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At the Transition from Late Medieval to Early Modern: the Archaeology of Three Wrecks from Turkey

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During surveys in the Rhodian Straits in 2005–06, the staff of the RPM Nautical Foundation discovered three deepwater wrecks which reflect elements of the transition from late medieval to early modern seafaring. The assemblages, and their plotting on site-plans generated from photographic evidence, point to the finding of a small oared warship equipped with wrought-iron carriage- and swivel-guns, a small coasting vessel armed with wrought-iron swivel-guns, and a larger merchantman equipped with cast-iron carriage-guns. While the features of the smaller vessels do not identify their country of origin, those of the larger merchantman have good parallels with known English wrecks.

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> Winds blowing down from *Rodos* channel strike with great force here and thus immediately after sighting this mountain, one should proceed at a distance of thirty or forty miles from the shore (Piri Reis, *Kitab-ı Bahriye*, in Ökte, 1988, vol. 2: 525).

During the summers of 2005 and 2006, RPM Nautical Foundation (RPMNF) conducted a survey along the Bozburun Peninsula of south-western Turkey, on the Turkish side of the Straits of Rhodes. With the generous permission and active co-operation of the Turkish Ministry of Culture and Tourism and the Department of Underwater Archaeology, the survey resulted in the discovery of 14 wreck-sites, of which five are from the modern era. Of the nine historic wrecks, three date to the transitional period from late medieval to early modern, *c*.1450–1600. Moreover, all three wrecks were probably equipped for combat, given the weapons found at each site. To find a high percentage of armed vessels from a narrow historical period clustered along the same stretch of Turkish coastline within the Rhodian Straits invites an analysis of the coastal geography and strategic context of those Straits, as well as the specific nature and assemblage of each site. Although two of the wreck-sites (TK05–AB and TK05–AH) have been previously reported, and the third (TK06–AD) described in a preliminary report (Royal, 2006; 2008a), it is appropriate, for a variety of reasons, to offer scholars a review of the first two wrecks, together with new comparative material, and a full description of the third, as the extensive assemblage of site TK06–AD has not yet been published systematically. The clustering of the three vessels in space and time is significant. The similarities and differences in their assemblages, especially as regards guns and anchors, are notable. The reactions of other scholars to those notices have led to a detailed re-examination of the evidence and a wider exploration of relevant parallels.

Methodology

The survey was conducted by two of RPMNF's research vessels, the 33-m *Hercules* and the 9-m *Juno*. Each vessel has a multi-beam echo-sounder: the system on the *Hercules* was effective for archaeological survey to a depth of 120 m, while that on the *Juno* was effective to 45 m. Accordingly, the *Juno* covered areas from the coastline to the 45-m contour, and the *Hercules* the area between the 40- and 100-m contours. The designed overlap between each vessel's coverage ensured that no gaps occurred when merging the two data-sets. Extending from shore roughly to the 80-m contour, the point reached within the time limits of the survey, the entire survey encompassed an area measuring *c*.140 km^2.

The system used on the *Juno* featured a side-mounted Reson Seabat 8125 multi-beam echo-sounder. This

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single-head unit emits 240 beams at a maximum rate of 40 per second, operates on a frequency of 455 kHz, and has a swath coverage of 120°. At depths up to 45 m, the data has a resolution of a few centimetres. Remote sensing with the *Hercules* was conducted with a hull-mounted multi-beam echo-sounder, model type EM3002D from Kongsberg Maritime division. This employs two transducer heads fixed to the underside of the research vessel, emitting upwards of 500 beams at a maximum rate of 40 per second. Its multiple frequencies (293, 300, and 307 kHz), and ability to control angular coverage dynamically, result in a practical depth resolution of 10 cm. After multi-beam data was collected and processed, it was reviewed as three-dimensional models which allow the visualization and editing of each individual beam. Likely anomalies were examined in this manner and assessed for either association with geological formations or characteristics consistent with shipwreck sites. Those meeting the latter criteria were plotted on an electronic chart, which made it possible to navigate both the research vessel and an ROV equipped with a transponder to each anomaly.

During verification, the forward-scanning sonar fixed to the ROV facilitated locating anomalies, and also examined for random objects in the area surrounding an anomaly or site. After locating an anomaly, the staff conducted a visual investigation, using the ROV's video camera. Although the sites lie below a safe depth for air diving, careful video and still photography allowed the drafting of preliminary site-plans. Furthermore, the visual documentation permitted identification of individual objects, once any light sediment covering the objects was dusted away. As the Turkish Ministry of Culture had made no provision for the removal of artefacts, and the local museums had not determined where to store retrieved objects, the RPMNF team raised no artefacts from the sites.

Figure 1. Survey area and wreck-sites discovered along the south-east portion of the Bozburun peninsula. (RPM Nautical Foundation)

Coastal geography of the area

The survey area spanned *c*.37 km along the Bozburun peninsula, from Kadirga Burun in the north-east to the bay of Bozuk Bükü at its south-western end (Fig. 1). Almost the entire coastline in the survey area features steep slopes and cliffs that descend into the sea to a depth of 30–50 m. At the base of these cliffs the sandy sea-bed extends out with a moderate gradient. Along this stretch of coastline mariners also regularly encounter rock-formations lying just beneath the surface, and small islands obstructing their passage, both of which are serious hazards for vessels sailing close to shore (Pryor, 1995: 216). The survey area contains two large bays, Bozuk Bükü, site of ancient Loryma, and Serçe Limanı, site of two shipwrecks excavated by the Institute of Nautical Archaeology in the 1970s and '80s (Bass *et al.*, 2004; Bass, 2006; Pulak, 2006). The coastlines of the mainland and nearby islands are pock-marked by safe and concealed anchorages. In the latter part of the 15th century, the western end of the straits between Turkey and Rhodes, where the Aegean meets the Mediterranean, took on increased strategic importance, as witnessed by the frequency of armed conflict there.

Wreck TK05–AB

During the 2005 field season, a small shipwreck was located 2 km offshore at a depth of 75 m (Royal, 2006: 197–201). A discernable mound running in an E-W direction measures *c*.26 × 2.5 m, and its most prominent feature is an elongated ballast-pile. This measures *c*.9 × 2.5 m, lies at the centre of the site, and anchors and ordnance are visible at either end of it (Fig. 2); notably there were no hull-timbers or small finds. The excavators of the Molasses Reef wreck from the early-16th century interpret the scarcity of ceramic sherds on that site as an indication that the vessel carried supplies in wooden casks and barrels (Keith, 1997: 281).

Ship's equipment

Four anchors are preserved at the eastern end of the site, along its E-W axis. They rest in a pattern which suggests that they were still stowed on deck or along the sides when the vessel came to rest on the sea-bed, though one

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Figure 6. Gudgeon from the east end (sector 4) of site TK06–AD. (RPM Nautical Foundation)

The line of the gudgeon straps indicates that they were attached to a flat transom and an external sternpost which was rectangular in cross-section. Similar gudgeons were found on the early-16th-century Molasses Reef wreck, which was reconstructed with a flat transom and exposed sternpost (Oertling, 1989: 237–9). At least one gudgeon was also found from a wreck on Western Ledge reef near Bermuda, which may be the Spanish *Santa Lucia*, which sank in 1584 (Watts, 1993: 214; Broadwater, 1997). Pintles attached to the rudder were slotted into the gudgeons at the eyes, which allowed the rudder to swivel (Smith, 1993: 91–3). So the transverse concretions formed on the rudder timbers may be the remains of the pintles. Three rudder pintles, one still attached to its gudgeon, were found on the Highborn Cay wreck from the first half of the 16th century (Keith *et al.*, 1984: 64; Keith, 1988: 59). By contrast, the Ottoman warship or naval transport excavated at Yassıada and dated to the last quarter of the 16th century had 'rudder hardware for a curved sternpost' (van Doorninck, 1997: 470–71).

Just beyond the presumed rudder are pieces of squared timbers which could be beams associated with the sternpost or the transom. A rectangular iron object buried in the sand has a slot equal in dimension to the gudgeons, but no eye to accept a pintle. Knowing that the gudgeon's sided dimension corresponds to that of the sternpost, it is worth noting that the width of the timber fragment and the square notch of the buried iron piece are of apparently identical dimensions, so this iron piece may have been a clamp on the transom.

At the centreline of the wreck's stern, a few metres from the rudder and stern debris, there is a central timber running beneath the remains of frames which lie perpendicular atop it. This timber is buried in the sand as it approaches the mound just abaft the estimated mid-point of the vessel. The assemblage of wood rises at the aftmost section of the site and sits higher off the bottom than any other group of centreline timbers (Fig. 7). The frames atop the central timber in this section appear to be fastened more

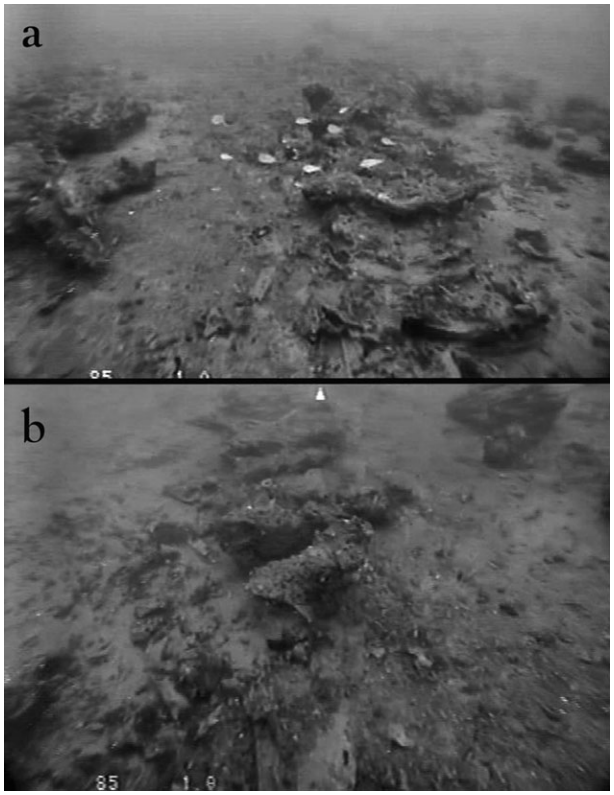

Figure 7. Framing timbers along the centre of the east end (sector 4) of site TK06–AD: a, looking east; b, looking west. (RPM Nautical Foundation)

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closely together than elsewhere on the vessel, with a centre-to-centre spacing of only a few centimetres. Although badly eroded, these frames have more of a Y shape, in distinction to the flatter floor-timbers found elsewhere on the site, and each of the Y-shaped frames sits slightly higher as the frames progress aft. A triangular-shaped deposit of degraded wood lies adjacent to the port side of this raised assembly of central timbers and marks the aftmost end of the deposit. If this triangular piece were rotated atop the central timber into a standing position, it would produce a steeply-sloped structure that rises aft. This configuration of closely-spaced Y-shaped frames and a mass of wood rising aft is almost certainly the ship's stern structure at the waterline where the keel was attached to the sternpost and some combination of a knee and/or deadwood attached atop the juncture as it rose towards the flat transom. By way of archaeological parallel, these timbers are somewhat similar to the knee, sternpost, and Y-pieces from the stern assembly of the wreck found at Western Ledge reef (Watts, 1993: 113–14, fig. 13), and also resemble the stern elements of the Alderney wreck (McElvogue, 1998: 28).

A small lead patch located near the rudder remains supplies evidence of possible repairs at the stern, or the material to make such repairs (Fig. 5). Sixteenth-century wrecks which had lead sheathing include *Lomellina* in the Mediterranean (Guérout and Rieth, 1998: 43) and the Cayo Nuevo wreck in the Gulf of Mexico (Smith, 1988: 88). The Emanuel Point vessel had lead patching on some of its plank-seams and hull leaks (Smith, 1997; Smith, 2001: 299). The Alderney wreck of 1592 carried two sheets of folded lead and had one piece of lead perforated by several tack-holes that was described as a possible 'repair tingle' (Bound, 1998b: 66–7). Similarly, *Sea Venture*, which sank off Bermuda in 1609, had several lead patches (tingles) used to plug leaks (Wingwood, 1982: 339–40, fig. 7).

The forward third of the wreck-site, which extends several metres west of the primary mound, also has significant remains of hull timbers. The slight mound at the centre of the site obscures any timbers that may survive here; however, numerous frames run in sequence atop the keel down the centre of the forward area towards the bow, and lie parallel to the sea-bed. This further indicates that the vessel probably came to rest in a relatively upright position. The frames here are flat and cross the keel, as is characteristic of floors (Fig. 8). Frame remains are also visible along the starboard (N) and port (S) sides of the site, often continuing below the vessel's equipment and ordnance. Frame-ends noted at the extreme port and starboard sides of the mound further support the possibility that the frames are buried deeper in the central section of the wreck-site under the mound. All frame-timbers are eroded and have suffered what appears to be damage from *teredo navalis*. Nonetheless, it is still possible to estimate a sided dimension for frames of 8–10 cm and an average centre-to-centre spacing of 20–25 cm.

Figure 8. Framing timbers along centre of the west end (sectors 2 and 6) of site TK06–AD: a, frames lying amidships looking E from port side; b, westernmost frames, looking east from starboard side. (RPM Nautical Foundation)

Although most frames run perpendicular to the centreline of the vessel, the frame remains visible in the forwardmost, starboard section of the site angle slightly inward. The orientation and location of these frames is consistent with those typically used to fashion the bow of wooden ships.

Nearly every sector of the wreck-site has significant numbers of planks, which extend beyond the primary mound. Generally, the planks run parallel to one another in an E-W orientation and lie beneath frame timbers. The forward section of the wreck-site exhibits the largest areas of preserved planks, with runs reaching several metres in length and up to a 14-plank span in at least one section. Although many sections of strakes appear parallel, there is a slight convergence towards the centreline noted in those at the forward end of the site, particularly those at its outer edges. This convergence occurs in the same areas as the angled frames, further indicating that the bow section collapsed at the western end of the site. The overall evidence from examination of the rudder, the frames and the strakes from the collapsed bow and stern areas all suggests that the vessel reached the bottom largely intact.

Ship's equipment

Among the clearest items observable on the site is a large anchor located amidships, the only anchor at the

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site (Fig. 9; its end is visible in Fig. 10). It rests atop the primary mound with its arms near the centreline and its shank angled aft toward the starboard side. The anchor's arms extend from the crown to form a rough V-shape; however, concretion at the crown obscures whether the shape there is rounded or angled. The arms terminate in large, spade-shaped flukes which curve into a sharp protruding bill (Fig. 9a). One of the flukes has broken free from, and lies beneath, its arm. The shape of the broken arm indicates that the arms taper toward the fluke. The shank appears to be square in section, although corrosion makes this difficult to determine, and it has a length *c*.2–2.25 times the width of the arms. The shank extends *c*.15–20 cm beyond the eye and features a large ring at its end (Fig. 10). No stock is immediately visible near the anchor. Although a segment of chain lies in sector 6 at the outer edge of the site, it is probably not associated with this anchor. There are also numerous other fashioned metal objects, in various stages of corrosion, which comprise items from the ship's equipment and hull-construction. These include a large ring in sector 2 and several right-angle pieces in sectors 3 and 7, and the apparent remains of a small wooden box lying alongside the anchor's shank. Such a box could serve a variety of purposes, including storage of shot.

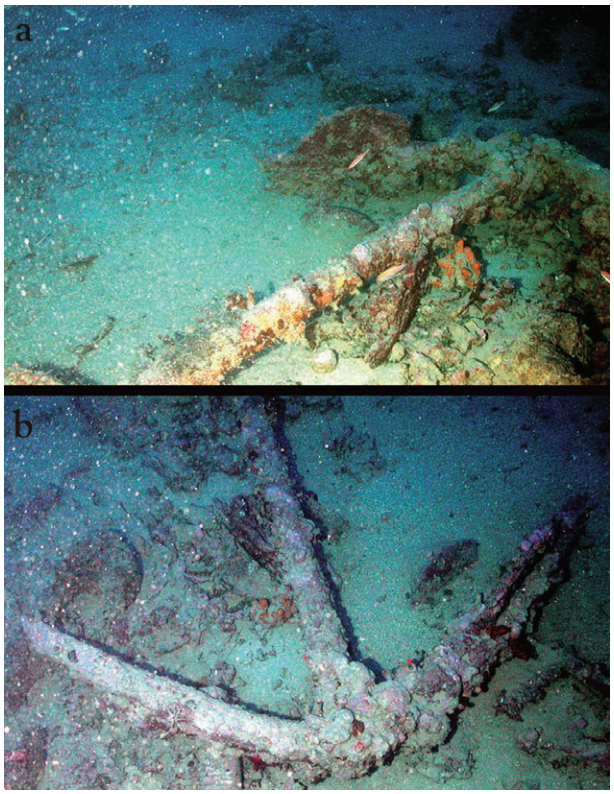

Figure 9. Anchor located at the centre (sectors 3 and 7) of site TK06–AD: a, bottom half of anchor looking south-east; b, same looking north. (RPM Nautical Foundation)

The anchor on this wreck differs from those on the TK05–AB and TK05–AH wrecks. General parallels for such an anchor include large iron examples from the Padre Island site (Arnold and Weddle, 1978: 224–30). The sheet anchor from the Spanish Molasses Reef wreck, which weighed *c*.273 kg for a vessel of *c*.100–130 tons, is similar, though its arms have a slight bend upward at mid-length (Oertling, 1989: 240–41). Such slightly-bending arms, typical of Spanish anchors, are also found on two possibly-Spanish anchors from the wreck of *La Trinidad Valencera* (1588), which have triangular flukes as well (Martin, 1979: 31–2; Curryer, 1999: 38–40). Most known Iberian anchors had triangular-shaped flukes (Smith, 1993: 122). The heaviest wrought-iron anchor from the Spanish Highborn Cay wreck, which weighed 270–300 kg, is similar in shape and dimensions, although it too has the slight bend in its arms (Smith *et al.*, 1985: 68–9). An anchor that may come from the 16th-century Basque whaler found in Red Bay, Labrador, has a crescent shape, welds at the throat and the shank scarf, and stock keys near the point where the shank meets the eye for the

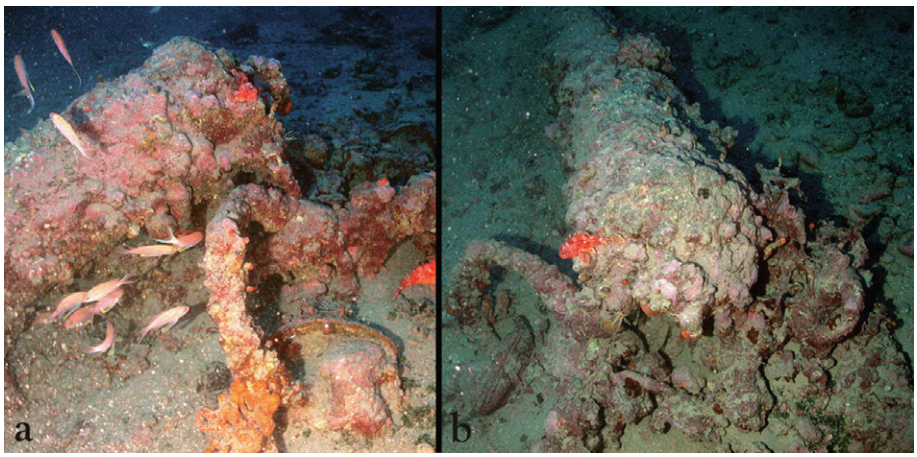

Figure 10. Starboard gun in sector 3 of site TK06–AD: a, base of gun and top of anchor, looking east; b, looking north along gun. (RPM Nautical Foundation)

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ring. The smith flattened one side of the arm to receive the fluke (Light, 1990: 310–11).

V-shaped hook anchors appear in some Venetian illustrations as early as the 13th and 14th centuries. An anchor in a sketch by Jacopo Bellini (*c*.1400–1470) has a large ring, rounded shaft and large flukes, but the arms are more rounded than the V-shaped arms on this site. Likewise, the arms of the anchor in Vittore Carpaccio's *Life of Ursula* dated to 1490–96 are much flatter in their angle. Other iconographic examples include the somewhat crescent-shaped anchor on a *karaka* sailing in the Rhodes channel and the anchors of another *karaka* shown sailing off Sardinia in Piri Reis, the anchors on the sailing vessels of unknown origin in the engravings made after drawings by Pieter Bruegel the elder, and the *göke* and galleass in the book of Kâtip Çelebi (Ökte, 1988: vol. 2, 532, vol. 3, 1144; Orenstein, 2001: 204–07, fig. 93 no. 85, 213–16, nos. 89, 92–4; Güleryüz, 2004: 42, 58, pls I-C, VII-C). Depictions of Ottoman anchors, though infrequent, generally show anchors with triangular flukes. The straight arms, long shank, and palm-shaped flukes of the anchor on the TK06–AD site better match an English long anchor. Around 1540, English anchors were changing from curved to straight arms, with the arms initially at an angle of approximately 40° to the shaft. The demands for anchors of greater dimensions for use on the larger ships being constructed led to a change in manufacturing design. By 1600 the angle of the arms had widened to *c*.60° (Curryer, 1999: 41). The anchor on this site, however, has arms angled closer to 45°.

Crew items or cargo

There are over 30 deep plates or shallow bowls observable on the surface of the site; they are intact and in some cases stacked. These tableware items are scattered in all sectors of the wreck; however, there is a small concentration aft on the port side (sector 8). Here the tableware deposit suggests the materials rest close to their place of stowage, perhaps in a cabinet or on shelves. As ships' galleys were typically located aft, it is possible that some of these plates and bowls were stowed for galley use. Tableware also settled between pairs of guns and all along the forward port section of the site (sectors 5 and 6). From the patterns of degradation, the plates and bowls appear to be formed from sheets of copper or a copper alloy such as bronze, or possibly lead-based pewter. Many of the bowls have decorative grooves running around the middle of their outer wall, a typical Ottoman stylistic feature from the 16th and 17th centuries commonly found throughout the Eastern Mediterranean. A tall, apparently copper, pot with vertical sides sits on the sand in sector 6 (Fig. 11). It has a rounded rim which flares outward and a flat bottom; the body also expands slightly outward near the base. From the beginning of the 16th century, a warehouse at the Galata Arsenal, the Leaden Cellar, stored copper pots and lead plates for use on Ottoman military vessels (Bostan, 2000: 738). Such tableware was also common trade goods in the Eastern Mediterranean.

Figure 11. Pot located in sector 6 of site TK06–AD. (RPM Nautical Foundation)

In addition to the plates and pot, there are two one-handled pitchers deposited near a scatter of plates in sector 6. The larger of the two pitchers seems crafted from a copper alloy and has a long, narrow neck extending from a rounded shoulder (Fig. 12a). The neck constricts slightly after rising from the shoulder with a gentle flare up to the rim. The body has a pinched waist and ends in a flared, flat bottom. The handle begins at the base, runs up the side, projects outward from the shoulder in a gentle curve and terminates at the rim. Preserved nearly in place is a conical lid which has a small bulbous decoration at its top and appears to be connected to the handle. The piece is consistent with an Ottoman *ibrik* or ewer (pers. comm. K. Johnsen, University of Chicago, 2007). The upper portion of the second, smaller pitcher is obscured by a large concretion. It has a short neck that meets the body where it flares outward before tapering inward just above a flat base (Fig. 12b). As with the larger pitcher, its handle begins at the base and extends straight upward, adjoining the body until it curves back into the neck at the rim. This pitcher is also consistent with an Ottoman *ibrik*, possibly on board for the crew's use or as an item of trade. The total quantity of visible tableware indicates there was a somewhat large consignment originally on board; this, in turn, points either to cargo or to a large crew, such as on a warship. Because the tableware lies scattered throughout the wreck, it is not likely to represent only galley items.

Other objects possibly associated with the crew in sector 3 include a capped container and a brazier. The capped container has a short neck projecting from its narrow side and was used to hold a liquid or possibly

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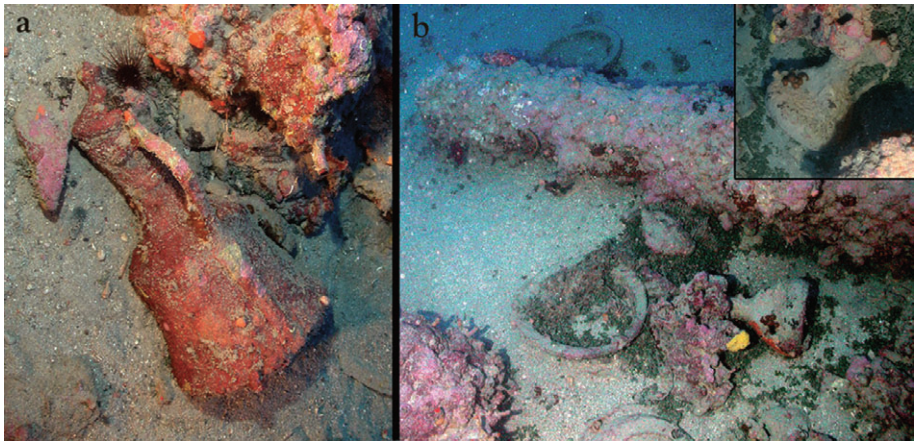

Figure 12. Two pitchers in sector 6 of site TK06–AD: a, larger *ibrik* located inboard of gun; b, small *ibrik* located outboard of gun. (RPM Nautical Foundation)

Figure 13. Three pieces of a brazier in sector 3 of site TK06–AD; a, base; b, pan; c, lid. (RPM Nautical Foundation)

to hold powder for firearms. Three distinct pieces of a copper or bronze brazier lie within a 2-m area (pers. comm. C. Pulak, 2007); these include a base (Fig. 13a), pan (Fig. 13b), and lid (Fig. 13c). The configuration of the three pieces is conspicuous, for the base sits below the bottom of the pan, and the lid sits just above the pan. The base is a metal cylinder whose rim projects from the sand and reveals a pair of holes on opposite sides. Nearby, the apparently-intact pan flares out from a narrow, ribbed cylinder that fits on the base to form a bowl. One of its two omega-shaped ring handles is clearly visible where it attaches to the outer edge of the pan's rim. This configuration of the rotating handle and the bowl shape reduced the risk of accidental burning or spillage when lifting. The brazier's lid has a tubular shape and tapers outward toward the top. Although damaged at both ends, it appears to have a spout or handle projecting upwards from its widest portion. For centuries, charcoal braziers comprised a basic cooking technology on round ships. While crusading in 1254, King Louis IX of France assigned his aide, Joinville, to make nightly rounds in order to assure that passengers and crew had extinguished all brazier fires except for one in the hold, from which the others would be re-lit (Pryor, 1994: 76). Braziers were found on *Vasa* from the early-17th century (Cederlund, 2006: 376, 378, fig. 13–32) and as late as the early-19th century on a Black Sea merchantman excavated at Kitten in Bulgaria (pers. comm. Kroum Batchvarov, 2007). Having found only a single pot and brazier on a site with minimal sand cover and a large number of objects visible, we infer that the vessel had a relatively small crew. That means that it was probably not a warship, and therefore some of the tableware comprised cargo for trade.

Sectors 1 and 2 each have a single damaged ceramic container, used either to transport goods or to store provisions. The containers have short necks and rounded bodies with no apparent handles, typical of such period wares in the Mediterranean, so they are almost certainly associated with the wreck. A large body-sherd of a ceramic container, located in sector 8, has a small handle and appears to have been a tall container. To date, no parallels have been found for this fragment. There are several clearly-intrusive ceramic items. For example, a partial Rhodian or Koan amphora and an Agora G199 amphora that dates to the 1st-early-4th century AD lie at the outermost edge of

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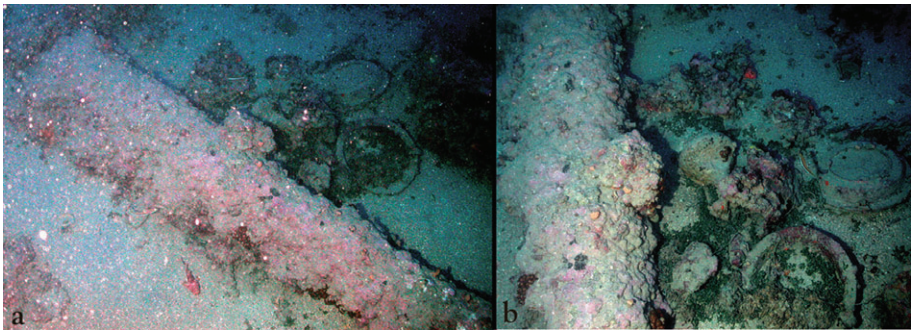

Figure 14. Port gun in sector 6 of site TK06–AD: a, plan view; b, looking east. (RPM Nautical Foundation)

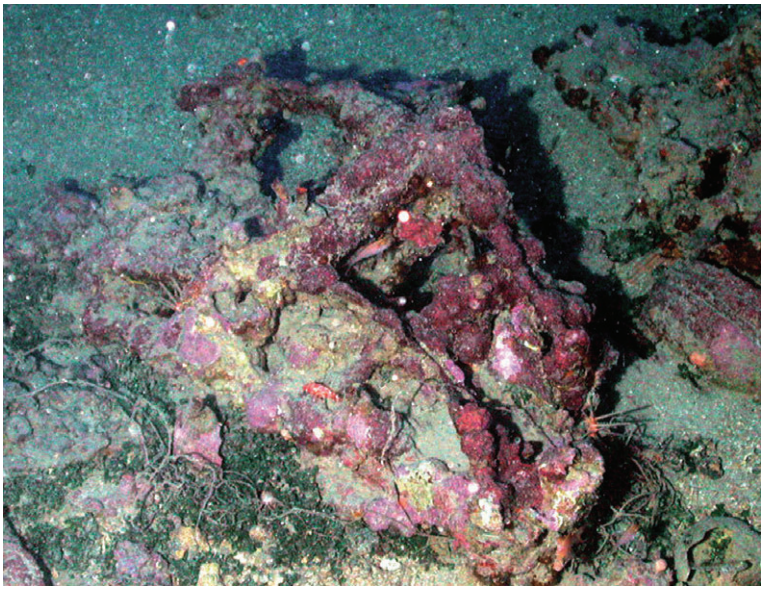

Figure 15. Crossbows located in sector 5 of site TK06–AD. (RPM Nautical Foundation)

the site in sector 3. Such items were probably dragged over the wreck-site and eventually dumped when the nets snagged on protrusions.

Ordnance

Eight carriage-guns, lying in the centre of the wreck-site, figure prominently among the remains, four each along the port and starboard sides (Figs 9, 12, 14 and 15). The four starboard guns lie transverse to the centreline of the wreck-site, while the four port guns lie parallel to it. All the guns are *c*.2 m long and show extensive corrosion, indicating their manufacture from iron. The diameter of each gun's barrel tapers along the length from breech toward muzzle, measuring *c*.40–50 cm at the breech and *c*.25–30 cm at the muzzle. However, the concretion has almost certainly enlarged this diameter, and the actual barrel was smaller. Each of the guns has a muzzle-ring, and several appear to have slight expansions at the muzzle. Such flaring reinforced a gun to resist the shock-wave as the shot left the muzzle. The taper of the barrel and the flare of the muzzle indicate that the guns were of cast, not wrought iron. The mouldings around the barrels of at least three of the guns lying on the port side (Fig. 14b) occur at regular intervals and more frequently, perhaps eight or more, compared with the four to six present on the starboard guns (Fig. 10).

Visible breeches have a cascabel ending in a button or loop. Trunnions are visible on all the guns except one on the port side which appears to be broken. These trunnions were located at approximately mid-gun length and below the bore centreline (Caruana, 1994: 2–5; Guérout and Guillaume, 1998). The degraded debris lying beneath many of the guns may be the remains of their carriages. Although these eight guns generally form a consistent assemblage of cast-iron ordnance, they do display slight individual differences. Dissimilar guns are not surprising as governments of the time could not afford to cast guns in large sets. Each gun was individual and a single vessel's armament was gathered from a variety of sources: guns in storage, guns cast explicitly for the vessel, or guns bought from other owners (Caruana, 1994: xvii; Hocker, 2006: 49–50). If there was also a difference in

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the bores of the port and starboard guns on this vessel, similar guns were probably deployed on each side in order to facilitate the distribution of shot.

Although it is unclear exactly how many guns the vessel carried, the eight visible guns may well be the entire complement. No other guns were located in the immediate area surrounding the wreck-site, nor were any likely anomalies detected in a 40-m radius on sweeps that also used the ROV's forward-scanning sonar. Even though a hull the size of the site-remains could accommodate additional guns, there is no evidence that the vessel was so armed, and the number of guns present appears adequate for the vessel's size. What is perhaps unusual is that, although smaller guns commonly complemented larger pieces on armed vessels, no smaller guns like the swivel-guns on the other two wrecks were located.

The vessel did, however, carry other weapons. The remains of crossbows are preserved amidships (Fig. 15), four of them grouped in sector 7 (Royal, 2008a: 93). The remains constitute the curved, bow portion of the weapon, as well as the stock and foot-stirrup (pers. comm. Guilmartin, 2006). Crossbowmen used the foot stirrup to secure the weapon while they drew the bow. The site may possibly have less-recognizable, fragmentary portions of other crossbows. The bows are manufactured from metal as their concretion attests, and may rightly be considered 'arbalests'. No debris overlies the bows, suggesting they were not stored in the hold; however, it is not known exactly where amidships they were stored. Close examination of the site revealed no recognizable remains of recurved bows or arquebuses; nonetheless, we cannot definitively say that such remains are not present, although, particularly in the case of recurved bows, the morphology of the site militates against their survival.

Summary and working hypotheses

In another forum (Royal and McManamon, 2009) the authors have offered detailed analysis of the data from the three wrecks and their context in maritime history. Here we wish to present our current hypothesis for each vessel's type, date, and cultural identity. The first wreck, TK05–AB, is probably a small galley of the *fusta* or *galiota* type, which the Ottomans, or the Knights of St John, or pirates, operated in the Straits of Rhodes between 1450 and 1600. This dating derives primarily from the wrought-iron guns and secondarily from the anchors. The site's length-to-breadth coefficient of *c*.10:1, the shape and narrowness of the ballast-pile, the absence of crew or trade items, the single centreline gun at the bow supplemented by smaller guns along the sides, as well as historical data and iconographic parallels, together suggest that the vessel is an oared warship akin to a *fusta*.

By the second half of the 15th century, historical documents and visual portrayals establish that galleys and *fuste* commonly had a large gun fixed to the central gangway or a bow platform and aimed forward (Guilmartin, 1974: 264–5, 296, 298–9; Rodger, 1996: 302–03). In late 1551 the exploits of a Spanish *fusta* illustrate the capacity of such a vessel to wreak havoc against other armed prey (Guilmartin, 1974: 23–5). The *fusta* captured, looted, and then freed several small boats operated by 'Turks' and 'Armenians' in the Aegean, its crew boarded a vessel sailing under French flag from Alexandria and made off with biscuit, it plundered several small vessels moored in port and enslaved all their Muslim crew members, it managed to outrun a patrol squadron of 14 Venetian galleys, it forced the captain of a Turkish *fusta* to run his vessel aground and then liberate its Christian slaves, it extorted 300 ducats from a Florentine vessel, and it forced another Turkish sailing vessel to run aground, which led to negotiations and agreement on a sum of money to spare the vessel from destruction.

The only archaeological example of a *fusta* presently known is the vessel scuttled on Lago di Garda to prevent is capture in 1509. That *fusta* is *c*.30 m long and 3 m wide, thus a 10:1 length-to-beam ratio, which is analogous to the estimated ratio for the vessel on site TK05–AB (D'Agostino *et al.*, 1997: 147–53). However, iconographic and manuscript sources indicate that Venetian galleys were usually fitted with grapnel anchors like those on the Lago di Garda *fusta* and that, by 1500, Venice preferred to equip galleys with a bow gun cast from bronze (Guilmartin, 1974: 173–4; Guilmartin, 1994: 146; Beltrame, 2007: 420–21). This vessel has wrought-iron guns, and anchors with two arms ending in flukes. Historical evidence suggests that this vessel more probably belonged to the Ottomans or the Knights of St John, or raiding corsairs sanctioned by either one, rather than to the Venetians (Royal, 2008b). Sources from the end of the 15th and beginning of the 16th century are filled with references to Ottoman use of smaller galleys such as *fuste* and *galiote* in their fleets (Brummett, 1994: 89–121). The *fusta* likewise proved the weapon of choice for Ottoman corsairs operating in the waters of the Aegean and the Levant. Its size and speed made it ideal for surprise attacks, and its technical progress in mounting iron or bronze guns even made it viable in direct skirmishes with Christian light galleys (Tenenti, 1960: 243, 273; Vatin, 1994: 81–3, 97–102). Most importantly, in the context of increasing Ottoman pressure on Rhodes early in the 16th century, such armed vessels operated regularly in the channel between the two powers (Brummett, 1993: 524–5, 532; Vatin, 1994: 94–6). The naval forces in the area which used smaller oared galleys such as *fuste* had to have supply-bases nearby. Both the Ottomans and the Knights of St John had them.

Whatever its affiliation, the small galley at site TK05–AB did not prove successful in its final mission, for it apparently came to a quick end in the straits. The oared warship sank well offshore, and did not collide with rocks or other hazards along the shoreline: it sank with its anchors stowed, and probably suddenly. An

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unpredictable storm or unexpected wave energy are the more likely possibilities. High seas would prove especially dangerous to an oared vessel with low freeboard. It is also possible that a larger enemy vessel or fleet fell upon this small galley and sank it in a skirmish. Nonetheless, tactics of the time dictated the capture, not the sinking of a warship. Whatever the cause of sinking, a warship is rare in the archaeological record. Wrecked war-galleys were not pressed down as far into the bottom sediment and, even when armed with wrought-iron guns and weighted with ballast, they lie exposed to damage from current and tidal action, marine organisms, or human disturbance. Hence, this small vessel offers a modest contribution to our understanding of Mediterranean naval warfare toward the end of 'the age of the galley' (Bound, 1995; Gardiner and Morrison, 1995; Bound, 1998a; Glete 2000: 93–111; Mott, 2003; Rodger, 2003).

The second wreck, TK05–AH, was probably a small coasting merchantman of unknown nationality operating in the same period from *c*.1450–1600. The dating again derives primarily from the wrought-iron guns, and to a lesser extent the anchors and visible pottery. The extent of the site indicates a low length-to-beam coefficient typically associated with merchant vessels, an inference supported by the quantity of ceramic finds. Calculating a minimum of 3–5 anchors on the site and considering the overall size of the ballast-pile, this was probably a small vessel about 15–20 m long. Spain and Venice led the way in arming their merchantmen, and the Genoese and Ottomans soon followed. By 1500, supply transports armed with guns were common all over the Mediterranean, and small swivel-guns became practically standard equipment on Mediterranean merchantmen (DeVries, 1998: 390–91). The fact that the guns are of wrought-iron does not exclude a date in the second half of the 16th century. Compared to cast-bronze guns, wrought-iron ones offered a savings in the costs of manufacture or purchase. That added to their shelf-life. This merchantman carried only anti-personnel swivel-guns to deter pirates from boarding and dissuade galleys from pursuit.

For period and size, the best archaeological parallel for this vessel is the 16th-century Contarina II vessel, *c*.20.5 m long and 6.3 m wide. This vessel had a hull built of oak, frames joined with iron bolts, and through-beams fastened to stringer and wale by dovetail scarfs (Occioni-Bonaffons and Gregoretti, 1901: 35–8; Bonino, 1978: 18–21). The view of Venice attributed to Jacopo de' Barbari from *c*.1500 has visual parallels to Contarina II in the double-ended round ships with lateen sails moored in the lagoon (Nance, 1955: 290; Howard, 1997). Taking into consideration the continuities of shipbuilding philosophy in the Mediterranean, the Culip VI wreck at *c*.16 m long and 4 m wide, and the Contarina I wreck at *c*.21 m long and 5.2 m wide, both from *c*.1300, may also provide helpful parallels (Bonino, 1978: 13–15; Pujol, 1989; Palou *et al.*, 1992; Pryor, 1994: 62–3; Steffy, 1994: 91–3; Rieth, 1996: 149–64; Palou *et al.*, 1998; Martin, 2001: 149–54, 208–09; Castro *et al.*, 2008: 353–5). All the archaeological parallels are examples of popular coasting vessels which had a long history in the Mediterranean (Balard, 1994: 135–8).

Like wreck TK05–AB, this vessel did not sink after hitting the shoreline. It did sink suddenly, given the presence of several anchors on the site. Perhaps the crew was unable to manoeuvre away from an enemy warship or to ride out inclement weather and reach safety. This armed merchantman illustrates that all such vessels had to protect themselves when trading goods or transporting supplies in an area of the Mediterranean infested with armed galleys. At least in strategic terms, the two wrecks are related. The smaller oared warship a few hundred metres distant represents the broader conflictual reality that led Mediterranean merchants to arm their small coasting vessels with wrought-iron swivel-guns. A sudden disturbance of the weather remains the most likely cause of the merchantman's demise. If, a less likely possibility, another vessel did sink this one, this is further proof that its complement of ordnance was inadequate for fully-fledged battle.

The third wreck, TK06–AD, was probably an armed merchantman with a flat transom stern and displacing in the range of 200–300 tons (Black, 2002: 167). We suspect that the vessel came from England and operated some time between *c*.1560 and *c*.1590, based primarily on a complement of weapons which includes cast-iron guns and metal crossbows. Until the early-17th century, England dominated the manufacture of cast-iron guns (Cipolla, 1965: 36–64; Guilmartin, 1974: 175; Cipolla, 1980: 286–7; Guilmartin, 1994: 149–50; Glete, 2000: 23; Black, 2002: 175), while late in the 16th century the English publicly debated the wisdom of using bows in warfare (Esper, 1965; McNeill, 1982: 91–5; Borman, 1997; Phillips, 1999). The length-to-breadth coefficient of *c*.4:1 implies a slightly-elongated cargo vessel. The single brazier, and the limited number of guns and personal weapons, all point toward a small crew capable of handling a merchant vessel of these dimensions. The fact that pottery, sherds, and tableware of types common to the Ottoman Empire, lie scattered throughout the site suggests that the vessel carried some of those items as trade goods. The working hypothesis of an English merchant vessel of the Elizabethan era helps explain the lack of a large mound of ballast-stones typical of the wreck assemblage of most other 16th-century merchantmen, particularly armed Iberian vessels in Europe and the Americas (Martin, 1975: 57–97; Keith *et al.*, 1984: 46, 48–51, figs. 3, 4, 6; Smith *et al.*, 1985: 69–71; Oertling, 1989: 241; Smith, 2001: 295–6). English vessels of the era, by contrast, often employed shingle ballast dug from local beaches (Adams, 1985: 279–84; Nelson, 2001: 51–2, 101, 115).

Archaeological parallels for the ordnance, the anchor, the ballast and the construction of the hull are

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predominantly English. However, the Cavoli wreck, a Catalan vessel dated *c*.1425–50, supplies early archaeological evidence for the transition from bows to firearms on armed merchantmen. It carried 8 wrought-iron carriage-guns, several smaller swivel-guns, shot, crossbows, swords, and musket balls (Martin-Bueno, 1992; 1998). The best parallels, however, for the cast-iron carriage-guns are English. At Western Ledge reef off Bermuda, archaeologists catalogued seven pieces of iron ordnance, including two wrought-iron swivel-guns and two cast-iron carriage-guns. One of the latter was manufactured in England and inscribed with a date of 1577. This gun is 2.04 m long, and it has its trunnions 0.93 m along the barrel from the cascabel, a bore that measures 0.05 m in diameter at the muzzle, and a first and second reinforce, suggesting that it was cast for corned powder (Watts, 1993: 115–18). Another cast-iron gun found off Bermuda near *Sea Venture*, wrecked in 1609, was identified as a minion. The gun was found about 7.62 m from the vessel's keel, perhaps after jettison, is *c*.2.5 m long and has features similar to those of the 1577 gun from Western Ledge reef. An inscription on the gun found near *Sea Venture* indicates that the maker was Richard Phillips and that the gun was therefore of English manufacture (Wingwood, 1982: 335, fig. 2, 339). The Alderney wreck of 1592 had only cast-iron guns, 8–10 in total, manufactured in England and capable of handling the same shot. A recovered example measures 2.13 m long and weighs over 710 kg (Davenport and Burns, 1995: 30–40; Bound, 1998b; *Alderney Elizabethan Wreck*, 2008). That vessel had no crossbows or longbows but did carry 45 muskets of both matchlock and wheel-lock type, incendiary grenades, and edged weapons. At least one of the heavy matchlock muskets was for use on board, given that it has a pintle on the underside of its stock (Guilmartin, 1974: 146–9; Davenport and Burns, 1995: 34–5; Bound, 1997: 25; Bound, 1998b: 68–77, fig. 14).

The straight arms, long shank, palm-shaped flukes and arms set at an angle of *c*.45° to the shank all suggest that the anchor on the site is of the English long-anchor type. The absence of ballast-stones and the probable use of shingle ballast have parallels in the English *Sea Venture*, which sank in 1609, and had shingle as its primary ballast material. Shingle ballast readily washes away in dynamic underwater conditions. The probable English wreck off Alderney was notable for lacking a large pile of ballast, though a reconstruction of the vessel indicates that it would have needed heavy ballast (Bound, 1998b: 81; Roberts, 1998: 35–6). The structural features of the hull, finally, have good English parallels. The limited number of guns and their placement suggest a vessel with a single deck and a raised, narrow stern. The Y-shaped frames atop substantial deadwood at the stern are characteristic of a high transom structure. This transom was flat with an external sternpost as indicated by the gudgeons that held a straight rudder. The guns were placed along the sides of the hull amidships, rather than at the extremities. The wrecks at Western Ledge reef and Alderney from the last quarter of the 16th century have somewhat similar arrangements. The Alderney vessel was probably a Channel merchantman acting as a transport in support of English naval operations—its 8 or more cast-iron guns were mounted for a broadside (Watts, 1993: 113–14, fig. 13; Bound, 1997; *Alderney Elizabethan Wreck*).

The conditions on the site supply clues as to why this vessel came to rest at the bottom of the Straits of Rhodes. The presence of a single large anchor amidships, the absence of any other anchors on the site, and the probable clearing inboard of the port-side guns suggest that the crew deployed their service anchors and tried to close the gunports before the vessel sank. The only anchor found on this site may even have been a spare, and the crew ran out of time to deploy it. Alternatively, as the detached fluke suggests, the anchor may have been broken, and, in that case, the crew had stowed it in the hold. The positions of the guns also provide clues to the sinking process. A prudent master operating in the waters of the Eastern Mediterranean, frequented as it was by enemy vessels, corsairs, and pirates, would probably have the vessel's guns prepared for action. Tudor and Elizabethan vessels may well have secured their guns outboard and manoeuvred the vessel to aim them effectively (Konstam, 1988: 19–20; Rodger, 1996: 311–14). The absence of most anchors undercuts a theory of surprise attack and rapid sinking. More likely, the crew noted that a storm was about to break and started to clear the guns lashed outboard and secure their gunports. They only partially completed their task, on the port side, before the vessel sank. Factoring in the maritime topography, the most likely scenario would see the crew struggling with foul weather but failing to prevent the vessel from rolling in the wind or, more probably, from striking the nearby point. Stormy weather or running aground, circumstances that at first allowed the crew to deploy most anchors, ultimately caused the vessel to sink. On the way to the bottom, the vessel re-stabilized itself, landed rather softly on its keel, and then heeled to port where the freed guns rolled under the rail.

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