individual amphoras were found resting inside small depressions, the apparent result of long-term current scour.

The Skerki Bank wrecks themselves, however, were mostly buried. As has been documented before, any wood placed in well-oxygenated bottom waters around the world is quickly discovered and attacked by various wood boring organisms.[33] This process, although quick by geologic standards, does take many years to remove the major wooden components of the exposed portions of ships. During this period of time, bottom currents result in the horizontal movement of sediment along the bottom and the construction of dune-like deposits on the down current sides of the ship's exposed surface. If tidal in nature, deposits can form around the entire perimeter of the shipwreck. Sediment also penetrates into ship openings, filling voids already there and those produced later as a result of the bio-degradation of the ship's exposed contents.

The combined result of these processes is the build up of sediments around the initially exposed portions of the ship. While wood removal continues as a function of time, the sediments continue to flood the interior compartments of the ship, filling in around the non-bio-degradable artifacts leading to the formation of a small topographic high. The fact that all of the amphora are filled with sediments, even those two meters above the base of the depression, show that the now exposed artifacts were once buried. This is further supported by the fact that the height of the amphora pile is the same as the surrounding ocean floor.

From these observations, we can conclude that after the upper wooden portion of the ship was removed by wood borers and the non-bio-degradable contents buried, bottom currents acting over a long period of time excavated a portion of the once buried ship. As this process took place, newly exposed wood was eaten leaving the observed pile of artifacts carefully stacked in place.

The fact that the ships were located more than 30 nautical miles from shore and on a straight line connecting Ashkelon with Egypt and distant Carthage further supports the proposal that ancient mariners commonly chose the more direct route than the one close to land.

Conservation and the Deepwater Environment

The conservation of archaeological assemblages from deepwater is, in many respects, similar to that of coastal sites. On the 1999 expedition, safe retrieval and transport remained the focus in the field while desalinization and drying were the critical activities in the landbased laboratory. New problems were, however, presented to the archaeological conservator by the deepwater environment of the artifacts. That environment preserved startling good surface detail on unbroken artifacts while at the same time, chemical alterations within those same artifacts created unexpected fragility.

The bulk of the artifacts collected are low-fired pottery vessels, mostly Iron Age earthenware and terra-cotta. Most are self-slipped with a finer portion of the same clay used for the body of the vessel.

All of the pottery shows solubilization to varying degrees. This term refers to pottery that is soft, even powdery, and prone to cracking when dried. This pottery fractures when re-dampened and can even crack when exposed to wide variations in storage room humidity.

The orientation of the finds on the seafloor must be considered when one attempts to understand the deterioration of the pottery. Three terms are used to describe the discoloration and erosion that occurs on different parts of a ceramic vessel from the Ashkelon region: the exposed side and the submerged sides of an artifact, and the biozone. The exposed side of a vessel is in contact with slowly moving, carbonate-saturated seawater. Generations of solitary coral grow and re-dissolve on this surface. The submerged side is embedded in foraminiferal mud having a higher pH than the seawater. At a few centimeters below the seafloor, this mud is often depleted of carbonates and dominated by silicates. The biozone of a deepwater artifact refers to the boundary between the submerged and exposed sides. Here, most coral growth occurs and can maintain a permanent mass of carbonate crust in the form of a ring circling the artifact. As each pot straddles these environments, it is differentially preserved and that, in turn, sets up stresses within the clay of the pot.

The primary environmental causes of the Ashkelon pottery weakness are varied. The exposed-side surfaces are thinned by repeated solitary coral growth cycles. Each cycle removes clay at the point of contact with the coral. Typically, all surface details are eventually lost. While the submerged side of the vessel is spared this, the higher alkalinity and salinity of the interstitial water in the surrounding mud causes increased dissolution of silica and other minerals. This allows the submerged surface of the vessel to have fine surface detail. But it also has the softest clay and most crack-prone surface after drying. Carbonate cementation and depletion also play a role in setting up stresses within the pottery. The biozone, the boundary between the two sides, is usually cemented with carbonates leading to a different shrinkage rate and water saturation content than either the submerged or exposed sides.

The expression of cracking on the dried Ashkelon vessels is the result of manufacturing weaknesses and environmental alteration. Manufacturing weaknesses were introduced during the mixing of the clay, the throwing and firing of the vessel. The environmental stresses slowly accrued during marine burial. A close examination of all finds from the artifacts recovered showed four types of fractures:

1. Biozone Fracture - occurs along the vessel at the point where it meets the seafloor
2. Edge Fracture - occurs perpendicular to the rims and edges of a vessel
3. Turn Fracture - occurs where the shape of the vessel abruptly changes
4. Slip Crazing and Lifting - refers to the fine and sometimes invisible superficial crack pattern on slipped pots

While there are many factors promoting the breakdown of the Ashkelon pottery, it is profitably viewed as a function of the pore volume within the clay body. It is a characteristic of low-fired pottery that it has a large pore or void volume. The solid-state sintering that strengthens fired clay at low firing temperatures does not vitrify the clay. This makes the interior of the clay body accessible to seawater. Chemical action and other environmental stresses will, over time, increase that pore volume and lead to a clay fabric that collapses in on itself during drying. When cracking occurred, it did not express itself until the final stage of drying when the water-swollen clay particles shrink and become brittle.

An indirect method measuring the relative pore volume in a clay body is to measure its maximum water retention. Measurements of the Ashkelon vessels taken at the time of treatment showed that they contained an average of 2 1 % of their dry weight in water. A few of them contained over 30% in water. As a comparison, modern bisque-fired clays absorb only 10 - 14% of their dry weight in water.

To limit drying cracking, each Ashkelon vessel was wrapped in wet fabric to give it an artificial drying surface and placed in incubators at 90-100° F. Elevated humidity was maintained within the incubator during drying to avoid steep moisture gradients within the pottery walls.

While this method is successful in most cases, the Ashkelon pots with the highest moisture content still experienced some cracking. In the future, improved humidity controllers will be installed in the drying tanks and the rate of drying will be further controlled at the expected fracture zones. Research is being done on two treatment refinements: the formulation of additives for the final desalinating phase that will decrease the surface tension of the water solution and a method of clay reinforcement prior to drying. In the field, data collection will be enhanced to better characterize the immediate environments of deepwater artifacts and thus predict their condition. These steps are essential if conservation is to keep pace with the field of deepwater archaeology as it retrieves low-fired pottery and other artifacts from earlier archeological periods.

Summary

In the latter half of the eighth century B.C., the time when Phoenicians were establishing coastal colonies in the central and western Mediterranean and Homer (according to many classicists) was putting the *Iliad* and the *Odyssey* into written form, a fleet of Phoenician ships, the *Tanit* and *Elissa* among them, set sail from the Phoenician mainland. Perhaps they sailed from the great seaport of Tyre, heading south toward their destination somewhere on the coast of northern Africa, probably Egypt or the new-found Tyrian colony of Carthage **farther** west. The two shipwrecks we surveyed were loaded with amphoras once filled with wine, more than 10 tons per ship.

In Ezekiel's famous oracle comparing the city of Tyre to a magnificent ship (chapter 27) – an account with all the credibility of an eyewitness[34], fine wine is being transported overland to Damascus from such far away places as Izalla, near Mardin in Anatolia, where cuneiform sources indicate, wine was fit "for a king." From Damascus these vintages, along with the wines of **Helbon** (a place near Damascus famous in classical sources for its fine wines), were transshipped to the Phoenician port of Tyre.

An enigmatic passage in Ezekiel (27:19) can now be deciphered as *dānê yayin mē'ûzāl*, meaning "pithoi of wine from Izalla."[35] The *dannu*- vessel has a capacity of ca. 180 liters, or 10 times the size of transport amphoras on the two shipwrecks.

So wine of renown was transported overland in large ceramic jars (pithoi) to be decanted into export amphoras at Tyre for shipment to other parts of the Mediterranean. What was obtained in the early 6th century B.C. may also be the case even earlier; which is to suggest that the tons of wine on board the *Tanit* and *Elissa* were not necessarily produce local to Tyre even though the transport amphoras were made in the vicinity.

Some evidence from the two shipwrecks provides clues as to the home base of the crew. At the stern end we found a ceramic mortarium for grinding condiments and cooking pots for the one-pot stews, replenished regularly with fresh-caught fish and other seafood. (The petrographic profile of the cooking pots is consistent with a locale in Lebanon, with best parallels at Tell Arqa.) The incense burner is in the Late Bronze Age tradition, conditioned through the Iron Age, of one being held aloft by a Canaanite sea captain, depicted in a fourteenth century B.C. Egyptian wall relief from the tomb of Kenamun.[36] In his other hand the captain holds a libation cup filled with wine. Both the incense and drink offerings were being offered probably to Baal –Saphon for the safe arrival in Egypt. The incense and wine offerings on **our** Phoenician ships proved to be less efficacious.

The best clue as to the crew's origin comes from the wine decanter with mushroom-shaped lip – the calling card of the Phoenicians from the Levant to the Pillars of Hercules.

The *Tanit* **and *Elissa*** were, then, Phoenician ships manned by Phoenician crews and mainly loaded with a single commodity, fine wines from elsewhere decanted into and transported abroad in Phoenician amphoras.

The ships were roughly the size of the 4th century B.C. Kyrenia ship, estimated to be 25 tons when fully loaded. The *Tanit* and *Elissa* were wide at the beam, about three times as long as they were wide. They are not as slim as Phoenician ships depicted in relief with horse head prows (and sometimes sterns) and known in Greek sources as *hippoi* (“horses”) but more like what the Greeks called *gauloi*, or “tubs.” However, to the Phoenicians and the Israelites these “tubby” seagoing merchant vessels were known by the more respectable rubric *ᶜonîyôt taršiš*, the famous “ships of Tarshish,” mentioned in the Bible (e.g. 1 Kings 10:22; Isaiah 23:1). Examples of these Phoenician merchantmen are illustrated in the famous relief of King Luli and his people fleeing from Tyre to Cyprus (ca. 700 B.C.)[37], and in a clay model ship from Amathus (Cyprus) in Iron Age II.[38] The *Tanit* and *Elissa* were probably part of a Phoenician fleet traveling south from Tyre when, en route from Ashkelon to points west, the unexpected east wind from the desert swept the ships off course, when they flooded and foundered. This is the cruel east wind (*rûᶜah qādîm*), which sank Ezekiel’s “Ship of Tyre” (Ezekiel 27:26), and by which, the Psalmist says the Lord “shelters the ships of Tarshish” (Psalm 48:8).

We can only speculate on the intended destinations of these ships. It could have been Carthage, where the Tyrian founders would not yet have had time to develop fine vineyards (grapes being unknown in the West before the arrival of the Phoenician colonists). We have noted the presence of the torpedo-shaped amphora there. Also we cannot rule out Egypt as their destination, although thus far we have not been able to document the presence of torpedo-shaped amphoras there. What is striking about Egypt is the pattern of Milesian and Sidonian shipping revealed in Aramaic bills of lading from Egypt in 475 B.C., a papyrus brilliantly deciphered by Ada Yardeni.[39] The large consignment of wine (totaling 300-400 resin-lined amphoras per ship) under which were metal ingots of copper, tin, and iron, and, surprisingly, clay for pot making were documented by the bill of lading. The pharaoh was little more than the harbor master and tax collector – the bulk of the cargo going elsewhere in Egypt after the king had taken his tithe or tenth. If Egypt were the intended destination of the *Tanit* and the *Elissa*, they seemed to be on or near a direct route between Ashkelon and the Delta, most likely not hugging the coast as they sailed. These north Sinai coastal waters are among the most treacherous in the eastern Mediterranean.[40] How direct the routes were that the ancient mariners took will only be known after years of deep-sea research. So far, these two shipwrecks are the earliest found in deep waters. There are tens of thousands more waiting to be discovered using these powerful research tools, and exploration has just begun.

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[1] Ballard 1985; Ballard 1998; Ballard et al 2000; McCann and Freed 1994.
[2] Ballard and Dunmore 1995.
[3] Ballard 1982; 1993.
[4] Ballard 1993; Ballard in press; Ballard et. al. 2000.
[5] Ballard 1990.
[6] Ballard, et al. 2000; Whitcomb et al. 2000 and 1999.
[7] Whitcomb, et al. 1999.
[8] Singh, et al. 2000.
[9] Singh et al, 1998
[10] Whitcomb et al. 1999.
[11] Coleman and Ballard, 2001.
[12] Ballard et al. 2000.
[13] Bikai 1978; Gal 1992; Gitin 1990; Geva 1982; Lehmann 1996.
[14] Gal 1992.
[15] Vegas 1999 , 430-431; fig. 21:195-197.
[16] Geva 1982.
[17] Bikai 1978.
[18] The petrographic profile of these vessels is quite distinctive for the eastern Mediterranean. The fabric contains the remains of algae of the genus *Amphiroa* which is a clear marker of the Quaternary beach

deposits of the central Levantine coast (for an extensive discussion of these formations on the northern Israeli coast, see Sivan 1996: particularly page 106, photomicrograph 31; also Yuval Goren, personal communication).

[19] Lehmann, 1996, Tafel 85.448/3.

[20] Lehmann 1996, Tafel 85.448/2.

[21] Yadin et al 1960, LXXXV:7.

[22] Oren 1984, fig 20:14.

[23] Lehmann 1996, Tafel 107.

[24] Blakely and Bennett 1989; Blakely, Brinkmann, and Vitaliano 1992.

[25] Hanfmann 1963, 233: pl 79:922.

[26] Gal and Alexandre 2000, 18: fig. VII, 11:19. *We are grateful to Amichai Mazar for this reference.

[27] Yadin et al. 1960.

[28] Lehmann 1996, Tafel 40.241b/1.

[29] Avigad 1972, 1-5.

[30] Deutsch and Heltzer 1994, 23-26 and fig. 6, pl 25; see also book jacket for color photograph by Zev Radovan.

[31] For a detailed discussion of the ships depicted in the Tomb of Khenamun, see Wachsmann 1998, 42-47 and figs. 3.2-3.6; also Pritchard 1954, No. 111.

[32] Frost 1970, 1991.

[33] Turner 1973.

[34] Diakonoff 1992, suggests (192) that Ezekiel visited Tyre between 588-585 B.C. or had access to a detailed report of the city and its commerce.

[35] Millard 1962.

[36] Pritchard 1954, No. 111.

[37] Barnett 1969, pl. 1:1-2.

[38] Amathus model ship (BM A202): Basch 1987, 254, fig. 559; Casson 1995, 65-66, figs. 86-87.

[39] Yardeni 1994, 67-78

[40] Ezra Marcus suggests a model for Middle Bronze Age sailing between the Egyptian Delta and Phoenicia in which the ship "is envisioned as tacking, or zig-zagging, its way up or down the coast although the latter involves going against the predominant current**"(Marcus 1998, 103).** For a detailed study of the prevalent winds in the Eastern Mediterranean as well as Iron Age navigation techniques see Davis 2000. Davis (2000, 208) and Wachsmann (1998, 331) believe that the brailed sail was invented at the beginning of the Iron Age; the invention opened up more direct routes between ports as ships became less dependent on dominant winds.