

Innovations in Ship Construction at Tantura Lagoon, Israel

Results of the INA/CMS Joint Expeditions (1994–96)

Shelley Wachsmann

Abstract – From 1994 to 1996 the Institute of Nautical Archaeology (INA) at Texas A&M University and Haifa University's Leon Recanati Institute for Maritime Studies (RIMS, previously the Centre for Maritime Studies, or CMS) joined forces to locate and to study shipwrecks buried in Tantura Lagoon, Israel. We located remains of seven shipwrecks during this exploration. Of these, we studied two in situ (Tantura A and B) and five others (Tantura C-G) were surveyed in part. This paper served as an introduction to a session at „In Poseidon's Realm XV“ dedicated to shipwrecks found in Tantura Lagoon during the INA/CMS Joint Expeditions (1994–1996) and their significance.



Inhalt – Von 1994 bis 1996 arbeiteten das Institute of Nautical Archaeology (INA) der Texas A&M University und das Leon Recanati Institute for Maritime Studies (RIMS, ehemals Centre for Maritime Studies [CMS]) der Haifa University zusammen, um Wracks in der Tantura-Lagune, Israel, zu lokalisieren und zu untersuchen. Bei dieser Suche stellten wir Reste von sieben Wracks fest. Davon untersuchten wir zwei (Tantura A und B) in situ und nahmen fünf weitere (Tantura C-G) teilweise auf. Dieser Beitrag diente im Rahmen der Tagung „In Poseidons Reich XV“ als Einführung in eine Sitzung, die den bei den gemeinsamen Expeditionen von INA und CMS 1994-96 gefundenen Wracks der Lagune und ihrer Bedeutung gewidmet war.

Introduction

Tantura Lagoon lies on the Carmel Coast, a half-hour drive south of the modern city of Haifa. It is one of the few natural harbors along Israel's long Mediterranean coast and is situated next to the ancient mound (tel) of Dor, which contains occupation levels 15 meters thick and is the second largest tel in Israel¹. While the local geography has no doubt changed dramatically over time, it is clear that the cove served as an anchorage for Dor and its immediate environs: it was a significant, if not *the most significant*, reason for the establishment of settlement at this location, acting as a gateway between the cosmopolitan Mediterranean Sea and the hinterland of the Carmel Mountains.

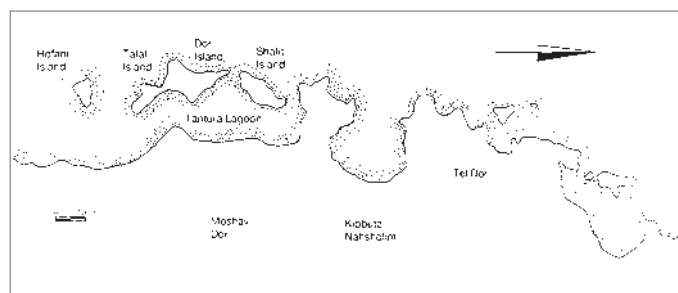


Fig. 1: Tantura Lagoon and its environs.

The tel and the cove contain four millennia of history and archaeology. Dor/Naphat Dor appears several times in the Bible. The city joined Jabin, the king of Hazor in opposing Joshua². Later, the Israelites under Joshua killed the king of Dor³. The city itself, was not defeated, however, and it remained a Canaanite enclave during the period of the Judges. Under Solomon, Naphat-Dor became an administrative center⁴.

In 1075 BC Wenamun, an Egyptian priest, visited Dor on his way to

Byblos in Lebanon to acquire wood for Herihor's rebuilding of the *Amunuserhet*, the cult ship of the god Amun⁵. Wenamun reports that in his time the site had been settled by Sekels, one of the groups of Sea

Peoples known from Egyptian and Ugaritic texts⁶. Phoenicians ruled this coast during the Persian period (586–332 BC)⁷. For a short time in the mid-fifth century B.C. Dor may have been absorbed into the Athenian empire⁸.

The lagoon could not compete with the great Herodian harbor at Caesarea during the Roman period and by the mid-third century A.D. the tel itself was abandoned, however, a century later a church arose immediately adjacent to the tel that attracted Christian pilgrims during the Byzantine period⁹.

Inhabitation appears to have declined in this area after the seventh century. The Arab village of Tantura, which gave its name to the cove, apparently sprang up opposite it in medieval times¹⁰. While Dor is not mentioned by Arab geographers of the ninth-twelfth centuries, an Arab graveyard dating to the eighth-fourteenth centuries in the vicinity of the Byzantine church testifies to continued occupation in the area at this time¹¹. Subsequently, numerous travelers recorded visiting this location. The Chevalier d'Arvieux, who served as the French consul to Sidon, describes the wrecking of a Greek ship in the lagoon during a visit to Tantura in 1664¹².

Undoubtedly, Napoleon Bonaparte was the most illustrious of these visitors¹³. He passed through Tantura during his benighted retreat from his siege of Acco, arriving there on May 21st, 1799. Bonaparte expected to liaison with his fleet in the cove, but it never arrived and he was forced to jettison a score of artillery pieces into the sea. A Turkish cannon and a Spanish mortar from among these have been retrieved from the lagoon¹⁴.

In the 19th century Tantura Lagoon continued to function as a port trading mainly in watermelons and charcoal. In the 1890s the Baron Edmund de Rothschild founded a short-lived glass factory at Tantura to manufacture bottles for the Zichron Yaakov vineyards¹⁵. Settlement continues with the Israeli communities of Nahsholim and Dor: the cove is home to a small fleet of Arab fishing boats and has also become a popular recreational beach¹⁶.

Today Tantura Lagoon is closed on the north by a sand tombolo connected to an unnamed rocky island and bordered to the west by a series of islands named from north to south: Shafit, Dor, Tafat and Hofami (Fig. 1). During storms water flows in between the islands resulting in a strong north to south current, which constantly shifts the thick sand layer covering the lagoon. This process tends to rapidly bury ships that wreck in the cover under a

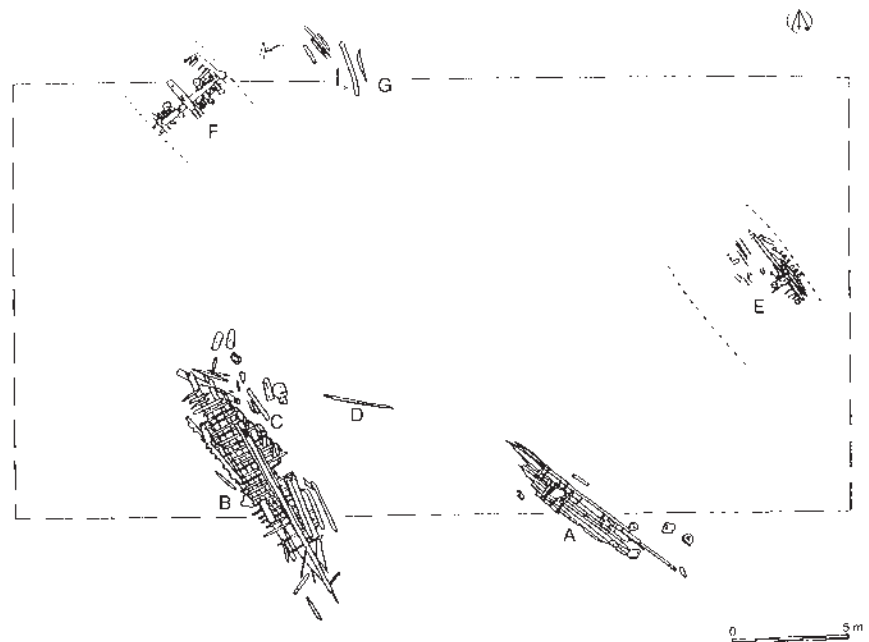


Fig. 2: Map of the vessels found in Tantura Lagoon by the INA/CMS Joint Expedition (1994-1996). The ship remains lay in an extremely small area. As a reference, the superimposed rectangle represents the size of a single regulation basketball court (28.65 by 15.24 meters). Note that all the coherent hulls align roughly northwest to southeast. This is perhaps the result of the eastern part of each ship being buffeted during its wrecking event by the cove's powerful north-to-south current generated during storms.

protective covering of sand. Thus, the lagoon acts as a natural mechanism for trapping and preserving the remains of hapless vessels and their related remains, as well as the regular jetsam and debris of a fully-functioning anchorage. These considerations, in addition to the four millennia during which the anchorage has been active, make Tantura Lagoon an ideal location for the study of shipwrecks.

From 1994 to 1996 the Institute of Nautical Archaeology (INA) at Texas A&M University and Haifa University's Leon Recanati Institute for Maritime Studies (previously the Centre for Maritime Studies, or CMS) joined forces to locate and to study shipwrecks buried in the cove¹⁷. During three seasons of exploration we located seven shipwrecks in an area about the size of a regulation basketball court (Fig. 2). Although the wrecks range in date from the Roman period to recent times, most of the vessels cluster in the Late Roman to Medieval periods. In early publications the wrecks were identified by the trenches in which they were discovered.

Subsequently, I assigned the wreck letter designations (Tantura A-G).

Tantura A (Trenches IV & VI)

The discovery of the Tantura A shipwreck began in 1983 when, while serving as Inspector of Underwater Antiquities for the Israel Department of Antiquities and Museums (IDAM, now the Israel Antiquities Authority), I conducted a routine survey with K. Raveh in the lagoon following a winter storm. During the dive my hand came to rest on something jutting from the seabed that felt „spongy“. Upon examination, this turned out to be the extremity of a ship's waterlogged wooden frame that was otherwise entirely buried in the sand. Hand fanning revealed additional strakes, frames and ceiling planking upon which lay intact „bag-shaped“ jars and copious quantities of sherds dating to the Byzantine period, A.D. 324-638¹⁸. Some of the timbers showed signs of charring.

It was not possible to expand the search area at that time as the same

storm that uncovered these timbers also revealed additional cargoes on the Carmel coast that required immediate attention¹⁹. By the time this work was completed, the shifting sands of Tantura had buried the timbers again. In 1985 we returned to the site with CMS staff members S. Breitstein and Y. Tur-Caspa, as well as a team of British divers from the Nautical Archaeology Society (NAS) led by Vallerie Fenwick. This attempt, too, was stymied due to logistical problems and we, again, succeeded in uncovering only a small area of the „hull“ and its cargo.

In 1994, I returned for a third time determined to excavate the „shipwreck“ that had eluded me for so long. By this time I was teaching at Texas A&M University, and I carried out this excavation under the INA aegis jointly with CMS led by Y. Kahanov.

In the 1980s I had recorded the location of the buried timbers by means of shore sightings: Unfortunately, a decade later structures that had formed one of my two reference lines had been demolished. This left us with a *line* rather than a point with which to relocate the timbers hidden under some 2 meters of sand. Following this line, we excavated a series of test trenches. These ultimately proved useful, as they gave us our first view of the positioning of artifacts beneath the sand in the cove. In this way we discovered a „flow“ of Byzantine period artifacts stretching north-south, which we followed for about 60 meters. Finally, in Trench IV we relocated the timbers studied in 1983 and 1985. Until then I had assumed – wrongly as it turned out – that these few timbers constituted part of a coherent shipwreck.

The newly enlarged area revealed, however, that the entire collection of timbers consisted of only a few strake fragments, ceiling planks and frames that had been ripped from a hull surrounded by Byzantine ceramics²⁰. I hypothesized that the timbers and pottery flow must have come from a shipwreck located farther north and that the cur-



Fig. 3: A) Using the hydraulic probe.



Fig. 3: B) Wood fragments raised by the probe.



Fig. 4: A) The Tantura A shipwreck..



Fig. 4: B) Charring on the strakes.

rent had transported them during the wrecking event.

Employing a hydraulic probe we began following the general line of the buried pottery flow north (Fig. 3 A)²¹. Along the way we located two lead-filled wooden anchor stocks under 2 meters of sand²². The stocks were barely 20 centimeters across and about 2 meters in length. Finding these anchor stocks is arguably the archaeological equivalent of finding a needle in a haystack and speaks volumes to the effectiveness of this search technique under the proper conditions.

Eventually, we found two adjacent wood anomalies at the northern end of the pottery flow suggestive of a larger wooden structure buried in the sand. Opening Trench VI we found a large section of hull, which I termed „Tantura“ A (Fig. 4 A). A post and the keel continued for over 6 meters²³. The hull is believed to have been about 12 meters long and 4 meters at its greatest breadth. The ship's southern side survived up to the turn of the bilge. The hull lay on an approximately northwest to southeast axis. At the southeastern end the keel had been snapped off cleanly, as if it were a matchstick. The entire northern side of the hull, except for a portion of the garboard strake had been swept away at the keel. Even on the surviving southern side of the hull we saw evidence of the forces that had ripped apart the ship. Most of the frames had been torn off the hull in what must have been a zipper-like effect, taking with them the superstructure and cargo. Only a few frame pieces remained in place near the post. Framing positions appeared as discolorations, some of which contained concreted iron nails that had once held the planking to the frames: In other cases the nails had been ripped out of the planks when they accompanied the frames, leaving behind holes in the strakes.

The hull showed signs of charring similar to that noticed on the flanks in Trench IV (Fig. 4 B). On Tantura A charring was limited to



the two ends of the hull. It also continued across framing stations, indicating that it was not the result of fire onboard ship, but rather that the planks had been charred prior to their attachment to the frames. These considerations led J.R. Steffy to conclude that the charring represents evidence of „char-bending“ a process by which water-soaked planks are formed into their required curvatures as they are heated over a fire. Thus, the charring is located specifically at the ends of the hull because that is where the stakes require their strongest curvature, as they bend inwards to meet the posts. This is the earliest documented evidence for this process on planked-hull ship construction.

At the time of Tantara A's discovery common wisdom had the transfer of technologies from shell-based with pegged mortise-and-tenon joints to frame-based construction was completed only in the 11th century A.D., with the Serçe Limanı shipwreck being the earliest known example of this type of construction²⁴. We fully expected to find the earlier construction techniques on the Tantara A vessel, which seemed to date to a half a millennium earlier than the Serçe Limanı shipwreck, but we found no indicators of shell-based construction. During the limited remaining time available in 1994 we studied the keel, as well as all exposed strake edges for mortise-and-tenon joints, but found none. It seemed that in its constructional details Tantara A found its closest parallels in the 11th-century A.D. Serçe Limanı shipwreck.

We considered other possibilities. We hypothesized that there may have been two shipwrecks: one that sank at the end of the Byzantine period and scattered its cargo across the lagoon and another (Tantara A) that wrecked in the cove a few centuries later and into which pottery from the first wreck had washed in. This scenario, although unlikely, is not entirely impossible due to the dynamics of the lagoon during storms.

Arguing against this, however, were two considerations. First, some of the Byzantine sherds lying on the hull were stuck to the planking with what appeared to be mastic, the putty-like material, now rock hard, that the shipwrights had placed between the frames and planking. Second, we removed sections of the keel for dendrochronological and radiocarbon testing. While the former proved inconclusive, the radiocarbon tests suggest that the wood was cut ca. A.D. 415-530, agreeing with the Byzantine date derived from the pottery²⁵.

Thus, the Tantara A shipwreck became the first of several vessels from the lagoon to indicate a complete transition to a frame-based hull construction about a half millennium earlier than previously thought²⁶. This modest little coaster had been built with the innovative methods that were to evolve more fully and to become standardized during medieval times. Steffy notes that such changes were likely to have taken place first on small vessels like Tantara A as these employed lighter timbers, which permitted the shipwrights to discontinue the use of mortise-and-tenon joinery that by their time were being used only to align planks on larger contemporaneous ships, like the seventh-century Yassı Ada shipwreck²⁷.

Paleoethnobotanical study of organic remains retrieved from the shipwrecks can give us additional information regarding the ships that wrecked in Tantara Lagoon, their crews and cargoes. A single sample of bilge mud recovered from near the Tantara A shipwreck's keel contained a potpourri of pollen from 19 taxa, while others remain unidentified. Olive (*Olea europaea*) is the most common domesticated plant in the sample, with cereal pollen second in quantity. Other significant fossil pollens include grape (*Vitis sp.*), hazelnut (*Corylus*), sumac (*Rhus*), terebinth (*Pistachia sp.*) and palm (*Areacaea*), as well as several species of umbels, a family that includes many spices, such as caraway, celery, cumin and dill.

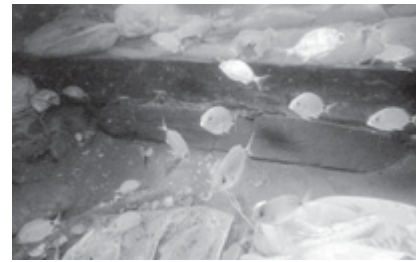


Fig. 5: A) Stone anchor stock in situ beneath the keel of the Tantara A shipwreck.

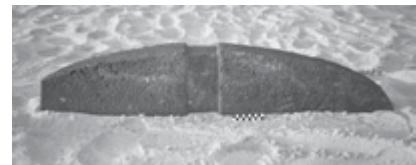


Fig. 5: B) The anchor stock.

The sample also contained three hemp (*Cannabis sativa*) pollen, which perhaps derive from the vessel's cordage. The only pollen grain, of wild grass, identified from a sample of rope derives from the cordage compressed between the keel and the anchor stock. The most common seed type was wine grape (*Vitis vinifera*).

One rarely finds multi-period stratigraphy while excavating a shipwreck, but Tantara Lagoon is so abundant in material culture that we repeatedly uncovered meaningful configurations. For example, Tantara A's keel rested on two earlier anchoring devices: a stone anchor and an inverted 53 kilogram stone anchor stock, which predates the wreck by about a millennium (Fig. 5 A-B)²⁸.

The hull must have come to rest here before it broke up entirely as otherwise it would be difficult to explain the near perfect alignment of the surviving strakes even though most of the frames are missing. The wrecking event apparently also caused the dispersal of the vessel's cargo. Cordage found beneath the wreck, between it and the stone anchor stock, presumably represents the ship becoming entangled in its own rigging during the wrecking event²⁹.

In 1995 we completed the in situ study of Tantara A. That year we also continued the hydraulic probe

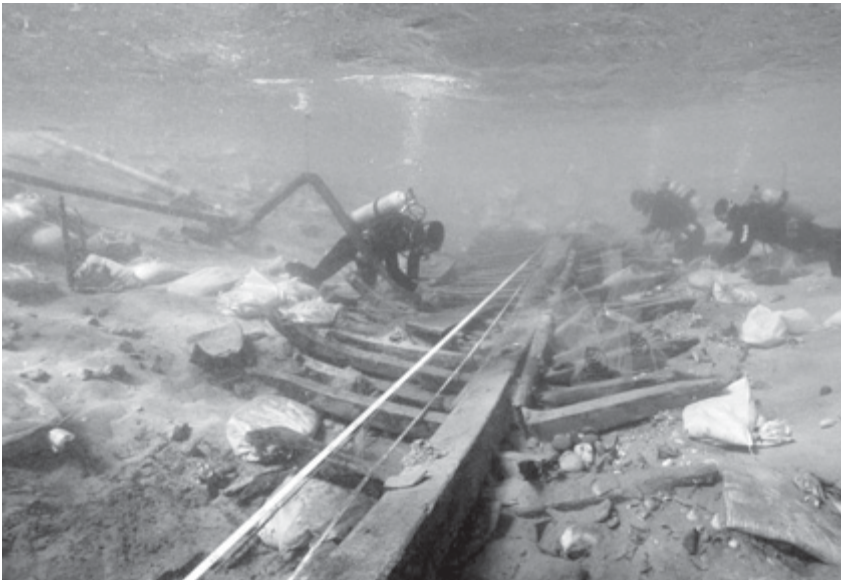


Fig. 6: A) The Tantara B shipwreck.



Fig. 6: B) Y. Kahanov records crenellations on the bottom surface of the Tantara B keelson.



survey in search of additional missing sections of the Tantara A hull. We did not find any, but the results were not disappointing for we discovered remnants of other shipwrecks.

Tantara B (Trench VIII)

One vessel lay west of Tantara A in Trench VIII. This wreck, designated Tantara B, was the primary focus of the 1996 expedition during which it was recorded entirely in situ³⁰. The continuity of this vessel's long and narrow hull breath indicates a galley (Fig. 6 A)³¹. Steffy felt that the surviving section might represent less than 25 percent of the hull's bottom³².

This vessel dates to the early ninth century A.D.³³. It is constructed in a skeleton-based method, which is indicated by planking joints situated against frame stations and the extensive use of caulking. The rockered keel is preserved for 9.8 meters and contains two horizontal hook scarves. The imposing rockered keelson, preserved for 7.48 meters is the most substantial centerline timber: it has a maststep cut into its upper surface and notches in its undersurface to seat the alternating floors and pairs of half-frames (Fig. 6 B). The extant part of the keelson is composed of two tim-

bers, attached by means of a hookscarf covered by a timber secured to it by nails.

The keelson has a lightly fastened longitudinal stringer on either side. This may indicate that the main purpose of these stringers was to serve as a base for the inner edges of ceiling planks aligned perpendicular to the keel. The outer edges of the ceiling planking would have been seated at the turn of the bilge. Three loose-fitting ceiling planks survived on the wreck. The crenellations on one ceiling plank apparently originally were meant to sit snugly over the frames at the turn of the bilge. It has a single graffito – HX – when viewed from the vessel's centerline.

The southwestern side of the hull had seven surviving strakes while six remained on the northeastern side. The sixth strake on each side is narrower and thicker than the other strakes and appears to be a bilge-keel or bilge-wale.

The hull is relatively flat, with a maximum beam of about 5 meters. The vessel's original length is impossible to determine as both extremities are missing. If it was a single master, it may have been 19 meters long, but if it carried two masts it might have reached an original length of 30 meters.

The shipwrights made the vessel's keel of oak (*Quercus*). They also used oak for the longitudinal strengthening piece placed over the keelson scarf and probably for the bilge keels as well. Pine (*Pinus*) was used for the keelson and planks. Aleppo pine (*Pinus halepensis*) served for the keelson stringers, frames, garboards, and the ceiling planking.

Cordage of various diameters was found throughout the hull. We recovered four wooden toggles, two of which were found with rope still adhering to them and three spatulate-shaped objects³⁴. M. Polzer has identified the latter as spill-toggles, each with a hole for the attachment of a trip-line. These may support the likely conclusion that the ship carried one or more lateen sails³⁵.

The wreck also contained an inlay of bone or ivory, a wooden decorative piece and a gourd, which still bears a deep orange color³⁶. Three wooden roundels were recovered: one bears a carved Kufic inscription: „God has the purest judgment“³⁷.

Although the hull contained no cargo, numerous artifacts recovered teach us much about the ship and crew. Of particular interest is a large Abbasid-period (A.D. 750-935) oil lamp, which was found



Fig. 7: Shipwrecked oil lamps. A) Tantara B.



Fig. 7: B) Tantara C.

associated with five bivalve shells (Fig. 7 A): similar shells found on the seventh century A.D. Yassı Ada shipwreck have been interpreted as spoons³⁸. A second Abbasid lamp, smaller in size lay just beyond the hull's northwest quadrant³⁹.

Tantara C-D (Trench VIII)

In a truly remarkable example of underwater stratigraphy, in 1996 we found that Tantara B rested upon another shipwreck, Tantara C, which was built in pegged mortise-and-tenon construction and covered with Roman pottery and glass (Fig. 8)⁴⁰. As this shipwreck was found at the end of the expedition and continued under Tantara B, we were able to reveal only a small portion of Tantara C, which we then recorded and reburied. D. Davis tentatively interprets the timbers as consisting of a keel, a false keel and a garboard strake⁴¹. One plank was identified as cypress (*Cupressus*)⁴².

The vessel's ceramic cargo consisted primarily of globular vessels with different upper finishings. It also contained a pristine oil lamp with a Christian *tau-rho* symbol, suggesting a fourth century A.D.

date for this shipwreck (Fig. 7 B)⁴³. Trench VIII also contained remains of a third wreck (Tantara D). During the 1995 season a small piece of plank with two pegged mortise-and-tenon joints was found northwest of the Tantara B wreck, associated with Roman pottery⁴⁴. The next year northeast of Tantara B we uncovered a keel and two frames belonging to a more lightly-built vessel, constructed with pegged mortise-and-tenon joinery (Fig. 9 A-B).

Fig. 8: The Tantara C shipwreck peeks out from beneath Tantara B.

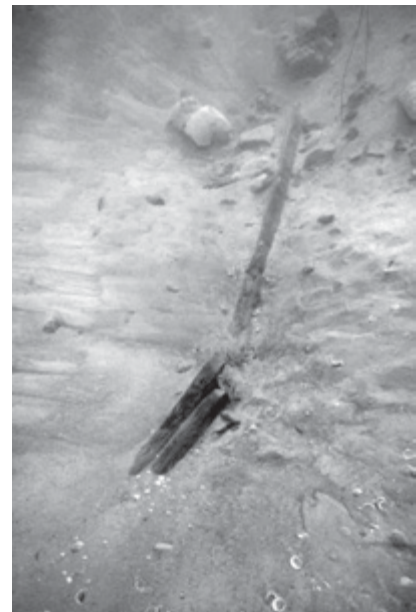


Fig. 9: The Tantara D shipwreck. A) The keel and the two frames.



B) Detail of the keel with a pegged mortise-and-tenon joint.



Fig. 10: The Tantara E shipwreck.

Tantara E (Trench IX)

On the last days of the 1995 season we found another shipwreck in the channel that had been deepened by storm action (Fig. 10)⁴⁵. We uncovered one of the keel's extremities and found a false keel that continues forward of the keel and is then slotted back into its end. The hull had many heavy stingers, most of which were only roughly finished. Of particular interest was a transverse timber placed over the frames and stringers, with a groove carved into the length of its upper surface, which appears to be the seat for a removable bulkhead⁴⁶. Ceiling planking covered most of the visible hull. The ceiling planking is laid perpendicular to the keel from the end of the keel to the bulkhead seat: beyond that, towards amidships, the planking is laid parallel to the keel. We found two graffiti carved into ceiling planks – one was a cross surrounded by an arc and the other was delta-shaped. This vessel dates

to the eighth century A.D. In 2006-2008 Tantara E was excavated in situ by a joint expedition of RIMS and NAS⁴⁷.

Fig. 11: The Tantara F shipwreck at the time of its discovery. Note the maststep.



Fig. 12: Timbers and cordage of the Tantara G shipwreck.



Tantara F (Trench X)

The 1996 hydraulic probe revealed another shipwreck, termed Tantara F (Fig. 11)⁴⁸. Trench X came down on the center of the hull, revealing a massive rectangular maststep. This was placed over a pair of rough-hewn centerline „stringers“, which were half-logs cut lengthwise down the center, each with one flat and one rounded end, which were placed flat side up. A layer of reeds had been placed parallel to the keel, over the frames, as dunnage. This vessel, which dates to the early eighth century A.D., was excavated in situ in 2004 by a joint expedition of RIMS and NAS⁴⁹.

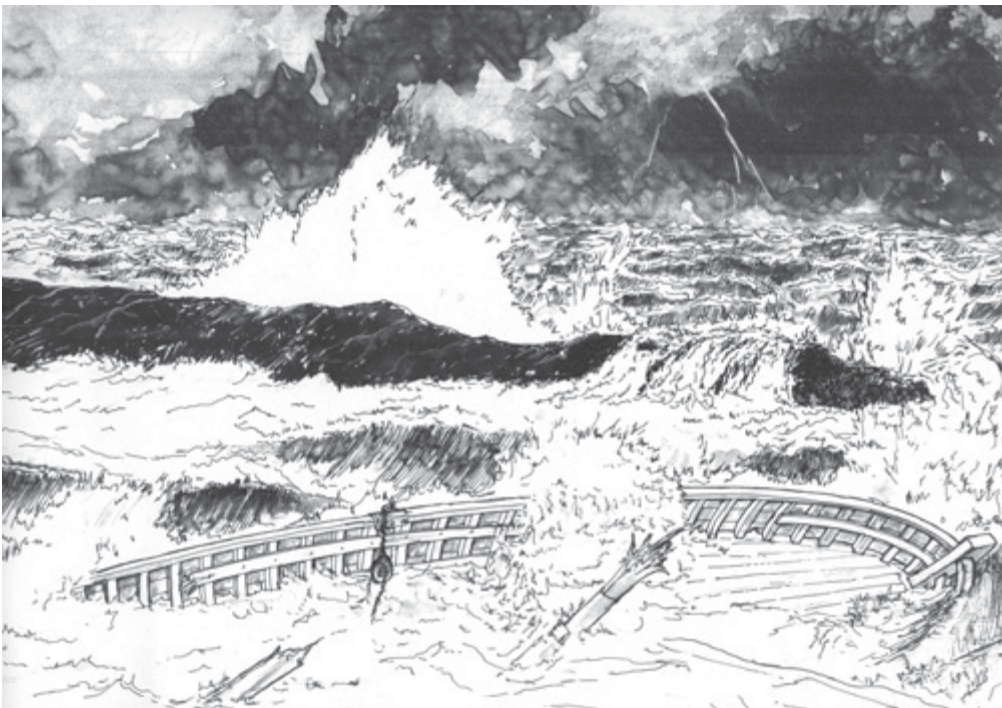
Tantara G (Trench VII)

Finally, north of Tantara A we located ten disarticulated frames and a single plank, designated Tantara G (Fig. 12)⁵⁰. This area also contained organic items including long spans of rope, basketry and some dyed



*Fig. 13:A + B
Artist's conception of
the shipwreck process
at Tantara Lagoon.*

A ship runs before a storm (A, right). She is caught against a lee shore and makes a run between two islands, but is broken on the shoals between the islands (A, center).



As the vessel takes on water (B), the surge and waves push her into the lagoon, where the large sections of the hull are swiftly buried by the constantly migrating sands.

cloth. One rope ended in an eyesplice and another was knotted. It appears that all these artifacts come from a single vessel. A radiocarbon test of one of the timbers suggests a date in the 18th century A.D.

Conclusions

Most of the ships discovered by the INA-CMS Joint Expedition ended

their lives traumatically. This is certainly the case with shipwrecks Tantua A, B, D and G. In some cases keels and keelsons were snapped like matchsticks, and entire sections of ships are missing or transposed⁵¹. We simply do not know the reasons for the sinking of Tantara C, E and F. As noted above, the islands prevent waves from entering even during the most violent winter storms. The onrush of water

results, however, in a very strong north to south current due to the northern tombola. The most likely scenario for the catastrophic destruction of these vessels is that they entered the lagoon between the islands during storms, were damaged as they went over the rocks between the island and began breaking up (Fig. 13 A). Once inside the lagoon, the current during a storm could account for the spread

of the ship's parts and its cargo across the bottom of the lagoon. Very soon after the sinking event the shifting sands must have buried the wreck and its cargo (Fig. 13 B).

Tantura Lagoon has proven to be a remarkable ship graveyard. Some of the loose ceramics recovered from the cove date to periods for which we have no shipwrecks⁵². If these remains have been spread across the lagoon by ships that wrecked and sank in the lagoon, in the manner that we documented with the Tantura A shipwreck then they suggest a treasure trove of archaeologically and historically significant shipwrecks. There are few Mediterranean ports that are likely to contain within them shipwrecks from such a wide swath of history.

Bibliography

Abbreviations: *IJNA*
IEJ

- Barkai, O. 2010: The Tantura F Shipwreck: A Case Study of Trade in the Eastern Mediterranean Between the Mid-7th and the End of the 8th Century AD, *SKYLLIS, Zeitschrift für Unterwasserarchäologie* 11, 2011, 18-20.
- Barkai, O. – Kahanov, Y. 2007: The Tantura F Shipwreck, Israel, *IJNA* 36, 21-31.
- Barkai, O. – Kahanov, Y. – Klein, S. 2007-2008: The Tantura F Shipwreck: Analysis of the Ceramic Material, *SKYLLIS Zeitschrift für Unterwasserarchäologie* 8, 30-32.
- Brosh, N. 1985: Finds from the Mamaluke Period: 15th Century CE, in: Misch-Brandl, O. (ed.), *From the Depths of the Sea: Cargoes of Ancient Wrecks from the Carmel Coast*. The Israel Museum Catalogue No. 263 (Jerusalem) 17-22, pls. 31-22.
- Carmi, Y. – Segal, D. 1995: How Old is the Shipwreck from Tantura Lagoon? The Radiocarbon Evidence, *IJNA* 22(2), 12.
- Charlton, W.H., Jr. 1995: The Rope, *INA Quarterly* 22(2), 17.
- Christides, V. 1988: The Coastal Towns of Bilād al-Shām at the Time of the Rāshidūn (632-661). Defence and Trade Ἐπιτηρις Κέντρον Ἐπιστημονικῶν Ἐρευνῶν 13-14 (1 Λευκωσία, 1984-1987), 49-62.
- Cvikel, D. 2007-2008: One of Napoleon Bonaparte's Ships? The Dor 2002/2 Shipwreck and Its Construction Details. *SKYLLIS Zeitschrift für Unterwasserarchäologie* 8, 83-85.
- Dahl, G. 1915: The Materials for the History of Dor, *Transactions of the Connecticut Academy of Arts and Sciences* 20 (New Haven).
- Dauphin, C.M. 1979: Dor, Byzantine Church, *IEJ* 29, 235-236.
- Dauphin, C.M. 1981: Dor, Byzantine Church, 1980, *IEJ* 31, 117-119.
- Dauphin, C.M. 1982-1983: On the Pilgrim's Way to the Holy City, *Bulletin of the Anglo-Israel Archaeology Society* 1, 25-31.
- Dauphin, C.M. 1983: La basilique de Dors, *Archaeologia* 180-181 (Juillet-Aout), 68-75.
- Dietrich, M. – Loretz, O. 1978: Das „Seefahrende Volk“ Šikila (RS 34.129), *Ugarit-Forschungen* 10, 53-56.
- Egberts, A. 1991: The Chronology of The Report of Wenamun, *Journal of Egyptian Archaeology* 77, 57-67.
- El'ad, A. 1982: The Coastal Cities of Palestine During the Early Middle Ages. The Jerusalem Cathedra: Studies in the History, Archaeology, Geography and Ethnography of the Land of Israel 2, 146-167.
- Gianfrotta, P.A. 1977: First Elements for the Dating of Stone Anchor Stocks, *IJNA* 6, 285-292.
- Gilboa, A. 2005: Sea Peoples and Phoenicians Along the Southern Phoenician Coast: A Reconciliation: An Interpretation of Šikila (SKL) Material Culture *Bulletin of the American Schools of Oriental Research* 337, 47-78.
- Greene, E. 2003: Endless Summer: The 2002 Excavation season at Pabuç Burnu, Turkey, *INA Quarterly* 30.1: cover, 3-11.
- Greene, E.S. – Polzer, M.E. 2004: Evidence for a 6th-Century Lifeboat and its Anchor? *INA Quarterly* 31.3 (Fall), 12-18.
- Haldane, D.D. 1984: The Wooden Anchor (MA Thesis, Texas A&M University).
- Hale, J.R. 2009: *Lords of the Sea: The Epic Story of the Athenian Navy and the Birth of Democracy* (New York).
- Heyd, U. 1956: A Turkish Description of the Coast of Palestine in the Early Sixteenth Century, *IEJ* 6, 201-216, pls. 29-30.
- Israeli, E. 2010: Tantura E, Hull Construction Report, *SKYLLIS* 11, 2011, 41-45.
- Kahanov, Y. – Breitstein, S. 1995: A Preliminary Study of the Hull Remains, *INA Quarterly* 22.2, 9-13.
- Kahanov, Y. – Royal, J.G. 2001: Analysis of Hull Remains of the Dor D vessel, Tantura Lagoon, Israel, *IJNA* 30.2, 257-265.
- Kahanov, Y. – Royal, J. – Hall, J. 2004: The Tantura Wrecks and Ancient Mediterranean Shipbuilding, in: Hocker, F.M. – Ward, C.A. (eds.), *The Philosophy of Shipbuilding: Conceptual Approaches to the Study of Wooden Ships* (College Station, Texas) 113-127.
- Kapitän, G. 1982: On Stone-Stocked Greek Anchors as Found in Thracia Pontica: Suggested Reconstruction of Their Wooden Parts, in: Fol, A. (ed.), *Thracia Pontica I. Premier Symposium International „La Mer Noire et le monde méditerranéen“*, 1979, *Sozopol (Sofia)* 290-299.
- Kapitän, G. 1984: Ancient Anchors? Technology and Classification, *IJNA* 13, 33-44.
- Karmon, Y. 1956: Geographical Aspects in the History of the Coastal Plain of Israel, *IEJ* 6, 33-50.
- Khalilieh, H.S. 2005: The Enigma of Tantura B: Historical Documentation and the Lack of Circumstantial Documentary Evidence, *IJNA* 34, 314-322.
- Khalilieh, H.S. 2008: The Ribā? of Arsūf and the Coastal Defence System in Early Islamic Palestine, *Journal of Islamic Studies* 19, 159-177.
- Kingsley, S.A. 2003: The Dor D Shipwreck and Holy Land Wine Trade, *IJNA* 32.1, 85-90.
- Kritzas, C.B. 1989: Remarks on an Inscribed Anchor Stock from Aegina (IG IV, 176), in: Tzalas, H. (ed.), *Tropis I. First Internat. Symposium on Ship Construction in Antiquity, Piraeus 1985 (Athens)* 203-207.
- Lehmann, G.A. 1979: Die Šikalāyū ? Ein neues Zeugnis zu den „Seevölker“-Heerfahrten im späten 13. Jh. v. Chr. (RS 34.129), *Ugarit-Forschungen* 11, 481-494.
- Liphschitz, N. – Pulak, C. 2007-2008: Wood Species Used in Ancient Shipbuilding in Turkey: Evidence from Dendrochronological Studies, *SKYLLIS Zeitschrift für Unterwasserarchäologie* 8, 73-79.
- Littman, R.J. 1990 [2001]: Dor and the Athenian Empire, *American Journal of Ancient History* 15, 155-176.
- Misch-Brandl, O. – Galili, E. 1985: Finds from the Hellenistic Period: 4th-2nd Centu-



- ries BCE. In Misch-Brandl, O. (ed.), *From the Depths of the Sea: Cargoes of Ancient Wrecks from the Carmel Coast*. The Israel Museum Catalogue No. 263 (Jerusalem) 12-16, pls. 8-30.
- Mor, H. – Kahanov, Y. 2006: The Dor 2001/1 Shipwreck, Israel – A Summary of the Excavation, *IJNA* 35, 274-289.
- Polzer, M.E. 2004: An Archaic Laced Hull in the Aegean: The 2003 Excavation and Study of the Pabuç Burnu Ship Remains, *INA Quarterly* 31.3 (Fall), 3-11.
- Polzer, M.E. 2008: Toggles and Sails in the Ancient World: Rigging Elements Recovered from the Tantara B Shipwreck, Israel, *IJNA* 37, 225-252.
- Rainey, A.F. 1982: Toponymic Problems (Cont.), *Tel Aviv* 9, 130-136.
- Rainey, A.F. – Notley, R.S. 2006: *The Sacred Bridge: Carta's Atlas of the Biblical World* (Jerusalem).
- Royal, J. – Kahanov, Y. 2000: An Arab Period Merchant Vessel at Tantura Lagoon, Israel, *IJNA* 29, 151-153.
- Royal, J. – Kahanov, Y. 2005: New Dating and Contextual Evidence for the Fragmentary Timber Remains Located in the Dor D site, Israel, *IJNA* 34, 308-313.
- Sibella, P. 1995: The Ceramics, *INA Quarterly* 22.2, 13-16.
- Sibella, P. 1997: Light from the Past: The 1996 Tantura Roman Lamp, *INA Quarterly* 24.4, 16-18.
- Simpson, W.K. (ed.) 1972: *The Literature of Ancient Egypt: An Anthology of Stories, Instructions, and Poetry* (New Haven).
- Steffy, J.R. 1982a: Reconstructing the Hull in: Bass, G.F.J. – van Doorninck, F.H. (eds.), *Yassi Ada I: A Seventh-century Byzantine Shipwreck* (College Station, TX) 65-86.
- Steffy, J.R. 1982b: The Reconstruction of the Serçe Liman Vessel: A Preliminary Report, *IJNA* 11, 13-34.
- Steffy, J.R. 2004: Construction and Analysis of the Vessel, in: Bass, G.F. – Matthes, S.D. et al. (eds.), *Serçe Limanı: An Eleventh-Century Shipwreck*. Vol. I. (College Station, TX) 153-169.
- Steffy, J.R. 1994: *Wooden Ship Building and the Interpretation of Shipwrecks* (College Station, TX).
- Stern, E. 1993a: Dor, in: Stern, E. (ed.), *The New Encyclopedia of Archaeological Excavations in the Holy Land*, Vol. 1 (Jerusalem) 357-368.
- Stern, E. 1993b: The Many Masters of Dor: Part I – When Canaanites Became Phoenician Sailors, *Biblical Archaeology Review* 19.1, 22-31, 76-78.
- Stern, E. 1993c: The Many Masters of Dor: Part I – How Bad was Ahab?, *Biblical Archaeology Review* 19.2, 18-29.
- Stern, E. 1993d: The Many Masters of Dor: Part III – The Persistence of Phoenician Culture, *Biblical Archaeology Review* 19.3, 38-49.
- Stern, E. 1994: Dor – Ruler of the Seas: Twelve Years of Excavation at the Israelite-Phoenician Harbor Town on the Carmel Coast (Jerusalem).
- Stern, E. (ed.) 1995: *Excavations at Dor, Final Report: Areas A and C: Introduction and Stratigraphy*, *Qedem Reports* (Jerusalem).
- Stern, E. 2008: Dor, in: Stern, E. (ed.), *The New Encyclopedia of Archaeological Excavations in the Holy Land 5: Supplementary Volume* (Jerusalem) 1695-1703.
- van Doorninck, F., Jr. 1982: The Hull, in: Bass, G.F. – van Doorninck, F.H., Jr. (eds.), *Yassi Ada I: A Seventh-Century Byzantine Shipwreck* (College Station, TX) 32-64.
- Wachsmann, S. 1982: The Ships of the Sea Peoples (*IJNA* 10.3: 187-220), *IJNA* 11, 297-304.
- Wachsmann, S. 1987: Napoleon's Guns., in: Throckmorton, P. (ed.), *The Sea Remembers* (London) 81-83.
- Wachsmann, S. 1995: The 1994 INA/CMS Joint Expedition to Tantura Lagoon, *INA Quarterly* 22.2, Cover, 3-8.
- Wachsmann, S. 1996: Technology Before its Time: A Byzantine Shipwreck from Tantura Lagoon, *The Explorers Journal* 74.1, 19-23.
- Wachsmann, S. 1998: *Seagoing Ships and Seamanship in the Bronze Age Levant* (College Station/London).
- Wachsmann, S. 2005: The Graveyard of Ships: Tantura Lagoon, Israel, in: Bass, G.F. (ed.), *Beneath the Seven Seas: Adventures with the Institute of Nautical Archaeology* (New York) 98-99.
- Wachsmann, S. 2007-2008: Deep Submergence Archaeology: The Final Frontier, *SKYLLIS Zeitschrift für Unterwasserarchäologie* 8, 129-153.
- Wachsmann, S. – Davis, D. 2002: *Nautical Archaeology in Israel*, in: Ruppé, C.V. – Barstad, J. (eds.), *International Handbook of Underwater Archaeology* (New York) cover, 499-517.
- Wachsmann, S. – Raveh, K. 1982: The Search for Napoleon's Lost Ordnance in the Sea off Tantura/Dor, *Qadmoniot* 15, (23 [58-59]), 87-91 (in Hebrew).
- Wachsmann, S. – Raveh, K. 1983-1984: *The Guns of Tantura: Napoleonic Weaponry from Beneath the Sea, Israel – Land and Nature* (English Edition) 9.2, 56-60.
- Wachsmann, S. – Raveh, K. 1984a: A Bronze Napoleonic Mortar from the Tantura/Dor Coast, *Qadmoniot* 17, 33-34 (in Hebrew).
- Wachsmann, S. – Raveh, K. 1984b: A Concise Nautical History of Dor/Tantura, *IJNA* 13, 223-241.
- Wachsmann, S. – Raveh, K. 1984c: Dor, Underwater Find, Excavations and Surveys in Israel 3, 25.
- Wachsmann, S. – Raveh, K. 1984d: In the Footsteps of Napoleon at Tantura, Israel, *Archaeology* 37.5, 58-59, 76 and 17.
- Wachsmann, S. – Kahanov, Y. 1997: *Shipwreck Fall: The 1995 INA/CMS Joint Expedition to Tantura Lagoon, Israel*, *INA Quarterly* 24.1, cover, 3-18.
- Wachsmann, S. – Kahanov, Y. – Hall, J. 1997: *The Tantura B Shipwreck: The 1996 INA/CMS Joint Expedition to Tantura Lagoon*, *INA Quarterly* 24.4, cover, 3-15.
- Womer Katzev, S. 1982: Miscellaneous Finds, in: Bass, G.F. – van Doorninck, F.H., Jr. (eds.), *Yassi Ada I: A Seventh-Century Byzantine Shipwreck* (College Station, TX) 266-295.

Notes

¹ Publications on the work at Tel Dor are extensive. For an introduction, see Stern 1993b; 1993c; 1993d; 1994; 1995; Khalilieh 2005. For a recent update on the excavations and a comprehensive bibliography, see Stern 2008. On the history of Dor/Tantura, see Dahl 1915; Wachsmann – Raveh 1984b.

² Joshua 11: 1-2.

³ Joshua 12: 23.

⁴ 1 Kings 4: 11; Rainey – Notley 2006, 175-176.

- ⁵ Simpson 1972, 143-144 (I, 9-28); Egberts 1991.
- ⁶ On the Sekels/Tjeker, see Dietrich – Loretz 1978; Lehmann 1979; Rainey 1982, 133-134; Wachsmann 1982, 297; 1998, 163, 324; Wachsmann – Raveh 1984b, 228-229; Gilboa 2005.
- ⁷ Stern 1993d.
- ⁸ Littman 1990[2001]; Hale 2009, 102-103, 106 (map).
- ⁹ Dauphin 1979; 1981; 1982-1983; 1983.
- ¹⁰ On possible sources for the name „Tantura“, see Dahl 1915, 28-33.
- ¹¹ Dahl 1915, 121-122; Stern 1994, 322. On settlement processes during the Arabic period in general, see Heyd 1956; Karmon 1956, 44-49; El'ad 1982; Christides 1988; Khalilieh (2008, 164 fig. 1) includes Tantura as a defensive position: the basis for this assertion is not clear. On remains of the Crusader period at Dor, see Stern 1994, 323-328.
- ¹² Dahl 1915, 123-129; Wachsmann – Raveh 1984b, 231-232.
- ¹³ Wachsmann – Raveh 1984b, 232-233, 235.
- ¹⁴ Wachsmann 1987; Wachsmann – Raveh 1982; 1983-1984; 1984a; 1984c; 1984d; Stern 1994, 329-332. Cvikel (2007-2008) proposes that shipwreck Dor 2002/2, found in Tantura Lagoon and dated to ca 1800, may be a local vessel related to Bonaparte's activities there.
- ¹⁵ Wachsmann – Raveh 1984b, 224 fig. 1, 225 fig. 2; Stern 1994, 333-336. The glass factory now serves as the site archaeological museum.
- ¹⁶ Wachsmann – Raveh 1984b, 237 fig. 17.
- ¹⁷ For annual reports, see Wachsmann 1995; Wachsmann – Kahanov 1997; Wachsmann – Kahanov – Hall 1997.
- ¹⁸ Wachsmann – Raveh 1984b, 230 fig. 11.
- ¹⁹ Misch-Brandl – Galili 1985; Brosh 1985.
- ²⁰ Wachsmann 1995, 4 fig. 3; Kahanov – Breitstein 1995, 9, 10 fig. 10.
- ²¹ A hydraulic probe consists of a small-bore 2 to 3 meter long metal pipe attached to a fire pump by means of a flex hose (Fig. 3 A). A survey line is defined by a rope attached to two weights placed on a defined compass heading. The probe is then drilled into the ground each meter along the line. This process is then repeated by moving the base-line in 1 meter increments and repeating the process. As the probe goes into the sand the water pressure creates a sleeve of water allowing the pipe to be drilled down into the sand. If during this process the pipe strikes buried waterlogged wood, pieces of it break off and migrate to the surface, indicating a buried timber anomaly (Fig. 3 B).
- ²² Wachsmann – Kahanov 1997, 11, 13 figs. 14-15.
- ²³ For comprehensive discussions on the construction of Tantura A, see Kahanov – Breitstein 1995; Kahanov – Royal – Hall 2004, 113-118.
- ²⁴ On the construction of the Serçe Limanı wreck, see Steffy 1982b; 1994, 84 fig. 4-8; D, 85-91; 2004.
- ²⁵ Carmi – Segal 1995.
- ²⁶ Wachsmann 1996. The Dor 2001/1 shipwreck, is better preserved than Tantura A, also dates to the fifth-sixth centuries A.D. and has frame-based construction (Mor – Kahanov 2006). Also *apparently* dating to the fifth-sixth centuries A.D, the poorly preserved Dor D shipwreck appears to be contemporaneous with both Tantura A and Dor 2001/1 but was constructed employing (mostly unpegged) mortise-and-tenon joints (Kahanov – Royal 2001; Kingsley 2003, 87-88; Royal – Kahanov 2005).
- ²⁷ van Doorninck 1982, 55 fig. 3-29, 56, 59, 61-62; Steffy 1982a, 71-73, 75-76, 78, 82-84.
- ²⁸ Wachsmann 1995, 6 fig. 7; 2005; Wachsmann – Kahanov 1997, 7 fig. 4, 8 fig. 5. On stone anchor stocks, see Gianfrotta 1977; Haldane 1984, 1-16; Kapitän 1982; 1984, 33-37; Kritzas 1989; Greene 2003, 8, 9 fig. 13; Greene – Polzer 2004; Polzer 2004, cover, 6 fig. 5, 7 fig. 6.
- ²⁹ Charlton 1995.
- ³⁰ On the Tantura B shipwreck's construction details, see Wachsmann – Kahanov – Hall 1997, 13; ; Kahanov – Royal – Hall 2004, 118-123.
- ³¹ Wachsmann 2005.
- ³² J.R. Steffy (pers. com.).
- ³³ On the date, see Wachsmann – Kahanov – Hall 1997, 10-11; Khalilieh 2005, 314-315.
- ³⁴ Wachsmann – Kahanov – Hall 1997, 5, 9 fig. 10, 10 fig. 12.
- ³⁵ Polzer 2008.
- ³⁶ Wachsmann – Kahanov – Hall 1997, 10 figs. 11: D, 13-14.
- ³⁷ Wachsmann – Kahanov – Hall 1997, 3, 5-6, 10 fig. 11: A-C. An uninscribed roundel was found on the seventh century A.D. Yassiada shipwreck (Womer Katzev 1982, no. MF 50, 288 fig. 12: 16). I thank F. van Doornick for bringing this parallel and that in the following footnote to my attention.
- ³⁸ Wachsmann – Kahanov – Hall 1997, 5, 9 fig. 9; Womer Katzev 1982, 293, 294 fig. 12-26).
- ³⁹ On the possible identification of the ship type to which the Tantura B shipwreck belongs in Arabic sources, see Khalilieh 2005.
- ⁴⁰ Shipwrecks Tantura C and D were studied by D. Davis (Wachsmann – Davis 2002, cover, 513, 514 fig. 30.9, 515).
- ⁴¹ Wachsmann – Davis 2002, 515.
- ⁴² Wachsmann – Davis 2002, 514.
- ⁴³ Sibella 1997.
- ⁴⁴ Wachsmann – Kahanov 1997, 10 fig. 8: A; Wachsmann – Kahanov – Hall 1997, 6, 12 fig. 17.
- ⁴⁵ Wachsmann – Kahanov 1997, 11 figs. 9-10, 12 fig. 11; Royal – Kahanov 2000.
- ⁴⁶ Wachsmann – Kahanov 1997, 12 fig. 12.
- ⁴⁷ Israeli 2010. See in this volume, pp. 41-45.
- ⁴⁸ Wachsmann – Kahanov – Hall 1997, 12 fig. 18.
- ⁴⁹ Barkai 2010; Barkai – Kahanov 2007; Barkai – Kahanov – Klein 2007-2008; Liphshitz – Pulak 2007-2008, 76. See in this volume, pp. 18-20.
- ⁵⁰ Wachsmann – Kahanov 1997, cover, 9 fig. 7.
- ⁵¹ Wachsmann 2007-2008, 143 fig. 12: B-C.
- ⁵² The earliest ceramics that we found inside the lagoon dated to the Middle Bronze Age II period (2000-1550 BC): Sibella 1995, 13 fig. 1. The discovery of Persian-period ceramics suggests that one or more ships may have wrecked in the lagoon during this era (Sibella 1995, 13 fig. 2 a-b; Wachsmann 1995, 7; Wachsmann – Raveh 1984b, 239).



Credits of figures

Fig. 1: Drawing S. Wachsmann; Fig. 2: Map P. Sibella; Figs. 3-6, 8-12: Photos S. Wachsmann; Fig. 7: Photos C. Tibi; Fig. 13: Drawing C. Brandon.

Address

Shelly Wachsmann
Institute of Nautical Archaeology
PO Drawer HG
College Station, TX
77841-5137, USA
Email: swachsmann@tamu.edu