

The Levanzo I Wreck, Sicily: a 4th-century AD merchantman in the service of the *annona*?

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Between 2005 and 2009 a deep-water shipwreck was located, mapped, and partially excavated by a joint team from RPM Nautical Foundation and the office of the Soprintendenza del Mare, Sicily. Located off Levanzo Island, one of the Egadi Islands off north-west Sicily, this wrecked merchantman revealed a mixed cargo of foodstuffs, coarseware, glass, and construction materials. The nature of the wreck-site, its cargo, operational date, and find-location indicate its likely association with the *annona* service which supplied Rome.

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Since 2005 the Office of Underwater Archaeology in Sicily (Ufficio di Soprintendenza del Mare) and RPM Nautical Foundation (RPMNF) have surveyed the coastal waters around the Egadi islands located off the north-west coast of Sicily, under the joint direction of Sebastiano Tusa, Superintendent of the Ufficio di Soprintendenza del Mare, and Jeff Royal, Archaeological Director for RPMNF. Large areas of sea-floor were surveyed intensively using multibeam sonar and ROV inspection; the work is still continuing.

Survey area and methodology

Based on historical routes and events, as well as recent finds in the vicinity, the area near Levanzo Island was the first survey objective. The Egadi Islands are situated along trade-routes which have connected North Africa, Sicily and Italy for millennia. Ancient settlements along the west coast of Sicily, such as Eryx, Drepanum, Motya, and Lilybaeum, served as trading centres within these regional networks. The three small Egadi Islands, which rise to over 150 m at their peaks, lie along the route between North African entrepôts such as Carthage, and Rome, as well as the coasts of Campania, Basilicata and Calabria on the Italian mainland. Key historical events also make the seas around the Egadi Islands an important research area. In 241 BC Roman and Carthaginian fleets clashed here in the final battle of the First Punic war. Polybius tells

us that the Carthaginian fleet left the westernmost island, ancient Hera Maritima, en route for the coast held by the Carthaginians, north of Eryx, but was surprised by a Roman fleet anchored on the eastern side of Levanzo Island. Considering the west-to-north wind directions noted, the battle probably took place near Levanzo Island.

Recent finds by fishermen support this as a promising survey area; a bronze ram was pulled up by a drag-net fisherman somewhere north of the island in 2002, and a Roman bronze helmet recovered by a static-net fisherman to the west of the island. To date the Egadi Islands Survey Project (EISP) has recovered five additional bronze warship rams which will be featured in a future publication by the authors.

The principal survey methods are remote sensing with a multibeam echosounder and verification of anomalies with a Remotely Operated Vehicle (ROV). Both survey and verification were carried out with RPMNF's research vessel *Hercules*. This is equipped with a hull-mounted EM3002D multibeam echosounder from Kongsberg Maritime division, which emits in excess of 500 individual sonar beams at a maximum rate of 40 times per second, on two frequencies, 297 and 303 MHz. The system has a depth-resolution rating of 1 cm. The ROV is a Panther XT small work-class vehicle from Seaeye division of SAAB; among the attachments are an HD camera, two Hydro-Lek multifunction manipulators, and a suction system.

Overlapping survey lanes are run along the sea-floor contours to achieve 200% coverage. Multibeam data is processed during, and directly after, the collection phase to produce 3-D models of the sea-floor (acquired through Kongsberg's SIS software, processed in CARIS HIPS/SIPS, and modelled in IVS Fledermaus). All acquisition and processing of data is performed by surveyors contracted from Highland Geo Solutions Inc. of Fredericton, NB, Canada. Anomalies are examined for association with either geological formations or deposits consistent with shipwreck-sites, and the latter are plotted in navigational and spatial recording software for verification. The RV *Hercules* is positioned over anomaly co-ordinates and the ROV deployed equipped with a transponder which allows the tracking of both *Hercules* and the ROV within the 3-D models of the sea-floor in Fledermaus to obtain precise locations for sites and individual finds. During verification operations the locating of each anomaly, as well as stray material near anomalies and sites, is facilitated by a forward-scanning sonar fixed to the ROV. Once cultural material is located and positions recorded, a visual investigation is carried out using still and video cameras.

Each of the seasons from 2005 to 2010 entailed multibeam survey, anomaly verification, and/or site investigations. Multibeam survey took place during four field seasons: 2005 (17.5 km²), 2007 (118.3 km²), 2008 (12.3 km²) and 2010 (61.6 km²), a total coverage of 210.7 km² (Fig. 1). Notable geological formations included large rock outcrops which produced shallow waters to the south and south-west of Levanzo Island, towards the north-west coast of Favignana Island. Most of the zone to the west of Favignana features open sandy stretches reaching depths of 60–85 m rela-

tively quickly. The numerous rock outcrops in the deep western section of the survey area may continue further west. The Levanzo I wreck-site was discovered during ROV verification of anomalies in 2006; subsequent visits to the site occurred in both 2007 and 2008. For the 2009 field-season the team focused solely on anomaly verification and work at the Levanzo I wreck. ROV verification efforts continued in 2010, along with a visit to the Levanzo I wreck-site to assess conditions.

The Levanzo I wreck-site

The wreck-site is located c.6 km north of Levanzo Island (Fig. 1), resting on a flat sandy stretch of sea-floor surrounded by three small rock outcrops, at a depth of 94 m. Based on video and still photography from the 2006 season, as well as the collection of artefacts for measurement, it was possible to render a preliminary site-plan; subsequent mapping in 2008 and 2009 resulted in a final site-plan. The c.30–40-cm-high mound measures c.20 × 9 m, is oriented generally NW-SE, and has concentrations of material at each end (Fig 2).

The north-west end of the site is dominated by large amphora sherds and pieces of tableware; at least four intact amphoras and several objects of unknown material which may be remnants of hull timbers were initially observed on the surface. It is clear that the large amphora sherds and intact amphoras extend only slightly into the site-mound. The central area is notable for its lack of surface artefacts, and of any apparent significant presence of sherds protruding from the sea-floor. The south-east end of the site features a distinctly square-shaped deposit (sector H/I-6), consisting of large amphora sherds, tableware, and a concentrated

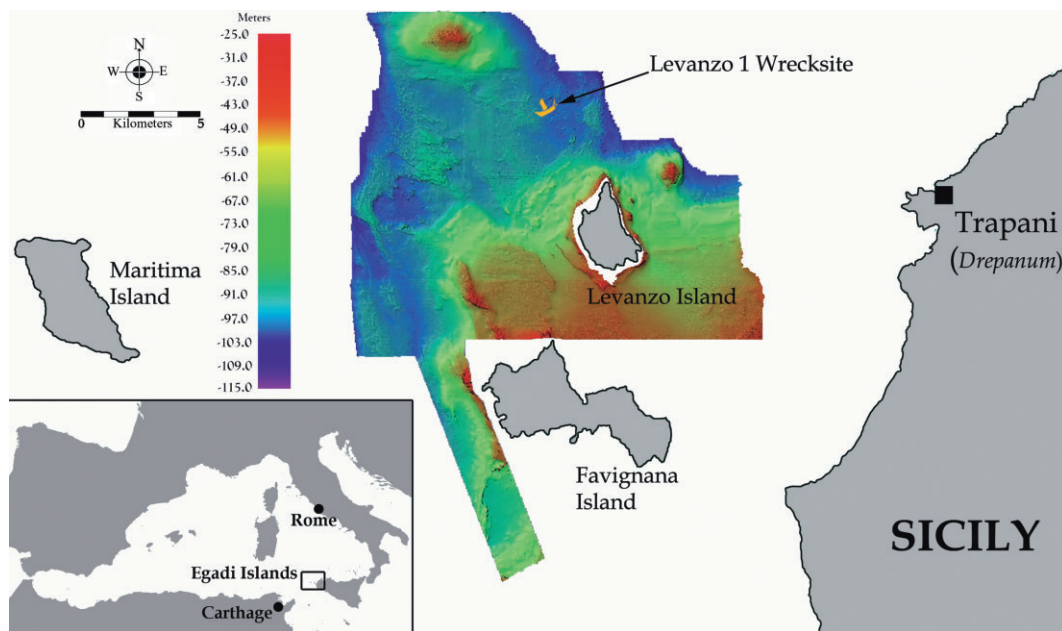


Figure 1. Survey area, 2011, with location of the Levanzo 1 wreck-site. (J. Royal, RPM Nautical Foundation)

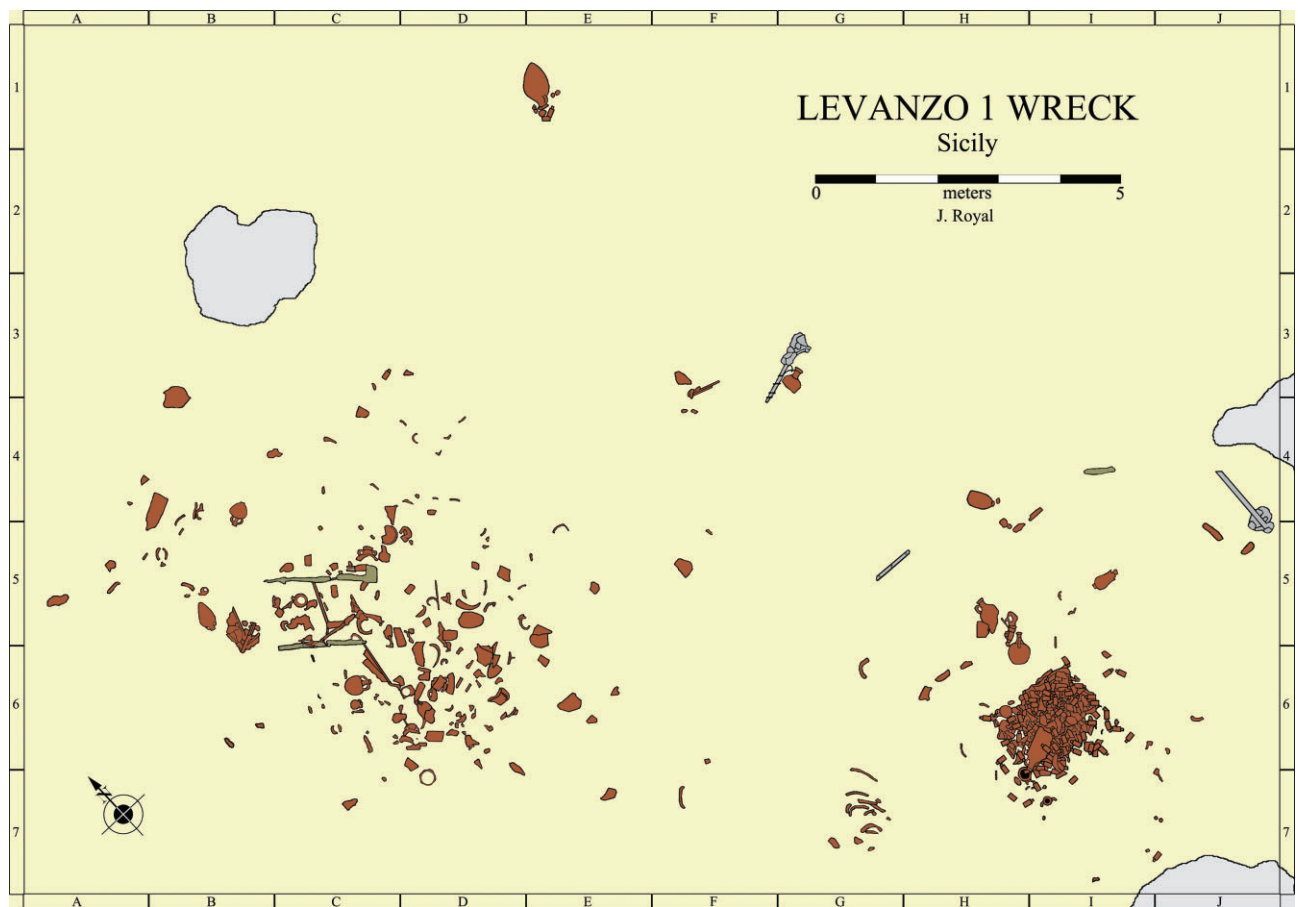


Figure 2. Site-plan of the Levanzo 1 wreck. (J. Royal, RPM Nautical Foundation)

deposit of over 100 vaulting-tubes (*tubi fittili*) mixed with amphoras and several pieces of coarseware (Fig. 3). A few other vaulting-tubes are scattered around the site, but the overwhelming majority are located in this square deposit, around which are amphora sherds, several intact amphoras and concretions. The vaulting-tubes are the only observed construction materials on the site.

Site investigation

Since 2006 the Levanzo I wreck-site has received several types of investigation each year. After discovery, the site was mapped with various video/still camera combinations and a small number of artefacts were collected to assess provenance. Anomaly verification in 2005 and 2006 indicated that many parts of the survey area had been severely impacted by drag-net fishing. Video recording in 2007 and 2008 confirmed drag-net impacts in the survey areas as a whole, and specific disturbance on the Levanzo I site, resulting in the scattering of artefacts. Before the beginning of the 2009 season it became clear that the Levanzo I site remained in danger of further drag-net damage and the co-directors agreed that this required mitigation. Consequently preparations were made for intensive

mapping, exploratory excavation, and artefact retrieval, to be carried out that year. Comparatively little is known about the nature of deep-water sites; but such projects as the EISP contribute to the understanding of these sites and the threats to them. The Levanzo I site's particular characteristics also make it ideal for testing equipment and methodologies which can later be applied to other sites.

Although largely disturbed by both drag-nets and bio-turbation, every effort was made to control and record the provenance of artefacts. One of the key stratagems for the control of artefact location in the x-y plane was to map them relative to datums. Seven 1-m-high datum poles constructed of PVC pipe and cement were positioned around the site. Two methods were used for measuring the position of these datums. Absolute positions were obtained by placing a beacon on each datum and recording the co-ordinates; these positions were displayed on the sea-floor model within IVS Fledermaus software, which allowed their depths to be ascertained from the bathymetric data. These beacon positions also provided real-world location and orientation for the wreck-site.

Then a high-frequency sonar fitted to the ROV performed inter-datum measurements by clearly imaging



Figure 3. Square-shaped concentration of vaulting-tubes and other ceramics in sectors H/I-5/6 of the wreck-site. (RPM Nautical Foundation)

each datum, as well as small objects on the site, in a 180° sweep. Images were recorded and precision measurements taken between, or along, objects in the sonar's software with sub-centimetric precision. In order to increase the accuracy of measurements the ROV was placed at three different vantage-points around the site; additional recordings and measurements were made during subsequent positioning for measuring temporary datums and at any time the ROV was at rest on the periphery of the site. Five to 10 measurements were thereby gathered between any two datums; statistical outliers were ignored and the remaining cluster of measurements was averaged. The inter-datum distances were placed in Site Recorder 4 and interpolated; along with datum beacon positions and bathymetric depths, and a highly-accurate representation of the datum positions was achieved.

The task of mapping datums was facilitated by the site's manageable scale and the low degree of artefact stacking. With the datum positions plotted on the sea-floor model, it was possible to ascertain the site's overall height profile. A transect was taken on the surface plane of the bathymetric map across the south-east portion of the site, between datums D1 and D6, at right-angles to the site's long axis (Fig. 4). Over this

30-m distance, the highest point rises less than 30 cm, some of which is probably due to the large rock formations that lie beneath the sediment and rise in places to form exposed outcrops, which were not included in the transect. A slight amount of sand has certainly built up around the artefacts, but their scattered presence due to drag-net incursions would not provide significant sediment traps. The rock outcrops rise to c.35–40 cm off the sea-floor around the site, and undoubtedly aided in its preservation, as they would have deflected drag nets, though any material situated above the height of the rocks could have been displaced. The depth/height of artefacts was always near the sea-floor's surface, and their height (in the z plane) was extrapolated with depth measurements as well as direct measurements relative to the sea-floor.

A downward-facing camera performed video recording of the site to document the datums' positions and produce a photo-mosaic. The ROV traversed 4–5 m above the site to obtain images, while wider-scale images from a greater altitude were used to formulate the general image of the area. Afterwards, the higher-resolution still photographs of artefact groupings obtained in 2006 and 2008 were overlain. The mosaic was then imported into Site Surveyor and

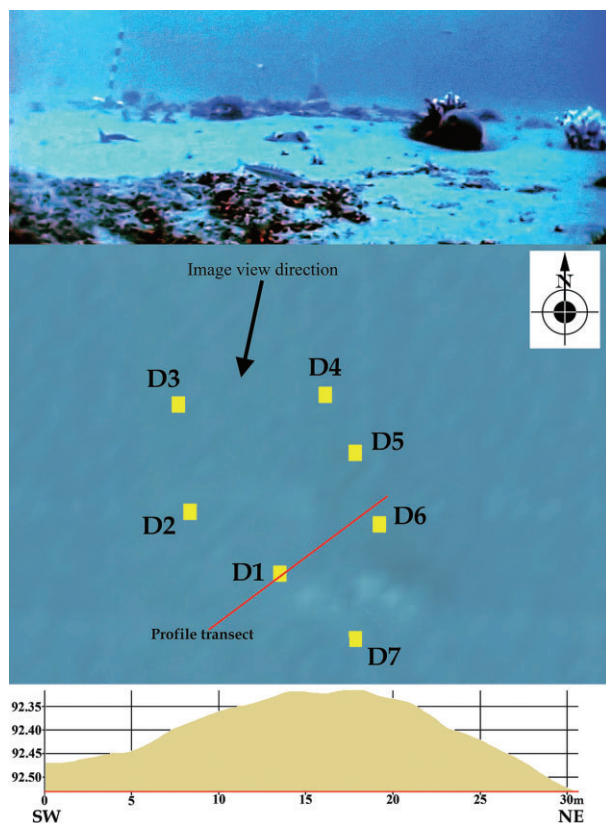


Figure 4. View looking south of the wreck-site (top), position of datums and elevation transect (middle), elevation profile of site (bottom). (J. Royal, RPM Nautical Foundation)

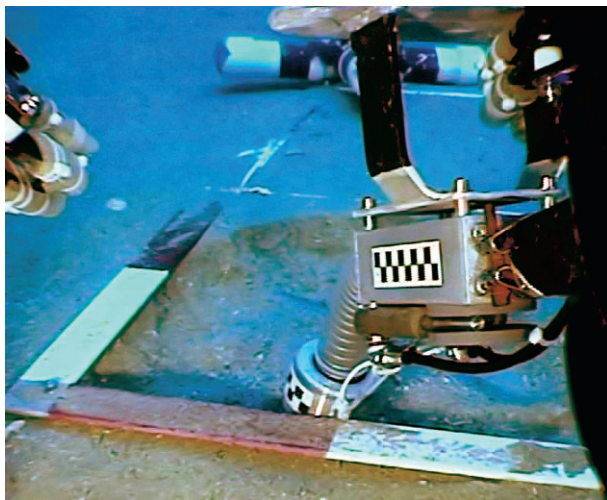


Figure 5. Excavation of Square 1. (J. Royal, RPM Nautical Foundation)

aligned with the datum positions and the final site-plan drawn from the mosaic, video, and photos. Several representations were available to ascertain the locations of surface artefacts, and allowed the measurement of features and objects. (Some of the larger

artefacts and natural features were discernible in the sonar data, and were measured in relation to datum positions and one another as a check on the overlay positions generated in Site Recorder 4, and this confirmed the efficacy of integrating the mosaic and datum measurements.) With mapping and provenance under control, it was possible to proceed with the collection of surface artefacts for analysis.

Another experimental phase involved two 1-m-square test excavations, at locations largely free of surface artefacts in the central part of the site. Each shallow trench was conducted within a form manufactured from flat aluminium and painted red/white in 25-cm increments; bolts attached through the corners resisted shifting after placement (Fig. 5). Based on the method commonly used when recording artefact locations during dive operations, the square was divided into four 50-cm² quadrants, A-D, each of which was further subdivided into four 25-cm² sub-quadrants, designated 1–4. Once these were in place a video flyover recorded each square's relative position. Additionally, temporary datums were placed on two opposite corners of each square and their positions recorded with the sonar and measured in relation to the seven fixed datums, and the position of the square interpolated in Site Surveyor.

A water-dredge on the ROV performed excavation duties (Fig. 5), with all dredged material run through a 5-mm-mesh bag and its contents examined on deck. The dredge featured a collar specially designed to shoot short bursts of water from six 2-mm holes in order to break up or move sediment for easier dredge operations, akin to hand-fanning. This jet collar was not required in the upper layer of loose sand, but was necessary to remove the underlying dense mud layer, excavated to a limited degree to test for the presence of artefacts. The deepest penetration was a 15-cm-deep sondage in one sub-quadrant. Depths of sediment layers and artefacts were ascertained with scales held in the ROV manipulator-arm or fixed to the dredge. When artefacts were encountered in the square and their positions noted in the log, they were removed with the manipulators or by the suction of the dredge to a small basket.

Video recording provided an important supplementary record; with real-time video of excavation it is possible to re-create and review all work performed, as well as create a permanent record. The provenance of artefacts within a square can be determined and re-checked if necessary, and any assessment of sediment in relation to the artefacts is also reviewable. This recording used three separate cameras: one pointing downwards for a plan view, a pilot camera providing a forward view, and a manipulator camera allowing custom views, all facilitated by two powerful lamps attached to the ROV's deployment cage, which features a tether-management system (TMS), and pointed downwards. With the TMS positioned above the excavation square, a much-improved image was achieved

with truer colours and far fewer particulates visible in the water.

Site morphology

Based on excavation in both squares the site's upper sediment layer is a medium-grained, light-coloured sand, 5–10 cm thick, mixed with shells and small rock fragments. Underneath this is a harder-packed mud layer, slightly darker in colour, which usually required mechanical assistance to dredge. All artefacts were found either on the surface or in the loose upper sand layer; the 15-cm-deep sondage extended *c.*10 cm into the dense layer with no artefacts encountered. The sandy upper layer appears slightly thicker on the north-west and south-east portions, where amphora and sherd concentrations helped to trap sand. The shallow sand-cover provides virtually no protection from teredo damage, and also means that the mounding is mainly accounted for by the rock formations around and probably beneath parts of the site.

The Levanzo I wreck is similar to many others in deeper waters, where sedimentation rates are lower than those nearer shore, and leave wreck-sites largely exposed. Consequently the ceramics and a few other features exposed on the surface were almost all that remained of the cargo and ship. A search of *c.*1/2 km² around the site yielded very little material scattered in any direction beyond the wreck-site. It produced several pieces of coarse tableware, large body fragments of cylindrical amphoras, probably North African, the upper part of a possible Keay 62 amphora (variant unclear), at least two upper parts of Greco-Italic V/VI amphoras, a Dressel 1A amphora, the upper portion of a Dressel 2–4 amphora, and a mill-stone. It is likely that the tableware and large cylindrical amphora sherds are associated with the wreck-site, but not certain. There is no trail of material leading from the site as is noted at other sites impacted by drag nets. Datums left in place after the 2009 field-season,

however, were observed lying on their sides during the 2010 season. As the Guardia Costiera assured us that no drag-net fishing had taken place, the remaining potential causes are currents, storm-action, or static-net fishing. It was also clear from detailed observation of the site between 2006 and 2010 that biogenic processes contributed to artefact movement.

Amphoras

The majority of the ceramic remains on the site are of amphoras, with smaller quantities of tableware and vaulting-tubes. Nine amphora-types are represented in the 14 identifiable amphoras collected (Tables 1–2). Many of the body-sherds are from large, cylindrical amphoras, probably the African 1 and 2 varieties. The amphoras were either lying on the surface or buried up to 8–10 cm in loose sand, so little or no excavation was required to lift them. Petrological analysis is planned, which will assist in determining more precise locations of manufacture. All artefacts collected are undergoing conservation with the Soprintendenza del Mare's office.

Although a majority of amphoras on the surface were damaged or fragmentary, a number of intact, or nearly intact, examples were exposed for identification. A single amphora was raised during the 2006 season along with tableware and several vaulting-tubes. After further mapping in 2009, a significant number of additional artefacts were raised, including ceramics and concretions. Both excavation squares were located in the central area of the site where no artefacts were present on the surface (Fig. 6). Square 1 (Fig. 7) produced two small amphora body-sherds (sectors B-1/, B-3), an amphora toe (sector D-1), and four nails (sectors A-3/C-1, C-3, and two in the collection bag, see below). Square 2 (Fig. 8) produced six small amphora fragments (sectors C-1, C-2, C-4, D-1, D-2, D-3) and what appeared to be a section of wood

Table 1. General information about the amphoras collected

Artefact No.	Type	Condition	Origin	Typical contents	Date range (centuries AD)
SI06AA-0012	MRA 1a	Intact	Tunisia	Unknown	1st–4th
SI06AA-0013	MRA 1a	Intact	Tunisia	Unknown	1st–4th
SI06AA-0040	MRA 1a	Intact	Tunisia	Unknown	1st–4th
SI06AA-0021	African 2C	Rim-neck-handle	Tunisia	Fish products	mid 3rd–4th
SI06AA-0018	African 2D	Missing base	Tunisia	Oil/fish products	mid 3rd–4th
SI06AA-0019	African 1 Piccolo	Rim-shoulder	Tunisia	Oil	mid 2nd–late 4th
SI06AA-0020	African 1 Piccolo	Rim-shoulder	Tunisia	Oil	mid 2nd–late 4th
SI06AA-0009	Dressel 30-Tunisia	Intact	Tunisia	Wine?	3rd–4th
SI06AA-0014	Almagro 51C	Intact	Spain	Fish products	3rd–mid 5th
SI06AA-0017	Almagro 51C	Intact	Spain	Fish products	3rd–mid 5th
SI06AA-0037	Almagro 51C	Intact	Spain	Fish products	3rd–mid 5th
SI06AA-0023	Keay 52	Intact	S Italy/NE Sicily	Wine	late 3rd–4th
SI06AA-0052	Knossos 18	Rim-neck-handle	NE Adriatic	Oil	2nd–4th?
SI06AA-0035	Agora M 236(?)	Hole near base	E Mediterranean	Unk/Wine?	4th?

Table 2. *Selected amphora measurements (mm)*

Artefact no.	Type	Rim diam. inner	Rim diam. max.	Rim thickness	Mid-handle max. diam.	Mid-handle min. diam.	Handle length	Neck circ. at body join	Neck height
SI06AA-0012	MRA 1a	56	80	12	29	28	192	222	116
SI06AA-0013	MRA 1a	64	77	8	30	30	174	234	80
SI06AA-0040	MRA 1a	50	81	15	30	25	172	224	109
SI06AA-0021	African 2C	78	120	26	42	24	203	446	118
SI06AA-0018	African 2D	79	117	19	45	23	198	440	115
SI06AA-0019	African 1 Piccolo	79	129	25	32	18	114	286	47
SI06AA-0020	African 1 Piccolo	92	123	16	38	23	154	352	79
SI06AA-0009	Dressel 30—Tunisia	67	93	21	31	18	104	197	72
SI06AA-0014	Almagro 51C	80	140	26	40	30	164	324	65
SI06AA-0017	Almagro 51C	82	128	23	40	30	170	383	35
SI06AA-0037	Almagro 51C	65	92	14	47	23	130	206	72
SI06AA-0023	Keay 52	56	74	9	23	23	165	250	95
SI06AA-0052	Troesmis type XIII	158	216	29	39	24	166	444	134
SI06AA-0035	Agora M 236(?)	85	109	12	29	17	133	349	73

running through D4 and beyond the edges of the square on both sides (discussed below).

Amphora type MRA 1

Three amphoras of this type were collected (Fig. 9, SI06AA-12, 13, 40), also described as ‘Agora M254’ and ‘Bonifay 59’ (Bass and van Doorninck, 1971: 35–6; Panella, 1973: 632, nos 44–6; Riley, 1979: 177). General features are a narrow neck, curved handles which are round-ovoid in cross-section, a carinated shoulder, a globular body, and a footed ring-base; the height is generally 40–45 cm. MRA 1 amphoras are often divided into variants ‘a’, with a biconical rim, and ‘b’ with a thickened, shorter rim (Riley, 1979: 177). The biconical rim of variant ‘a’ was described in early work as having a ‘horizontal flange just below the sharp lip’ (Robinson, 1959: 108). Riley postulates that the rim of variant ‘a’ has a sharper profile in the 2nd to 3rd centuries AD, and becomes lower and thicker by the 4th century (1979: 177–80). The necks also differ in that ‘a’ is smooth whereas ‘b’ is often corrugated. Our three examples are of variant ‘a’ and have the more-rounded rim associated with later production. With little research on this type, there remain difficulties and discrepancies in assigning individual examples to each variant.

Two of the three intact MRA 1a amphoras, SI06AA-0012 and SI06AA-0013, were collected from the north-west part of the site (site sectors B-4 and C-6 respectively) and one, SI06AA-0040, from the south-east area (H/I-5/6). The representation and dispersion of this type on the wreck-site suggest that they were cargo rather than crew items.

Description and dimensions

The three amphoras range from 468 to 485 mm high, 320–345 mm in maximum diameter, and have triangular rims (Table 2). There was no sign of re-use on the

interior of the rims. SI06AA-0012 is complete, 485 mm high, with a maximum diameter of 265 mm. It has a 26-mm-high triangular rim with a peak at mid-height (maximum diameter). Flanges circle the top and bottom of the rim, 13 and 17 mm wide respectively. Handles join at 18 mm below the rim, where there is a slight bulge in the neck’s circumference, and connect c.73 mm above the shoulder. The handles are round in cross-section, but have a small ridge running the length of the outer face. A slight flare occurs at the bottom of the neck where it joins the body. A less-defined shoulder carination is noted on this example. This amphora sits on a ring-base 86 mm in diameter, 13 mm high, with a nub in its centre 5 mm in diameter.

One side of the rim on SI06AA-0013 is damaged, but the discernable features are similar to the previous example, 480 mm high, with a maximum diameter of 320 mm. Where the 45-mm-high rim is broken the thickness is 7–8 mm. When viewed from on top the handles are set slightly askew. Its shoulder has a more defined carination, and although its 102-mm-diameter ring-base is concave there is no central nub. SI06AA-0040 is 468 mm high, 329 mm in maximum diameter, and has features consistent with the previous examples. The 31-mm-high rim is triangular in cross-section. Its shoulder exhibits more defined carination, the handles are slightly askew, and there is a small nub in the centre of the base. The ring-base is 99 mm in diameter, 12 mm high and 13 mm wide.

Although waterlogged and exposed to the marine environment, the outer surface of SI06AA-0013 was brown (2.5YR 3.3) and of SI06AA-0040 was yellow-brown (7.5YR 5/4). No surface on SI06AA-0012 was exposed, and none had new breaks for determining a cross-section colour. Examples of MRA 1 fabric are reported to have a pale red colour (2.5YR 5/6–6/6) with small white inclusions including limestone, feldspar, mica, and calcareous foraminiforan microfossils; this is

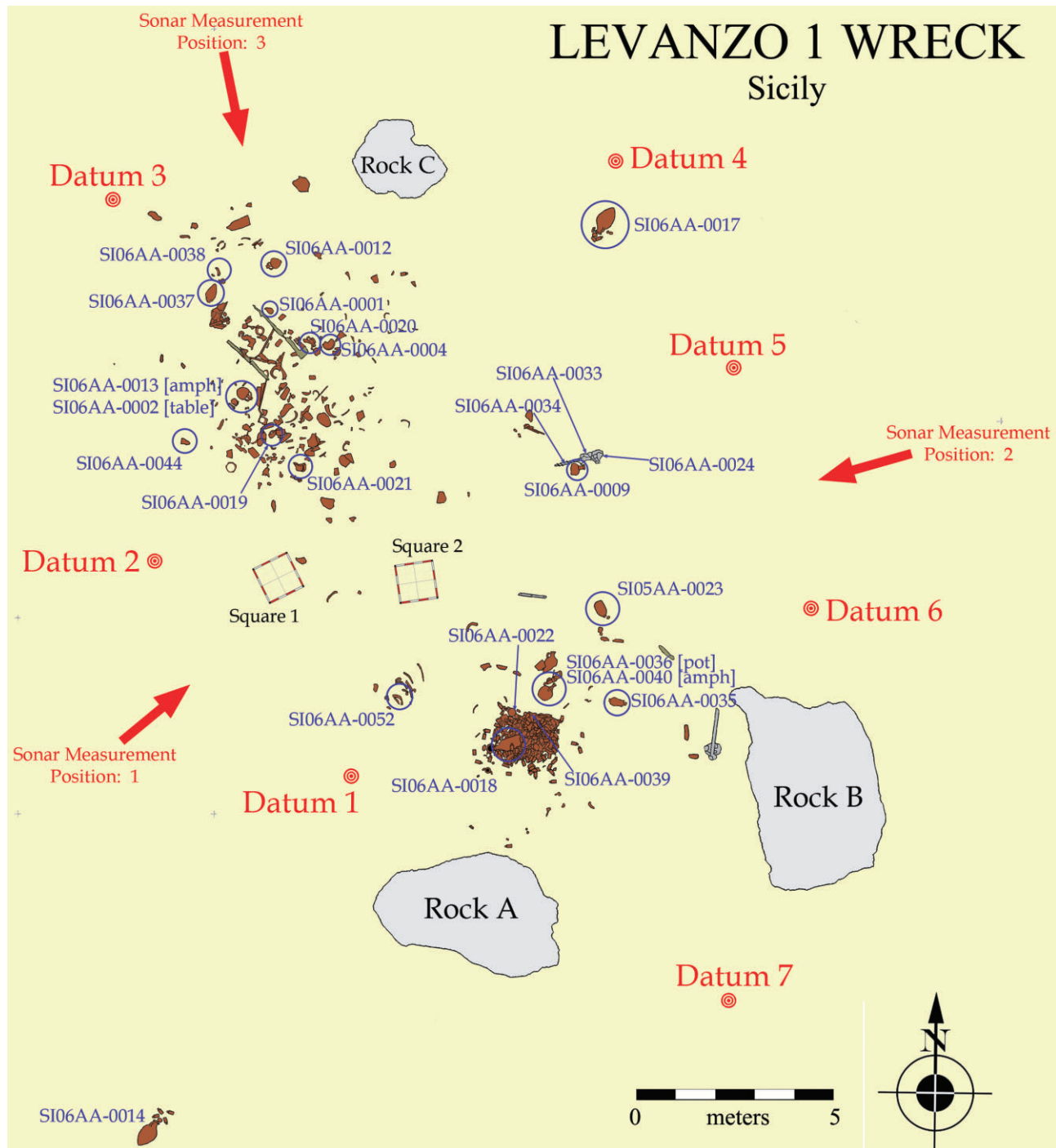


Figure 6. Artefact designations and positions on the Levanzo 1 wreck-site. (J. Royal, RPM Nautical Foundation)

very similar to fabrics from eastern Tunisian kiln-sites producing African 2 amphoras (Riley, 1979: 177–9; Bonifay *et al.*, 2002; Bonifay, 2005b; Capelli, 2005). Two examples from Sidi Khrebis, Benghazi, have different fabrics; one orange red (2.5YR 5/6) with small white grits, and the other creamish-grey with small white grits (Riley, 1979: nos. C543 SK S14.3, C506 SK J31.14).

Comparative examples

Comparative amphoras are all slightly smaller. These include a mid-4th century amphora from the Athenian agora, with a restored height of 432 mm and maximum diameter of 300 mm (Robinson, 1959: 108, no. P11581, pl. 28-M254). The lone example from the galley area of the 4th-century wreck at Yassiada is 405 mm high and 293 mm maximum diameter, and

also has a flange just below its lip (Bass and van Doorninck, 1971: 35–6, pl. 3, fig. 26). The Yassiada wreck's cargo comprised eastern Mediterranean amphora types such as Opaï 3C, LRA1 variants, as well as a possible Keay 59 variant. An apparent lone find on the Pampelonne wreck near St Tropez,

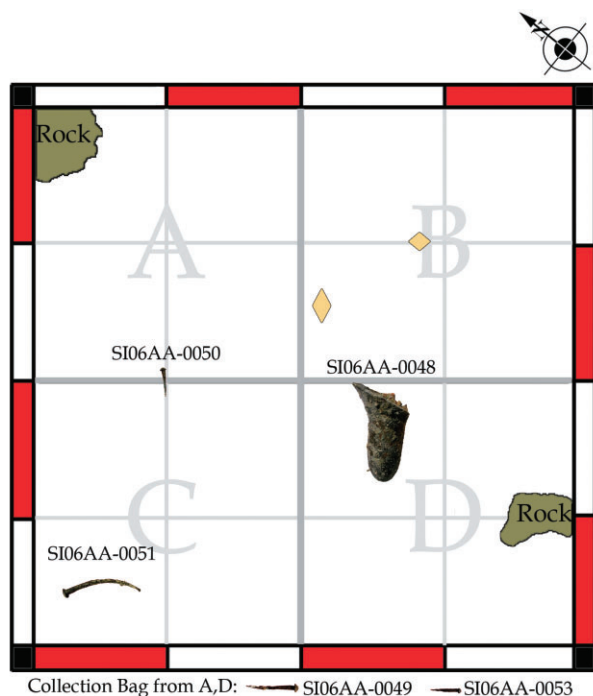


Figure 7. Excavation Square 1. Order of excavation: D, A, B, C. (J. Royal, RPM Nautical Foundation)

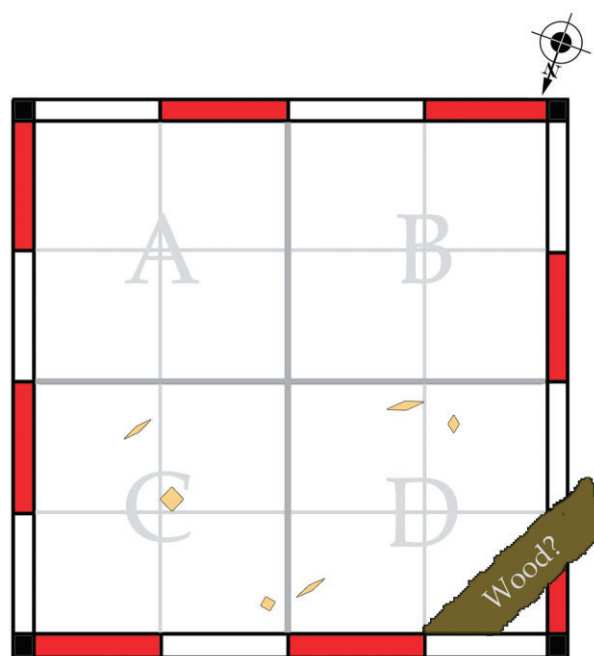


Figure 8. Excavation Square 2. Order of excavation: D, C. (J. Royal, RPM Nautical Foundation)

France, dated to the first half of the 4th century, is 460 mm high and 300 mm maximum diameter (Lequément, 1976: 184–5, Fig. 8a). The cargo of this wreck consisted primarily of African 3A amphoras, but also included Beltran 72 and Almagro 51C amphoras from Hispania. There are also good parallels from the excavations at Sidi Khrebis, Benghazi, which have a reduced curvature along the mid-length of the handle, as is found in the Levanzo examples (Riley, 1979: figs 82.220 and 81.215).

Date and contents

Variant MRA 1a was produced for export between the 1st and 4th centuries, with a possible local distribution in North Africa continuing into the 6th century (Panella, 1973: 469–71). Ostia has a high representation of MR1 amphoras in the 1st century, while the earliest example of a MR1a variant at Berenice is from a late-2nd-century cistern deposit (Riley, 1979: 177–80). The contents remain uncertain.

Production and distribution areas

A production area for MRA 1 remains uncertain, but a central Mediterranean origin is supported by its distribution in Tripoli, Malta, Ostia, Syracuse, Marseilles, and into Europe (Riley, 1979: 177–8, see map, fig. 27 for general distribution in the Mediterranean). It would appear that a Tripolitanian origin is ruled out due to its inverse correlation with the quantitative distribution of other known Tripolitanian types, and the fact that it does not have typical Tripolitanian fabrics (Riley, 1979: 179; Gallioui, 1990; Bonifay, 2004: 147–8; while Panella, 1973: 471 argues for a Tripolitanian origin indicated by its distribution). Production in Sicily is also unlikely based on the fabrics of tested examples (Bonifay, 2004: 147–8; for arguments in favour of a Sicilian origin, primarily based on distribution, see Wilson, 1990: 264; Freed and Wilson, 1999: 268; Wilson, 2000: 361–3). Given the current MR1 fabric and distribution, one likely production area is Tunisia. A North African origin is suggested by Panella (1973: 471). Although Bonifay argues for an Italian origin, the possibility that there may also have been production of this type somewhere in North Africa is considered (2004: 147–8). Notably, the sudden increase in MRA1 imports at Ostia, following a brief downturn, corresponds with the rise in African 2 imports from Byzacena.

This type has a high representation at Ostia during the 1st–2nd centuries, and to a lesser extent in the early-3rd and later-4th centuries, and at Berenice where its representation increased from the 1st century to a peak in the mid-3rd century (Riley, 1979: 178–9, fig. 26; also see fig. 81.215 for an example dated to the second quarter of the 3rd century). Finds also occur further north, for example at Trier and Cologne. Riley reports no examples of MRA1 from assemblages in Spain, Alexandria, Caesarea, or the Black Sea region (1979: 177–80, fig. 27). There are few examples from shipwreck-sites. The single examples on the Yassiada



Figure 9. Small- and medium-sized amphora-types recovered from the wreck-site. (J. Royal, RPM Nautical Foundation)

and Pampelonne wrecks are probably galley items; their small size and flat ring-base make them ideal for re-use in ship's galleys. In any case, the type's inclusion in the cargo of the Levanzo I wreck is the latest evidence from a shipwreck-site which supports this type's overseas distribution within the central Mediterranean during the 4th century.

Amphora type African 2C

African 2 amphoras are also known as Keay 6; Riley combines sub-types A-C into a single type MRA 16b (Riley, 1979: 203). These amphoras are large, cylindrical containers with a wide shoulder and a tapering body. There are four sub-types, A-D, and two variants of sub-type C—C1 can hold over 50 litres and is typically twice as large as C2 (Panella, 1973). Typical features are a conical neck with ear-shaped handles, oval in cross-section. Their bases narrow to a spike, the end of which often widens then comes to a point, 'baluster shaped' (Peacock and Williams, 1991: 155; Bonifay, 2004: 114–15). The tall rim of sub-type C1 is convex on its outer side and flat on the inner; the later variant has a taller and narrower rim (Bonifay, 2004: 114).

A single rim-neck-handle portion of an African 2C amphora, SI06AA-0021, was recovered in site sector D-6 (Fig. 10). Other rims on the site also appear to be of this type. Its presence in the cargo along with amphoras from Hispania is paralleled on the Planier 7 wreck which, although looted, evidently carried African 2C type amphoras along with Almagro 50 and 51C types (Benoit, 1962: 157–61; Zevi and Tchernia, 1969: 197–9).

Description and dimensions

This fragment includes the upper shoulder, rim, neck, and handles. The outer rim is 45 mm high and convex, so it is categorized as variant 1. It has ear-shaped handles, ovoid in cross-section, and a body thickness of 10 mm at the shoulder. The conical neck tapers upward with a mid-length diameter of 142 mm.

The example from the wreck was over-95% covered in growth, and without fresh breaks no useful colour



Figure 10. Large-sized amphora-types recovered from the wreck-site. (J. Royal, RPM Nautical Foundation)

determination could be made; it will have to await petrologic analysis. The fabric in other examples is noted to be hard and red-orange, often with a white wash on the outer surface (Manacorda, 1977: 164–5). Nearly all examples from Catalonia are dark red to bright orange with transparent orange crystal, muscovite mica, and clay temper inclusions (Keay, 1984: 119, 447).

Comparative examples

Comparative examples are found at Puppit (Bonifay *et al.*, 2004: fig. 11.19), Catalonia (Keay, 1984: 120, fig. 45.1, no. T/9/3), and an example from Ostia which was 1.1 m high with a 370-mm maximum diameter (Zevi and Tchernia, 1969: figs 4, 13a; Panella, 1973: 629, no. 28). Another good comparison is from the Golfe de Fos wreck, 1.15 m high with a maximum diameter of 385 mm (Zevi and Tchernia, 1969: fig. 21b), as well as a rim from Sidi Aoun (Ghalia *et al.*, 2005: 506, fig. 8.42–3). An example from the Planier 7 wreck was 1.13 m high and had a maximum diameter of 350 mm (Zevi and Tchernia, 1969: fig. 18c).

Date and contents

African 2C amphoras date from the second half of the 3rd to the early-4th century and carried fish products (Keay, 1984: 119–21; Bonifay, 2004: 114–15; Ghalia *et al.*, 2005: 498). Examples on the Planier 7 wreck-site have been provisionally dated to the first half of the 4th century (Benoit, 1962: 157–61; Zevi and Tchernia, 1969: 197–9). This type's presence on the Levanzo 1 wreck supports its production and distribution into the 4th century, and potentially pushes its use into the middle of the century. This sub-type is possibly also present on the Scauri wreck dated to the end of the 4th or early-5th century (Baldassari, 2009: 109).

Production and distribution areas

African 2C amphoras were produced in Tunisia, particularly around the Nabeul area (Bonifay, 2004: 114–15) such as Sidi-Zahrani (Ghalia *et al.*, 2005: 495–8), supported by their fabric and numerous stamped examples (Panella, 1973: 588; Manacorda, 1977: 164–5; Bonifay, 2004: 115). The type was produced for export, and is not found at Berenice or Cyrenaica, areas which interacted with Tunisia in a more local market system (Riley, 1979: 203). These amphoras are found at a wide number of sites throughout the western and central Mediterranean, and to a lesser extent the eastern Mediterranean. Generally, this type is infrequently represented on wreck-sites compared to the other three sub-types, particularly A and B.

Amphora type African 2D

African 2D amphoras on the Levanzo I wreck (Keay type 7), have a high straight-sided rim, often thickened on the inside, a conical neck, ear-shaped handles with a circular cross-section, a long cylindrical body, and a rounded base terminating in a pointed foot (Riley, 1979: 203; Keay, 1984: 121–2; Bonifay, 2004: 115). Average rim diameters are recorded as c.118 mm, maximum body diameters of 300–370 mm, and typical heights of 1.1–1.2 m (Zevi and Tchernia, 1969: 173; Keay, 1984: 121–2; Bonifay, 2004: 116). Two variants of sub-type D are usually identified, the main difference being their rim forms. Variant 1 has a somewhat thickened, straight-sided collar-rim which forms a slight shelf where it joins the neck, while the rims of

variant 2 are more a continuation of the neck straight upwards (Bonifay, 2004: 115–17). Keay also noted this, describing the rim as a continuation of the neck, although some examples have a slight differentiation at the rim-neck join (Keay, 1984: 121–2). The example from the Levanzo I wreck-site is African 2D1.

SI06AA-0018 was raised from site sector I-6/7. African 2D1 and 2D2 amphoras were often carried together in ship cargoes, and this may have been so on the Levanzo 1 wreck given the evidence for numerous large cylindrical amphoras on board. Both variants were part of the cargo on 4th-century wreck-sites in southern France such as the Planier 7 wreck (Benoit, 1962: 147–76; Zevi and Tchernia, 1969: 196–9, the overall representation of, or percentage within, the cargo of the Planier 7 wreck for each variant is not known) and the Port-Vendres A wreck (Chevalier and Santamaria, 1972; 1973, nos PV1.A19 and PV1.A78; Liou, 1974). Only African 2D1 amphoras were found on the Pomegues A wreck (Gassend, 1978) from southern France and the Cabrera C wreck from southern Spain (Bost *et al.*, 1992), yet these are both dated to the 3rd century.

Description and dimensions

The base is missing on this otherwise complete example (Fig. 10). Its preserved partial height is 860 mm and maximum body diameter 375 mm, in the lower third. At the break at the base the body thickness is 10 mm. The handles are ovoid in cross-section and ear-shaped in profile. The conical neck tapers upwards, with a mid-length diameter of 145 mm, to a 37-mm-high rim.

The exterior colour is reddish-yellow brown (2.5YR 3/6, wet), while the section at an old break was slightly more reddish (2.5YR 4/8). No fresh breaks were available to examine and the determinations were made from exposed and waterlogged surfaces. This type is strongly associated with Tunisia, where typical fabrics are hard-fired, red-orange (2.5YR 6/6) and have quartz and limestone inclusions. Surfaces are often white or cream (10YR 8/3). It is difficult to distinguish between fabrics within certain areas of Tunisia, notably around Carthage, while eastern production-sites such as Salakta are more easily distinguishable. In addition to Salakta, fabrics from Sidi Zahrani, Henchir ech Ckaf, and Jerba are well documented and identifiable. Fabrics from all four areas are iron-rich, and those from Salakta have a brick-red to brown-grey colour. Each of the four fabrics shares similar inclusions including limestone, quartz, calcareous microfossils and mica. Differentiation between the area's fabrics is mainly by grain-size and relative presence of the inclusions (Bonifay *et al.*, 2002; Bonifay, 2005b; Capelli, 2005). The majority of examples from Catalonia had the same fabric as African 2C examples (Keay, 1984: 122, 447).

Comparative examples

Comparative examples include an amphora found in Catalonia, 1.17 m high (Keay, 1984: 80, fig. 20.4, no.

E/A/C.19), while four complete examples from Ostia had an average maximum diameter of 340 mm, an average empty weight of 17.8 kg and held on average 62.7 litres (Zevi and Tchernia, 1969: 175–7, figs 1–3, 12, also figs 15a, 16a, b, d, nos 15301–03, 15312). A similar variant 1 example on the Planier 7 wreck was *c.*1.18 m high and *c.*335 mm maximum diameter (Benoit, 1962: 157–60, fig. 24, refers to this type as Dressel 26/27; Zevi and Tchernia, 1969: 196–7, figs 17c–d, no. C410; Bonifay, 2004: 116, fig. 62a.1, 10) as compared to the two variant 2 examples in the cargo which were *c.*1.09 m high and *c.*300 mm maximum diameter (no. C418, Benoit, 1962: 157–60, fig. 25, refers to this type as Almagro 52; no. C430, Zevi and Tchernia, 1969: 196–7, figs 17a–b).

Date and contents

Current evidence supports a production period in the 3rd–4th century. Quantitative increases in the importation of this type both at Ostia and in Spain indicate a probable production peak during the late-3rd to early-4th century (Manacorda, 1977: 168; Keay, 1984: 126). Examples are also found at Sabratha, Tunisia, in a layer dated to 365 (from Mausoleo B, Keay, 1984: 126), and in late-4th-century levels at Carthage (Riley, 1979: 203). Additionally, there remains the conundrum of this type's presence at the site of Turrus Libysonis in contexts after 425 (Villedieu, 1984: 183).

Some of the earliest examples are found at Ostia in contexts dated to *c.*230/250 (Keay, 1984: 126), in mid-3rd century contexts at Athens (Robinson, 1959: 69, pl. 36-K116), and on the Cabrara C shipwreck dated to *c.*255 (Bost *et al.*, 1992: fig. 35.1). Keay argues that the African 2D amphoras reported on the Ognina A wreck from near Syracuse, dated to *c.*215–230 (Kapitän, 1972), are intrusive. Both African D variants were in the amphora cargo of the Planier 7 wreck dated to 300–350 (Zevi and Tchernia, 1969: 196–7). Bonifay supports the 3rd-century date for earliest export, but suggests the type may extend beyond the early-4th century based on evidence from wreck-sites (Bonifay, 2004: 117). Keay reports African 2D amphoras within early-4th/mid-5th-century tombs in Catalonia (1984: 126). Manacorda reported African 2D amphoras in late-5th to early-6th-century contexts at Castellum du Nador (1989: figs 42.227–9); Keay, however, notes that amphoras identified as African 2D in 5th/6th-century contexts are in fact variants of his types 56 and 57 (Keay, 1984: 126).

Evidence for a later circulation of African 2D amphoras is also found in shipwreck evidence. The Port Vendres A wreck has a deposition date between 395 and 410 (Liou, 1974), while the Femmina Morta wreck has operational dates potentially in the late-4th century (Parker, 1977: 625) and the Scauri wreck at the end of the 4th to the early-5th century (Baldassari, 2009: 109, 111, table 2.8). This type of amphora was produced primarily for overseas export and appears to have contained olive oil and/or fish products, or possi-

bly wine in fewer instances (Keay, 1984: 123; Bonifay, 2004: 117; Bonifay, 2007: 19–24).

Production and distribution areas

Production of African 2D amphoras occurred in areas including the Roman provinces of Byzacena and Tripolitana in North Africa, the coasts of eastern Tunisia and western Libya. Kiln-sites from the east coast of Tunisia include Salakta, El Jem, Leptiminus, and Nabeul (Bonifay, 2004: 117), and evidence from stamps also indicates production in Leptis Minor, Hadrumetum, Sullectum, and Thanae in Libya (Zevi and Tchernia, 1969: 180–81; Panella, 1973; Keay, 1984: 123). Export destinations were mainly in the central and western Mediterranean. It is possible that African 2D amphoras were carried to more distant areas—examples have been found at sites in England, Morocco, and Gaza—but the distribution of sub-types is less clear (for a general distribution see Riley, 1979: 202, fig. 39).

There are many wreck-sites with African 2D amphoras along the Provence coast of France (Bonifay, 2004: 117, although African 3 types are most common on 4th-century wreck-sites). This type is regularly found along the north-western coasts of Sardinia and Italy, the south-eastern coast of Sicily, at Ostia (Manacorda, 1977: 168), and at sites in Catalonia (Keay, 1984: 125–7). African 2D amphoras were found on the Lazzaretto wreck dated to *c.*320, along with Almagro 50 and 51C and Dressel 20 and 23 types (Riccardi, 1987). African 2D amphoras were mixed with Spanish types such as Beltran 68 on the Marzamemi D wreck in Sicily, dated to the first half of the 4th century (Parker, 1979). The Porto Azzurro wreck is dated to the second half of the 3rd century by its cargo of African 2D amphoras and by T. S. Chiara (Zecchini, 1982: 97–127; Pallarès, 1983). A shipment of African 2D amphoras found off the east Algerian coast may have been re-used in local trade (Lequément, 1975; Parker, 1992: 102) and finds of African 2D2 amphoras were reported in the entrepôt of Turrus Libysonis after 425 (Villedieu, 1984: 183). However, few examples are found at Berenice in Cyrenaica, which supports primarily overseas trade rather than local distribution for this type (Riley, 1979: 203).

Amphora type African 1 Piccolo

African 1 Piccolo (Keay type 3 and Ostia type IV) is medium-sized with a cylindrical body and a solid spike, usually *c.*0.95–1 m high with a maximum diameter of 300–330 mm, and typically holding 39–42 litres (Zevi and Tchernia, 1969; Panella, 1973: 55–9; Peacock and Williams, 1991: 153–4; Bonifay, 2004: 107). Two sub-types are differentiated by rim-shape; 'A' has an everted convex rim with a flat inner face, while 'B' features convex outer, and concave inner, faces (Panella, 1973: 575–9; Keay, 1984: 100–01). Bonifay makes a further distinction by defining three sub-types; 'A' and 'B' each have convex outer rim faces, 'A' being

symmetrical and 'B' asymmetrical, while 'C' has an everted convex rim (2004: 107). Stamps are sometimes located on the neck.

The two large fragments were recovered in site sectors D-6 and C-5 (SI06AA-0019 and 20 respectively) (Fig. 10). Both are within the north-western end of the wreck-site where concentrations of large body-sherds also lie. Many of the cylindrical body-sherds conform to this type and attest to its probable high representation on the site.

Description and dimensions

Both the examples recovered included the rim, neck, handles and upper shoulder, and exhibit typical features: a short neck with a straight profile and ear-shaped handles with an ovoid cross-section, 32 × 18 mm for SI06AA-0019 and 38 × 23 mm for SI06AA-0020, with an asymmetrical indentation along the outer faces on both. The body thickness at the broken shoulder is 7 mm (SI06AA-0019) and 10 mm (SI06AA-0020). SI06AA-0019 has a mid-height neck diameter of 91 mm, while the neck of SI06AA-0020 has a mid-length diameter of 101 mm. The two examples have different rim forms, and are designated as sub-type A (SI06AA-0020) and B (SI06AA-0019) under Panella's differentiation and B (SI06AA-0019) and C (SI06AA-0020) in Bonifay's classification. The everted rim of SI06AA-0019 is 29 mm high with a rounded-profile outer edge. A more upright everted rim on SI06AA-0020 forms a slight shelf where it joins the neck. Its rim is 35 mm high and has a flattened upper face. The handles on amphora SI06AA-0019 are set slightly askew when viewed from on top and are proportionally smaller rings than on amphora SI06AA-0020. The shoulder of SI06AA-0019 slopes downwards at a greater angle from the neck than the broader shoulder of SI06AA-0020. Marine growth prevented seeing whether stamps were present on the neck.

This type has a central-Tunisian fabric, hard brick-red (2.5YR 6/6), yet there is often a white wash on the outer, and sometimes inner, surfaces (Fulford and Peacock, 1984: 263–4; Peacock and Williams, 1991: 154; Bonifay, 2004: 107). All examples of Keay's type A and the majority of type B examples from Catalonia had the same fabric as African 2 C and D types (Keay, 1984: 103, 447). Nearly 90% of the surfaces of our examples were waterlogged and covered with marine growth; the small areas that were possibly the outer surface appeared orange-brown (7.5YR 4/6). Post-conservation examination in a dry state would probably reveal a lighter, redder colour.

Comparative examples

A good comparative example for SI06AA-0020 comes from Pupput (tomb 1207, no. PP2686.1, Bonifay, 2004: 106–07) and an upper portion of a Keay type IIIB from Emporiae in southern Spain (Keay, 1984: 104, fig. 38.2, E/A/C.18). Comparative examples for SI06AA-0019 include an upper portion from Nabeul (basin XLIX,

inv. NB 1850, Bonifay, 2004: 106–07) and a Keay type IIIA nearly-complete example from Emporiae, as well as a rim from Tarraco (Keay, 1984: 103, fig. 37.1 and 9, E/A/C.5 and T/1/265). Another good comparison for SI06AA-0019 is presented by Zevi and Tchernia (1969: 179, fig 6., no. 14540).

Date and contents

African 1 Piccolo amphoras are most commonly found in 2nd- to 4th-century contexts. Bonifay dates his sub-type C to the second half of the 3rd and into the 4th century, whereas sub-types A and B run from the end of the 2nd to the 3rd century (Panella, 1982: 174; Bonifay, 2004: 107; Bonifay, 2005a: 452). There is sub-type B (Panella's classification) on the Scauri wreck dated to the end of the 4th/early-5th century (Baldassari, 2009: 109); but as this is quite late for this type, it is possible that it is intrusive on this harbour wreck-site. Although the presence of Bonifay's sub-type C on the Levanzo I wreck is congruent with his dating, the example of his sub-type B on the site suggests it extended into the mid-4th century. Olive oil is usually associated with this type (Panella, 1982: 174; Bonifay, 2004: 107); olive pits were found on sherds from the c.200 AD Plemmirio B wreck with no apparent lining (Gibbins, 2001: 315). However, one example from the c.180 AD Procchio wreck had fig seeds, and presumably figs (Zecchini, 1982).

Production and distribution areas

African 1 Piccolo amphoras were produced around Carthage (Panella, 1982) and along the eastern Tunisian coast (Zevi and Tchernia, 1969; Panella, 1973; Bonifay, 2004: 107). From Tunisia, this type's shipment overseas, particularly to Italy, increased during the reign of Septimius Severus, probably due to the addition of olive oil to the free provision of foodstuffs to the populace of Rome. It is likely that the production and distribution of this type was closely tied to demand in Rome as well as the condition of the logistical network which supplied this demand (Gibbins, 2001: 328).

Amphora type Dressel 30-Tunisia

This has been described as an imitation of a Gaulish type, and also referred to as 'Maurétanie Césarienne' and Pelichet 47 (Riley, 1979: 195–6; Bonifay, 2004: 148). Keay (type I) describes it and notes that it has often been confused in Spanish contexts with Dressel 30/Pelichet 47 from Gaul, and that it was a common import to Catalonia (Keay, 1984: 95–9). This type has a wide variety of shapes and fabrics, which limits Keay's sub-types to the role of variants of the sub-type Dressel 30 Mauretania Caesariensis (Bonifay, 2004: 148–50). Typical features include broad shoulders, tapering body, low foot, short neck with a thick everted rim, and handles that bend at the top to form a 'V'-shaped channel and join at mid-neck. Two sub-types were described by Keay based primarily on

rim-form: 'A' having a 'ring-like' rim while 'B' has a taller, everted rim (Keay, 1984: 95; see also Panella, 1973 and Manacorda, 1977).

SI06AA-0009 (Fig. 9) was removed from the north-central portion of the site, sector G-3, where it was lying next to a large concretion. It was one of the few surface finds in the central area, but lay at its outer edge.

Description and dimensions

The intact example is 411 mm high, with a maximum diameter of 222 mm at the shoulder. It features a heavy collar rim, 21 mm high, with a somewhat triangular cross-section. From the body, the neck narrows to a diameter of 63 mm at the join with the handles, then flares out slightly again towards the rim. The ovoid handles, attached in a curve from midway on the neck to midway on the shoulder, have flat outer and inner faces with a wide groove running along their central length on the outer face. Below its sharply carinated shoulder, the body tapers consistently into a short toe *c.*40 mm long with a mid-length diameter of 34 mm. Without a more well-defined typology for sub-types of Dressel 30 amphoras, this example is categorized as 'Tunisian'.

The outer body surface of SI06AA-0009 is reddish-brown (5YR 4/3), and slightly redder on the rim (10R 3/4). Fabric analysis has confirmed Tunisian sources, around El-Assa and Nabeul; but also a wide variety of fabric-types indicative of many production areas throughout Mauretania Caesariensis and Africa Proconularis (Bonifay, 2004: 148–51). The fabric is described as pale brown to buff, sometimes with a red core with whitish inclusions (Riley 1979: 195–6), and often with a light or dark beige wash or slip (Keay, 1984: 95–9). A single Dressel 30 amphora found on the Plemmirio B wreck from south of Syracuse, dated to *c.*200, had the same fabric and burnished finish on its outer body, as did the African 1A, 1B and 2A amphoras which comprised its cargo; all of which were produced in Tunisia (Gibbins, 2001: 313–14). Examples from southern Spain are described with a Mauretanian pink-orange fabric with transparent-orange quartz crystal, calcite crystal, black volcanic, and limestone inclusions (Keay, 1984: 96, 453).

Comparative examples

Comparative examples come from the 4th-century Carmague wreck (Long, 2002: fig. 36c), but our example has a much sharper shoulder-angle and longer neck. The handle profiles are more similar to an upper portion from Nabeul dated to the later-4th century (basin 31, inv. NB 1186.74, Bonifay, 2004: fig. 81–7) as well as an example from Spain (Keay, 1984: 97, fig. 35.3, T/8/37). The rim of our amphora has good parallels with one from Ostia dated to the late-3rd to early-4th century (Panella, 1973: 602, #536) and others from 3rd- and 4th-century contexts at Ampurias, Spain (E/A/C.1, 697 mm high with a maximum diameter of 372 mm, Keay 1984: 79 fig. 19.2, see also 97, figs

35.3–7). The thick, cylindrical toe on our example is similar to that on an amphora from Nabeul (inv. NB1055.3, Bonifay, 2004: 149, fig. 81.5); the majority of other examples have thick toes that flare at the end.

Date and contents

Panella (1973: 603) argues that stamped types would not have been produced after provincial reorganization by Diocletian in 286, but Manacorda (1977: 150ff) asserts that unstamped production continued into the early-4th century. This date-range possibly extends both earlier and later. Contextual evidence indicates that this type was produced in the 3rd and 4th centuries (Riley, 1979: 195–6; Keay, 1984: 95–9; Bonifay, 2004: 148). Finds at Volterra are dated in the late-3rd to early-4th century, and another example from the villa of Fosso de la Crescenza is dated in context to the end of the 3rd century (Fentress *et al.*, 1983; Keay, 1984: 99). Fragments of this type were found at Vilauba in early-4th- to mid-5th-century contexts (Keay, 1984: 95–9) and at Luni in levels dated to the 4th and 5th centuries (Frova, 1977). Bonifay suggests this type held North African wine, often destined for local commercial trade (2004: 151).

Production and distribution areas

Given the varied forms of this type, it is unsurprising that several areas have evidence for its production. Among these are southern Gaul near Toulon, Velaux, and Avignon, based on kiln finds (Riley, 1979: 195–6); Ostia; southern Spain, for example Vilauba, based on stamp evidence; and areas of North Africa, for example Tubusuptus in Mauretania Caesariensis, based on stamp evidence (Keay, 1984: 95–9). North African production-sites also include kiln-sites at Nabeul and El Assa in Tunisia 'septemtrionale' and in the Byzacena region at Salakta (Ben Lazreg *et al.*, 1995; Ghalia *et al.*, 2005). Dressel 30-Tunisian amphoras are considered to be locally distributed, primarily around North Africa, and through Sicily and southern Italy. There are a few finds in the wider western Mediterranean regions. Keay reported this type in Catalonia, where sub-type B was more common than A (1984: 95). This type was not only produced in multiple areas but widely copied. Its presence on the site is consistent with other 4th-century contexts, and also supports a production area in North Africa; fabric analyses, however, are crucial for determining the production area of this type.

Amphora type Almagro 51C

This well-documented type is also classified as Keay XIX, Peacock and Williams 23, and Lusitana 4 (Peacock and Williams, 1991). Its typical features are a short neck, tapered body, and curved handles that join just below a round/beaded rim. Examples examined by Keay averaged 698 mm high, 257 mm in diameter, with a rim diameter of 96 mm (1984: 172–3, 469; 13 of Keay's 19 examples had handles that

joined at the rim, while the other 6 joined below the rim). Two forms are sometimes differentiated by shoulder type. However, a wide variation has been noted, even from the same site. For example, there is significant diversity in overall sizes and rim shapes for contemporaneous examples from the Rua do Correiros excavations in Lisbon (Raposo *et al.*, 2005: 39, 51, fig. 22). These extend the type's height range between *c.*550 and 750 mm and its maximum diameter between *c.*200 and 400 mm. Likewise, there is variation in the bases where the filled spike either comes to a point or has a short, rounded shape (Keay, 1984: 172; Raposo *et al.*, 2005: 38–9).

Three intact amphoras were found, SI06AA-0017 from site sector E-1, SI06AA-0037 from sector B-5, and SI06AA-0014 from *c.*12 m SW of the site (Fig. 9). The representation of this type among the surviving cargo indicates it was possibly a substantial component. As two of the three examples were found at the periphery of the site, it is possible that they sat higher in the hold.

Description and dimensions

The three examples varied in their dimensions and morphological characteristics. In general form, SI06AA-0014 and SI06AA-0017 are similar but have a somewhat rarer morphology: a space between the handle-connection and rim, a base that tapers to a point, and a soft rounded shoulder. Although atypical, they are designated as Almagro 51C due to the preponderance of typical characteristics exhibited; hourglass necks, triangular rims, ovoid handles, and rounded shoulders into a tapered body.

SI06AA-0014 is intact, 625 mm high, with a maximum diameter of 330 mm. Its neck is constricted into an hour-glass shape, with a mid-length diameter of 103 mm, and bulges at the body join. The 30-mm-high rim has a triangular cross-section. A ridge runs along the outer face of the slightly ovoid handles which are curved in profile. The handles join *c.*15 mm below the rim, and the body tapers to a rounded point. SI06AA-0017 is 565 mm high, intact, with a maximum diameter of 290 mm. The rather short neck, compared to the other two examples, is also hour-glassed shape with a mid-length diameter of 122 mm. Its 29-mm-high rim is also triangular in cross-section. The handles are slightly ovoid, curve in profile, join 8 mm below the rim, and have a ridge running along their outer face. As with the previous example, the body tapers in to a rounded point.

SI06AA-0037 is intact, 638 mm high, with a maximum diameter of 298 mm, and the commonly noted features for this type. Its neck, constricted into an hour-glass shape, has a mid-length diameter of 64 mm. The 26-mm-high rim is triangular and 14 mm thick; the handles join at the base of the rim. There is a more ovoid cross-section to the curved handles and no prominent ridge is noted on the outer face. The inner faces are slightly concave with a 14-mm-wide groove

running lengthwise. The body tapers to a heavy toe, 73 mm long and 47 mm in diameter at its terminus, and a slight bulge at its midpoint.

All three examples were intact with no fresh breaks, and the surfaces were either covered with marine growth or discoloured from exposure to the marine environment. The fabric of this type is often reported as hard and light reddish-brown (2.5YR 6/4). Inclusions include frequent quartz grains, flecks of muscovite mica, potash feldspar, limestone, fossils and metamorphic rock (Peacock and Williams, 1991: 133). Keay (1984: 173, 456–7) reports four varieties of fabric among the Catalan finds; the majority having transparent and orange quartz crystal, clay temper, and black-plate inclusions.

Comparative examples

The small gap between the rim and handle-join and ridge on the outer handle face on both these examples also has analogies from finds in Spain (for the gap between rim and handle-join see T/1/279, Keay, 1984: 174, fig. 69.1; for the ridge on the outer handle see T/1/45, Keay, 1984: 175, fig. 70.2). However, our two amphoras have one feature with no readily identifiable comparative examples; a base ending in a simple, smooth point. Whether stub or elongated, Almagro 51C amphoras typically feature some form of knobbed base. It may be that these are North African imitations, or simply that there are other better comparisons than those identified by the authors.

Comparative material for SI06AA-0037 is plentiful from both terrestrial and shipwreck-sites. Its elongated, narrow shape has good parallels from excavations in Catalonia. An amphora 741 mm high and 337 mm in diameter (no. T/1/8) is an excellent parallel; also see intact amphora no. E/B/E.21 and the upper half of example no. T/1/279 in Keay 1984: 82, 172–3, fig. 22.6; see also nos E/B/E.21 (82, fig. 22.4) and T/1/279 (174, fig. 69.1). Similarly-shaped amphoras of this type are also recorded from two kiln-sites in the lower Tejo River valley of Portugal, at Porto dos Cacos and Quinta do Rouxinal, as well as an example from the Rua do Correiros excavations (Raposo *et al.*, 2005: 44, figs 6, 48, Fig. 15 for the Tejo sites; 39, 51, fig. 22 for Lisbon). Parallels from shipwreck-sites include those from the 4th-century Pampelonne and Chrétienne D wrecks (Lequément, 1976: 186, figs 9.a-c), while the example from the Planier 7 wreck has a greater maximum diameter relative to its height than our example (Zevi and Tchernia, 1969: 186, Fig. 9.b).

Date and contents

This amphora's distribution begins in the early-3rd century and continues into the 5th century (Manacorda, 1977: 142; Keay, 1984: 178). Almagro 51C amphoras were produced at sites in south Spain, such as Rua do Correiros, from the mid-4th to 5th century, along with types Almagro 51 A and B, Dressel 23 and Keay 19 (Pineda de las Infantas *et al.*, 2003: 146).

North African imitations were being produced as well (Raposo *et al.*, 2005: 39). Olive-oil production in Spain decreased drastically during the mid-3rd to 4th century, while fish-product exports increased. Finds indicate that Almagro 51A-C amphoras were used for the export of fish products (Fabião and Carvalho, 1990; Raposo *et al.*, 2005: 39).

Production and distribution areas

On the present state of kiln and fabric evidence, Almagro 51C production was centred in Portugal (Keay, 1984: 173; Peacock and Williams, 1991: 132; Fabião and Carvalho, 1990). In addition to the kilns in the lower Tejo River valley and at Quinta do Rouxinol, there were kiln-sites in Marateca (Setubal). Almagro 51C and 50 types were produced at the Tejo River valley kiln-sites including Porto do Cacos, while both types and lamps were produced at Quinta do Rouxinol from the mid-2nd to 4th century, as indicated by coin and ARS evidence (Parker, 1977: 35; Raposo, 1990; Raposo *et al.*, 2005: 37–9, 48, Fig. 15; Dias *et al.*, 2009). The sites in the Tejo River valley are also associated with Hayes 61a ARS ware that dates the production layer of the amphoras from 325–400/420 (Raposo *et al.*, 2005: 37–8). Fabric analysis indicates other production areas are possible, such as Catalonia, Baetica and other areas of the south-east coast of Spain, as well as the North African coast (Keay, 1984: 173). This type was transported throughout the western Mediterranean. Although shipped to North Africa, it does not appear widely in local distribution networks; for example, there is no indication of this type at Berenice (Riley, 1979).

Amphora type Keay 52

Keay type 52 amphoras are smaller, usually c.600 mm high, tapering from the shoulders to a flat base. The neck is cylindrical and the body features prominent rilling. Rims range from triangular to having several flanged forms, while the handles vary from arched to having a downward-sloping straight section from the neck (Keay, 1984: 267; Arthur, 1989b: 133–42; Di Gangi and Lebole, 1998: 761–8; Pacetti, 1998: 187–8). Auriemma (1998: 753–5, figs 1–3) describes two sub-types, the first with a short neck and downward-sloping handles; the second a longer neck and handles more rounded in profile.

A single example, SI06AA-0023, was recovered in site sector H-4 (Fig. 9). Given the low representation, there is a question as to cargo versus shipboard item, as discussed below (see Auriemma, 1998).

Description and dimensions

SI06AA-0023 is intact, 530 mm high, with a maximum diameter of 255 mm. The neck is cylindrical with a mid-length diameter of 77 mm. Atop is a pulley-wheel-shaped 15-mm-high rim. The handles, round in cross-section, join 17 mm below the rim on the neck and slope downwards to the shoulder. A bulge at the handle-join

runs around the entire circumference of the neck. From the shoulder the body tapers, with a slight bulge near the base, with rilling spaced at an average of 17 mm. The base is concave to a depth of 19 mm and forms an 81-mm-diameter ring. Our example fits sub-type 1.

Comparative examples

Comparative examples include one found at Piazza Celimontana, Rome (Pacetti, 1998: fig. 2 left). Another similar one was found along the Ionian coast of Salento in Apulia, Italy (Auriemma, 1998: 754–5, figs 1–2). There are examples from early-4th-century contexts in the Athenian agora (Robinson, 1959: 106, pl. 28, M234) and the Dramont F wreck (Joncheray, 1975: 113, DF73).

An exposed portion of the outer surface is reddish-brown (5YR 4/6, slightly wet, and would be lighter when dry). The fabric of Keay 52 amphoras is hard, rough, micaceous, pinkish light-brown (7.5Y 7/4 to 6/4) sometimes ranging to an orange-pink. Amphoras thought to be from Calabria typically have metamorphic inclusions of quartz-mica-schist, mica strands, calcite, and quartz grains (Keay, 1984: 267, 458–9; Williams and Keay, 2005). Analysis of examples in 5th-century contexts from Pallero revealed two Calabrian fabrics: light brown with irregular quartz inclusions, and orange-brown with quartz and carbonate inclusions (Gassner, 2011).

Date and contents

This type has a long life as a wine container, traditionally extending from the mid-4th to the 7th century (Sagui, 1998), with its greatest distribution in Rome in the later-4th century (Pacetti, 1998). Samples subjected to gas-chromatographic analysis indicate wine residue (Williams and Keay, 2005).

Production and distribution areas

Analysis of the fabrics from later-5th- and 6th-century Keay 52 amphoras indicates a clay source from the areas of Calabria and north-east Sicily (Capelli, 1998; Pacetti, 1998: 186). Kiln-sites discovered at Pellaro and Lazzaro dating to the 5th century (Andronico, 1991; Gasperetti and di Giovanni, 1991), as well as other finds in the region of Reggio di Calabria (Lattanzi, 1991), also indicate a southern Calabrian production area. The concentration of land and maritime finds around Calabria and north-east Sicily further supports this (Arthur, 1989a; Arthur, 1989b; Sagui, 1998). The primary direction of distribution was around Rome and into the north-west Mediterranean (Bonifay and Villedieu, 1989; Reynolds, 1995; Sagui, 1998).

Amphora type Knossos 18

Opait (1980: 310) categorizes what appears to be this amphora as type Troesmis XIII. The most distinctive feature of our portion is the wide, tall funnel-shaped neck terminating in a small trapezoidal-shaped bevel where the rim has a slight inward slope. Generally the

rim is wider, but not as tall as the neck-rim associated with the Porto Recanati type from north Italy. SI06AA-0052 was discovered in site sector G-7 (Fig. 9). Its morphology does not lend it to being a suitable general storage jar for shipboard use. It is possible that it was in the lower section of the cargo, given the nature of the site.

Description and dimensions

A large fragment including the upper shoulder, rim, neck, and handles. Its neck has a 129-mm diameter at its join with the body where an incised line runs around the circumference. The neck expands upwards to within c.12 mm of the mouth, where it becomes more vertical and attains its 216-mm maximum width. A 29-mm-thick rim has a flat upper surface with a 7-mm-wide bevel running around it, 8 mm from the outer edge and 14 mm from the inner edge. Handles are ovoid in section, curved in profile, and run from around mid-neck to the upper shoulder. The body thickness at the shoulder break is 7–9 mm.

Although the specimen was waterlogged and marine growth affects the determination of colour, the exterior surface was dark brown (10YR 4/4–6), the interior more orange-brown (5YR 6/8–5/8). A small fragment separated during examination and exposed a minute area of the inner fabric: it appeared light reddish-orange (5YR 5/6), with numerous white inclusions, some apparently micaceous, and a small number of sand-sized black inclusions. Opaït (1980: 310) describes the example from Romania as having a brown, very fine, soft fabric, somewhat sandy with small white inclusions.

Comparative examples

A good comparison for the form is found on the early-3rd-century Torre Mazza wreck near Sicily (Ollà, 1997; Volpe, 1998: 593, fig. 27.1), and from excavations at Brindisi (Auriemma and Quiri, 2004: 50, fig. 10.2). Another is from the site of Troesmis in the Dobrogea region of Romania, between the Danube and the Black Sea, a rim-neck-handle portion, but also a base portion which featured a large, solid button; it had a neck height of 145 mm, an inner diameter of 170 mm and an outer diameter of 210 mm. Its handle diameter was 45 × 25 mm in cross-section (Opaït, 1980: 310, 318, pls X.1, XV.4, no. 4495).

Date and contents

Knossos 18 amphoras, typically carrying olive oil from Dacia (Żmudziński, 2009: 286–7), have a traditionally earlier date than the Levanzo I wreck-site. The Torre Mazza wreck, which included Knossos 18 amphoras in its cargo along with Agora F65–66, Dressel 30, Zemer 57 and Agora G199, is dated to the first half of the 3rd century (Ollà, 1997). Examples were found at Brindisi in 2nd- and 3rd-century contexts along with Knossos 15 and Zeest 90 types, all thought to represent eastern Mediterranean goods shipped into the Adriatic (Auri-

emma and Quiri, 2004: 49). Examples were also found in 3rd-century contexts at Lyon (Desbat *et al.*, 2003), and one from Troesmis was found in a level dated to the first half of the 3rd century (Opaït, 1980: 310). Its presence indicates that its use continued into the early/mid-4th century.

Production and distribution areas

Given its association with the Dacian olive-oil industry, it appears this type was produced near the western Black Sea coast. Distribution based on meagre maritime and terrestrial evidence suggests it was shipped throughout the Mediterranean, but not in large quantities.

Amphora type Agora M236(?)

A single amphora, so far unidentified, was found on the south-east end of the wreck-site (site sector I–5; Fig. 9: SI06AA-0035). Its length was intact but a portion of its lower section was missing. 575 mm high, with a maximum diameter of 235 mm, it features a wide cylindrical neck, 106 mm in diameter taken at mid-length, and a bulge that runs around the entire circumference at mid-length. On top is a simple beaded rim 8 mm high. Handles are ovoid in cross-section, curved in profile, and join halfway up the neck at the bulge. From the sharply-rounded shoulders the rilled body tapers towards the base and has a slight waist. The base is sharply carinated, forming a nearly-45° angle to a 79-mm-long solid spike with an upper diameter of 54 mm and a lower of 17 mm. The body-thickness at the break is 5 mm. A close parallel is an amphora from the Athenian agora, M236, found in a level dated to the early-4th century. However, it was missing the portion above the shoulder and has a preserved height of 420 mm (Robinson, 1959: 88, 108, pl. 28). Given the similarities of the body and chronological context, the provisional identification of SI06AA-0035 is type Agora M236.

Tableware

Another ceramic artefact class found was coarse tableware (Fig. 11). As with the amphoras, the tableware was located roughly equally in the north-west and south-east areas of the site and absent in the central portion. During artefact collection in 2006 and 2009, seven nearly-complete examples were raised: five flagons (each of a different form), a small table amphora, and a broken plate, and also the bottom portion of what appears to be a small beaker. The forms are like those produced in North Africa in the Late Roman period. Assuming that this was not the entire corpus of coarse tableware, but a sample, as with the amphoras, the tableware is also considered to be a cargo item, particularly given the number of flagons. Key measurements for each piece are found in Table 3.

Flagon SI06AA-0036 has a sharply-curved shoulder, where the handle joins, and tapers to a concave



Figure 11. Tableware recovered in 2006 and 2009. (J. Royal, RPM Nautical Foundation)

Table 3. Selected measurements of intact tableware (mm)

Artefact no.	Type	Max height	Max diam.	Rim thick-ness	Mid-Handle diam. max.	Mid-Handle diam. min.	Handle length	Rim diam. inner	Rim diam. outer	Base diam.
SI06AA-0001	Flagon	225	179	7	29	19	153	8.9	103	104
SI06AA-0002	Amphora	203	154	10	28	11	86	37	53	65
SI06AA-0004	Plate	49	304	9	—	—	—	263	304	—
SI06AA-0015	Flagon	212	145	7	33	14	134	46	59	85
SI06AA-0022	Flagon	203	154	13	30	14	138	83	109	75
SI06AA-0036	Flagon	211	159	10	30	13	131	70	90	79
SI06AA-0038	Flagon	234	190	6	24	14	163	72	84	80

base with a central nub. Its neck only slightly flares and the almost-vertical handle joins at the top of the rim; no spout is present. The rim is flat on top with a groove running around the circumference in the centre. A preliminary identification is Bonifay common type 47A (2004: 280–82). A more-rounded body characterizes SI06AA-0038, which also has a concave base with a central nub. The neck is more vertical and the handle, running from the rim to $\frac{1}{3}$ the length down the body, is slightly curved. Its body is 3 mm thick.

The body of SI06AA-0001 is more ovoid with a ring-base and a flared neck resulting in a wide mouth; no spout is present. From the top of the rim, its slightly bowed handle runs to $c.\frac{1}{3}$ down the length of the body.

An exposed section of handle provided a reddish colour (2.5YR 3/6) with what appear to be white, grit-sized inclusions. A preliminary identification is Bonifay common type 50 (2004: 284–5). Another example, SI06AA-0022, has a nearly-vertical neck and a curved handle attached at the top of the rim, which is flared, 13 mm thick, and 10 mm high. A slight rise is noted on the inner edge of the rim's upper surface. Its handle is ovoid in cross-section with four ridges running the length of the flat outer face. The body is ridged and ends in a concave base, $c.56$ mm deep, with a small central nub. SI06AA-0015 has a rounded body, a ring-base, and a neck that only slightly flares, so it has a narrow mouth. Two small incisions/ridges are

around the neck 62 mm below the rim, and three additional ones 129 mm below. A prominent ring runs around the middle of the neck, and just below is the handle-join. The curved handle comprises four bands forming a flattened ovoid cross-section; it joins with the body near mid-height. An exposed section of the outer body yielded a dark brown colour (2.5YR 3/1).

SI06AA-0002 is a small table amphora. Atop its 33-mm-high neck is a triangular rim. Its handles are ovoid in section, 28×11 mm, with a groove running along the flat outer face. The rounded body terminates in a ring-base 6 mm high. Colour determination on the rim indicated a red outer surface (5YR 5/8). A plate, SI06AA-0004, is c.60% intact. The rim is triangular in cross-section, 9 mm high. A thickness taken on the broken flat portion near the centre was 8 mm. The bottom of the plate has portions of its surface visible and was red (2.5YR 4/6). Preliminary identification is Bonifay cookery (B) type 6 (2004: 216-17 or Hayes form 182). SI06AA-0039 is possibly a small beaker, but the entire upper portion is missing. Its maximum diameter is 94 mm and it has ridging along the entire body, spaced 4 mm apart. There is a possible handle attachment on the uppermost portion of the body; the flat base is 44 mm in diameter.

Vaulting-tubes

One of the more important finds is the large number of vaulting-tubes—over 100 pieces concentrated in a roughly square deposit (site sector H/I-6) in the south-east part of the wreck-site (Fig. 12). Others are scattered around the remainder of the site and were also found within some of the larger amphoras, presumably dragged in by octopuses. Four tubes were collected and examined in 2006, and in 2009 another seven were either collected or found within amphoras. Each is consistent in shape and size (Table 4). Their bodies are cylindrical and feature an irregular rilling spiralling at an angle from the base to the beginning of the nozzle constriction. The nozzles narrow to small openings. Each tube is crudely fashioned from reddish clay with large, coarse white inclusions, somewhat similar to the coarseware. The tubes sampled were very consistent in the nozzle-opening and the proportions of body to nozzle. The fabric was red at a break (10R 4/3), at the opening of the large end (10R 3/3), and on the surface at mid length (10R 4/4), as well as a lighter red (2.5YR 3/6) on a body surface (all taken when wet).

The vaulting-tubes are consistent in dimension, shape, and form with those found *in situ* within early-Imperial architectural remains at North African sites, the majority of which are in Tunisia (Lezine, 1954; Peacock, 1984: 242-6, fig. 92.1-2; Wilson, 1992). Comparative examples from shipwrecks include Punta del Fenaio (Bound, 1987: figs. 1-2) and Los Escollete II (Más García, 1985: 164-8). The lack of mortar visible on any of the tubes, and their suggested position low in the hold, eliminates a hypothesized use in deck struc-



Figure 12. Vaulting-tubes recovered in 2006 and 2009. (J. Royal, RPM Nautical Foundation)

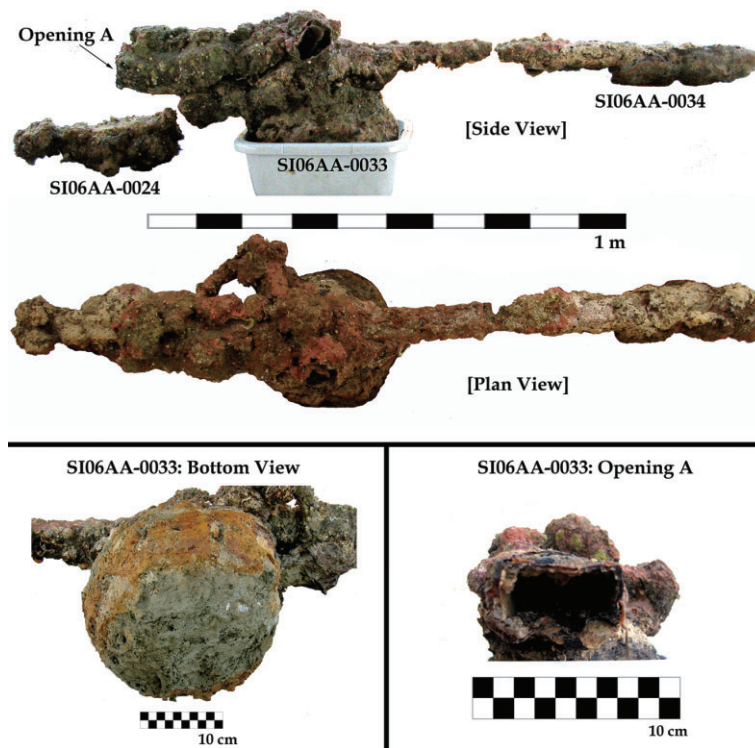
tures, which anyway has no parallels in shipwreck excavations, or iconography, and is also not suited to the nature of these tubes. Our deposit is also dissimilar to the Punta Ala wreck in north-west Italy, dated to c.250, which had a short section of pipe formed by vaulting-tubes in the hold, mortared together, suggested to belong to a bilge-pump system (Lamboglia and Pallarés, 1983). The quantity and concentration of vaulting-tubes on the Levanzo I wreck indicates that they were construction material carried as cargo.

Concretions and small finds

Numerous apparent concretions are visible on the site. Many are nondescript and, if concretions, are probably items such as ship's fastenings or pieces of equipment. Two distinctly large concretions, which may contain intact objects, were noted in site sectors G-3 and J-4. One (from G-3) was raised in three segments and, on initial examination, appears to consist of iron bars, square in cross-section, attached to a larger rounded object (Fig. 13). Rectangular cavities at breaks, old and new, allowed the bars to be measured; the typical width is c.50 mm. An estimate of the concretion's original length is c.1.5 m. The inner cross-section of the

Table 4. *Selected measurements of vaulting tubes (mm)*

Artefact no.	Total length	Max. body length	Max. body diam.	Body thick-ness	Open end inner diam.	Nozzle length	Max. nozzle diam.	Min. nozzle diam.	Nozzle open inner diam.	Average ridge spacing
SI06AA-0003	131	89	53	7	41	42	35	21	13	13
SI06AA-0005	138	93	59	5	43	45	35	21	15	15
SI06AA-0006	133	90	51	7	37	43	27	22	16	11
SI06AA-0007	136	90	54	6	41	46	32	21	13	10
SI06AA-0016	133	90	54	5	41	43	32	27	16	13
SI06AA-0025	—	94	55	4	47	—	—	—	—	11
SI06AA-0026	136	93	52	7	38	43	31	19	16	11
SI06AA-0027	—	89	52	5	42	—	33	—	—	7
SI06AA-0029	135	92	55	4	43	43	30	20	13	15
SI06AA-0030	134	91	54	4	39	43	31	21	13	11
SI06AA-0031	130	90	53	4	39	40	33	21	13	11
Average	134	91	54	5	41	43	32	21	14	12
St. deviation	0.25	0.17	0.21	0.13	0.28	0.17	0.24	0.22	0.15	0.23

**Figure 13.** A large concretion recovered in three sections. (J. Royal, RPM Nautical Foundation)

rectangular bars ranges from 49×21 to 76×34 mm. Around the length of one of the bar concretions something resembling a small-linked chain is wrapped. The larger spherical concretion at the bottom is 230–250 mm in diameter and appears to have numerous oblong ring-shapes on its outer surface. It is possible that this concretion was formed from a large-link chain within a rounded container or sack.

Although further analysis is required to determine the precise nature of the concreted items, some possibilities can be discussed. The concretion could be

remains of iron bars shipped as a raw material. Such rectangular bars were found on the earlier Plemmirio wreck from south-east Sicily, dated to *c.*200, which had ‘type A’ iron bars 900–1150 mm long and $50\text{--}77 \times 40\text{--}60$ mm in cross-section (Gibbins and Parker, 1986: 291–2). Likewise the mid-2nd-century Saint Gervais A wreck had small iron bars *c.*550 mm long and 31×27 mm in cross-section (Monguilan, 1977; 1987). Another find dated to the Roman era from the foot of the reef at Cassidaigne bank, south-east of Marseille, consisted of two long iron bars, rectangular in

cross-section, lead pieces, and other concretions. This find had analogies with others determined to be gear used to fish on coral reefs. The mechanisms featured baskets suspended from crossed iron bars (Benoit, 1962: 166–8, fig. 44). Perhaps a chain stored in nested round baskets along with iron arms aligned for storage could account for this large concretion on the Levanzo I wreck.

Numerous small finds were identified on examination of the contents removed from raised amphoras. The amphoras were generally full of small rocks, shells, and artefacts, the majority of which were nondescript ceramic sherds and small pieces of concretion, indicat-

ing that amphoras were used as homes for octopuses, direct evidence for a high degree of bio-turbation (this underscores the need for biological study of wreck-site formation in order better to interpret the spatial distribution of artefacts). Among these small finds were the base of a glass bottle or small jug (SI06AA-0028), the base of a glass bowl/plate (SI06AA-0032), a glass body fragment, and iron nails (Figs 14–15).

Each glass fragment is blown, thin, and appears of good craftsmanship. SI06AA-0028 has a slightly white tint, and its corners flare outwards, indicating a decorative shape. Outside dimensions at the base are 73×71 mm, and the walls are *c.* 2 mm thick. A

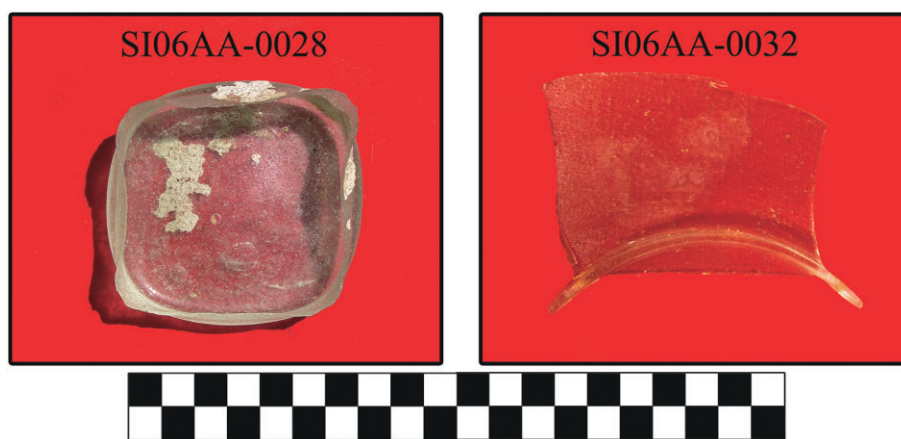


Figure 14. Two of the glass fragments found within amphoras. (J. Royal, RPM Nautical Foundation)



Figure 15. Iron ship's nails from excavation squares and found within amphoras. (J. Royal, RPM Nautical Foundation)

Table 5. *Selected measurements of nails (mm)*

Artefact no.	Lot no.	Find location	Intact	Total length	Max. shaft width	Min. shaft width	Head diam.	Head height
SI06AA-0041	SI06AA-L05	Amphora	x	117	6	2	13	5
SI06AA-0042	SI06AA-L05	Amphora	x	87	4	1	10	4
SI06AA-0043	SI06AA-L05	Amphora	x	67	5	1	10	5
SI06AA-0044	SI06AA-L05	Amphora	x	27	2	5	6	4
SI06AA-0045	SI06AA-L06	Amphora		—	5	3	—	—
SI06AA-0046	SI06AA-L06	Amphora	c.90%	—	6	4	13	7
SI06AA-0049	SI06AA-L09	SQ1-A/D	x	88	6	1	13	5
SI06AA-0053	SI06AA-L09	SQ1-A/D	x	48	3	1	7	3
SI06AA-0050	SI06AA-L10	SQ1-A3/C1	x	57	5	1	10	4
SI06AA-0051	SI06AA-L10	SQ1-C3	x	145	9	3	18	6
Average				80	5	2	11	5
st. deviation				3.82	0.19	0.15	0.36	0.12

light-green square bottle found in a mid-4th-century tomb context at Beth Shean, Israel, was 90 mm high and featured a wide flaring rim (Fleming, 1997: 30, figs 11.A-B, UPM no. 32–15–58). SI06AA-0032 is clear, with an applied ring-foot on a flat base. It is possible that this was from a small plate or bowl. The walls are 2 mm thick, the base 4 mm, with a reconstructed diameter of 122 mm.

In addition to the four iron nails discovered between the two excavation squares, six were found within two of the intact amphoras (Fig. 15). All nails were iron, square in cross-section, with round heads which peaked into a rounded cone. Their dimensions are listed in Table 5. The inconsistency of lengths is expected as there were different requirements for fastenings depending on the thickness of the ship's timbers. Head-diameters and heights, as well as maximum shaft thicknesses, also varied, and there were no patterns in the ratio of dimensions. The majority of the nails are relatively straight with only the longest example (SI06AA-0051) having a regular curve.

A grain cargo

The amphoras indicate a cargo that contained oil, fish, and to a lesser extent wine, along with tableware and vaulting-tubes; but it is possible that grain was included as well. Amphora and tableware remains are concentrated in the north-west and south-east zones, but are nearly absent in the central area (Fig. 2). Both excavation squares were within this area and neither produced more than a few small amphora bodysherds, a toe from a cylindrical North African type amphora, and four nails. The overall size of the site, as well as limits dictated by contemporary ship construction, do not support the merchantman having split in two either during or shortly after deposition. Moreover, nails and possible timber fragments (discussed below) excavated from this central area indicate that the hull was probably extant here after deposition.

A logical conclusion, although admittedly argued by absence, is that a perishable cargo was carried in the central hold; the most likely being grain. North Africa was an important source of grain for Italy, the military, and large provincial cities during the Imperial era, and one of the primary foodstuffs carried on merchantmen leaving North African ports. Rickman (1980: 261–2) suggested that merchantmen carried grain loaded in *dolia*, sacks, or separated by bulkheads within the hold in order to maintain ownership designations. There were no signs of *dolia* on the Levanzo I wreck, and it would be unlikely given the weight of the container. Sacks or bulkheads would not have survived in the archaeological record, and may have been used. Bulkheads may have been used in any case due to the practical consideration of compartmentalization and stability of the cargo. The relatively small volume of amphora remains at the site also support a grain cargo. Typically, merchantmen carrying grain had significantly lower numbers of amphoras in their cargo compared to those with primary cargoes of oil, wine, and/or fish products.

Ship's timbers

Given the shallow nature of the site, its long exposure, and damage from net-drags, hull-timbers on this site are meagre, with evidence found in only two areas. The first was in excavation square 2-D4 (Fig. 8). A dark tan object, somewhat irregular on the edges but clearly linear, was discernable during excavation. It had an estimated width of 15 cm and a flat upper surface similar to a hull-timber lying on the sea-floor. Accounting for the irregular surface, perhaps compacted mud, on its edges, the object was c.12 cm wide. Its long-axis orientation is such that it runs perpendicular to the long axis of the wreck-site; it is possible this is a framing timber or a section of loose ceiling planking.

In the western portion of the site there are two degraded linear objects oriented parallel to one another, which run along the long axis of the wreck in site sectors

the 4th century: individual merchant-ship cargos. The *annona* was a redistribution system of grain and oil collected as an in-kind tax within provinces and shipped to population centres, primarily the capital(s), and select military posts. As an important measure to avert famine in Rome, the *annona* was overseen by aediles during the Republic and by a *praefectus annonae* during emergencies. Augustus later formed the *cura annonae* and made the *praefectus annonae* a permanent appointment. The primary resource areas for the *annona* were North Africa and Egypt. Not only does this wreck-site reflect the types of goods moving from North Africa towards Rome, but the nature of the site also provides evidence for the wider system of Mediterranean trade-routes, and the varied cargoes on merchantmen operating within these networks, and potentially for shipments within the *annona*, as well as for types of secondary cargoes.

Many, if not most, of the merchantmen plying the Italy-North Africa routes during the 3rd to 4th centuries were in the *annona* service. Grain and oil were the two primary foodstuffs shipped within the *annona* system, and were also commodities purchased from private suppliers outside it (Rickman, 1980; Fulford, 1987; Duncan-Jones, 1990). Although wine and fish products were often shipped alongside grain and oil they were not goods directly collected as a tax within the *annona* system; but they were in high demand in the markets of Rome as well as other densely-populated areas of Italy, and were components of military provisions. As such the products shipped in amphoras were often secondary in proportion to the grain cargo carried out of North African regions such as Mauritania (Reynolds, 1995: 41), which assuredly was the case for many shipments originating in Africa Proconsularis as well.

Demand in Rome drew from Mediterranean-wide sources including the eastern Mediterranean from where imports rose in the 3rd century. For example, Aegean amphoras account for nearly 20% of those found in mid-3rd-century contexts at Ostia, while eastern Mediterranean amphoras account for approximately 25% of those in Rome during the second half of the 3rd century (Reynolds, 1995: 70). Beginning as early as the 3rd century there is an expansion of the oil industry in Tunisia to inland areas in order to fulfil demand generated within the *annona* system (Manning, 1988: 44–9), and indigenous amphora production increased to ship oil to Rome. Amphoras from many areas in Iberia carrying olive oil, wine, and fish products were also shipped in large quantities to Rome during the 3rd century (Keay, 1984).

With the founding of Constantinople in 330, the administration of the Empire was divided between West and East, as was the state *annona* system. North Africa, Sicily, and much of the western Mediterranean supplied grain to Rome, while Egypt along with areas of the eastern Mediterranean supplied Constantinople (Keay, 1984: 414). Consequently, amphora evidence

indicates that eastern Mediterranean supplies of wine reaching Rome, Iberia, southern Gaul, and the western army decreased from the mid-4th century. At Ostia, the presence of Aegean amphoras dropped to c.8% during the 4th century, while at Rome eastern Mediterranean amphoras had fallen to less than 3%, and at Carthage less than 2%, by the second half of the 4th century (Reynolds, 1995: 70, 110). Contemporaneously there is a dramatic increase in eastern Mediterranean wine amphoras at Constantinople in the later-4th century, while Sicilian and Calabrian wines filled a portion of the unmet demand in central and western Mediterranean markets by the second half of the 4th century (Reynolds, 1995: 70, 108–10). North African exports come to dominate goods shipped to Italy in the 4th century. The wide variety of North African, particularly Tunisian, goods and wares is testament to the high intensity of the North Africa-Italy sea-routes, and the prominent role of Tunisia in supplying Rome (Fulford, 1987; Reynolds, 1995). Tunisian amphora remains on the Palatine account for 25% of the total for the second half of the 3rd century, rising to 50% during the 4th century. Likewise at Ostia, Tunisian imports of oil and fish products account for c.45% of all amphoras by the end of the 4th century. Rome's increased dependence on North African grain is evidenced in 4th- and 5th-century assemblages at Ostia which have a higher presence of North African pottery, fineware and coarseware, than in earlier periods. This increased demand for North African foodstuffs (grain, oil, and fish products) resulted in an associated rise in the number of farms, press-sites, processing centres, and kiln-sites in Tunisia and other North African areas (Reynolds, 1995: 23–78). Conversely, Iberian wine and oil imports to Italy drastically decrease in the 4th century, although fish-product exports from southern Spain and Portugal persist (Reynolds, 1995: 67, 110).

It can be argued that from the 3rd century, and particularly from the mid-4th century onwards, the heavily-used Italy-Tunisia route increasingly formed the backbone of the western- and central-Mediterranean trade network. Routes in the Italy-Tunisia corridor supported other overseas routes connected with Tunisian ports, such as Carthage, directly because Tunisia became a market extension of Italy, and most importantly Rome. The disproportionate demand by Rome for foodstuffs and other commodities provided a ready market for central- and western-Mediterranean goods. Given the large number of merchantmen constantly plying the Italy-Tunisia route, many of them subsidized, added overseas transport costs for goods passing through Tunisian ports en route to Rome were negligible compared to direct shipments. It may be argued that using Tunisian ports may actually have been preferred by ship operators (*navicularii*), as they offered more profitable cargoes. Hence, routes between Iberia-Tunisia and Sicily/Calabria-Tunisia were strengthened and maintained by the Italy-Tunisian route.

North Africa enjoyed an economic boom as overseas trade increased, as evidenced by the increase in Tunisian wine and fish-sauce amphoras throughout western ports. Although Iberia was connected with ports throughout the central and western Mediterranean in the 3rd century, the routes with North Africa were among the few maintained by the 5th century (Reynolds, 1995: 23–78, 130–3). Fish products from Iberia were the commodity that maintained demand in Italy during the 4th century, while oil exports were eclipsed by supplies from North Africa. In the other direction, North African amphoras are common imports to southern Spain in 4th- and 5th-century contexts (Keay, 1984). The potential to sell surplus North African agricultural products in Spain and Portugal, either imperial or private, provided profitable cargos which particularly maintained the Iberia-Tunisia route. Exports from North Africa to Iberia were unlikely to have been direct *annona* shipments, but rather private ventures (Reynolds, 1995: 108). The Iberia-Tunisia route was fuelled by the heavy overseas *annona* shipments that linked Tunisia with Rome.

The significant presence of Amalgro 51C amphoras on the Levanzo I wreck-site, which carried fish products from Portugal, indicates that fish products moved over the Iberia-Tunisia route on their way to Italy. The extended market of Rome to Tunisia, combined with the array of products available in Tunisia, made the Iberia-Tunisia route both viable and in many instances more profitable than Iberia-Italy routes. Merchantmen carrying fish products from Portugal and southern Spain to Tunisia could return with North African produce and finewares. Similarly wine from Calabria/Sicily, evidenced by Keay 52 amphoras, and possibly also the MRA 1a amphoras on the Levanzo I wreck, were shipped to Tunisia, which served as an entry point into the extended central Italian market. Such commodities could be loaded on top of construction material, for example, in Calabrian/eastern Sicilian ports, not long after departing Ostia or other central Italian ports, to increase the profitability of return legs to Tunisia. After arriving in Tunisia, some of this wine cargo may have remained on board a given merchantman as cargo or crew items prior to lading with *annona* goods destined for Italy, or sold. Either may be a possible scenario for the presence of the Keay 52 and MRA 1a amphoras on the Levanzo I wreck-site.

The presence of goods in Knossos 18 and possible type Agora 256 amphoras from the regions of Dacia and the eastern Mediterranean respectively indicate that overseas trade links with North Africa, although greatly reduced, were maintained during the 4th century. Shipments of oil from the Dacian shores of the Black Sea into the Central Mediterranean during the 4th century would have most probably been to North Africa as part of an overseas trade connection. Goods from the central and western Mediterranean, fish products from Portugal and southern Spain, and olives

from Italy, reached Dacia in the 2nd and 3rd centuries. Terra Sigillata also reached the markets of Dacia (Bader, 1975). However, the volume of shipments steadily tapered off over this period from all areas except North Africa. Many of the African products were shipped to Dacia in African 2 Grande, African 1 Piccolo, Dressel 30, and MRA 1 type amphoras (Ardeț, 2004: 330–41; Ardeț, 2006; Żmudziński, 2009: 287), all found in the Levanzo I's cargo.

Eastern Mediterranean amphoras maintain a slight presence in central Mediterranean cities during the 4th and 5th centuries. LRA 3 and 4 amphoras are found at Carthage by the second half of the 4th century (Hayes, 1976: 117–8; Reynolds, 1995: 71), while LRA 1 amphoras reached the city by the early-5th century (Riley, 1979, 213). These trade connections are sustained throughout the 5th century, as evidenced by North African (African 3) and Eastern Mediterranean (LRA 1–4) amphoras found together at Marseille (Bonifay and Piéri, 1995), Barcelona (Monfort and Millet, 2005), Otranto (de Mitri, 2005: 414), Corte Vanina just north of Modena, Italy (Corti, 2005: 356), and on a shipwreck-site in Pantelleria (Abelli *et al.*, 2007, 59–61; Baldassari, 2009). Merchantmen also carried North African amphoras eastward during the 4th century, for example into the east Adriatic shipping route, where they were sometimes shipped together with LRA types (Jurišić, 2000; Royal, 2012). North African and LRA amphoras are also found together and in 5th-century contexts at the sites of St George and Koper in western Slovenia (Perko and Župančič, 2005: 523).

Along with the Levanzo I wreck's primary cargo of foodstuffs there were smaller consignments of coarseware (tableware), glass and bulk construction materials (vaulting-tubes). These items attest to the economics of shipping as they relate to the selection of trade goods for private consignments transported to overseas markets. Reynolds (1995) cogently lays out general categories for the types of trade goods commonly comprising ships' cargoes in the Roman era. Primary goods were typically bulk agricultural items such as oil, grain and wine; secondary goods included fish sauces, finewares, and wild animals; while tertiary goods were those of limited value such as coarseware and bulk construction material (Reynolds, 1995: 127–9). Reynolds also argues that the intensity of trade over specific routes for primary goods dictated the presence, range, and quantity of secondary and tertiary goods; all three categories of goods were a feature of the trade from Tunisia to Ostia/Rome. Consequently, the distribution paths of secondary and tertiary goods will correspond with the distribution patterns of primary goods.

With an intensification of *annona* shipments between North Africa and Italy at this time, a greater number of secondary and tertiary goods were conveyed by *navicularii* (Reynolds, 1995: 127–9). These extra cargos were commonly shipped with government-contracted goods, and were actually

encouraged through tax incentives as a method to entice *navicularii* into the *annona* service (Jones, 1986: 357, 420, 486, 745). There were two types of state contracts: military supplies, and transportation of produce from imperial estates. Using private contractors operating under favourable tax-exemption laws produced a mixing of state and private cargoes on many, if not nearly all, merchantmen in the *annona* service. By the 2nd century those individuals had their ships exempt from property on which they were taxed (Tacitus, *Annals*: 13.51), did not have to pay harbour dues (Finley, 1985: 159), and received an exemption from normal public obligations (*publici muneris vacatio*) such as *tutela* (guardianship over a woman), *honores*, and serving as a *decurion* (*Theodosian Code*: 13.5.7; *Digest* of Justinian: 50.2.9.1, 50.4.5–5.3, 50.6.1.5–6.6.5; Garnsey, 1988).

Private operators found a source of income not only from the Imperial *annona* contracts, but also from personal secondary cargoes. Additional income was necessary as the payment to *navicularii* was approximately 4% the value of the cargo, or roughly one-third of a commercial rate (Jones, 1986: 828). Allowing private goods on top of *annona* shipments was further encouraged in the 3rd century, when such goods shipped with fiscal cargoes were tax exempt (Warmington, 1954: 61–2; Tengström, 1974: 38; Tomber, 1988: 27). This provided an incentive for trading at numerous ports in order for the ship-operators to take advantage of the tax-exempt status of their personal trade goods. By 409 it became necessary to issue an imperial law forbidding fiscal ships from stopping at extra ports to trade in order to keep the *annona* shipments on schedule (Tengström, 1974: 43–4). It can be inferred from such a statute that these extra profits were not uncommon and assuredly continued. These private cargoes were secondary and tertiary goods that did not have added transport costs on arriving in Italy, and maintained profitability. The presence of mixed cargoes from varied sources aboard ships suggests the possibility they put in at multiple ports and thus were afforded ample opportunity for carrying secondary and tertiary cargoes to sell in these ports. For merchantmen heading to ports such as Ostia, the entire cargo could find a ready market that would produce a profit and not necessitate stopping at intervening ports; something penalized after 409. Lowered costs of overseas shipping, already the most cost-effective transport method, combined with a broad and deep central-Italian market, attracted a wide variety of secondary and tertiary cargoes to Tunisia as the entry point for the extended Italian market. Merchantmen on the return leg to Tunisia would find the wines of Calabria/Sicily a ready trade item for both North African and eventual central Italian markets. Likewise, fish products from Hispania, as found on the Levanzo I wreck, could also be loaded in Tunisia as a private cargo for sale in Ostia.

As the economic fortunes of North Africa increased, based largely on agriculture to provide

annona and other goods carried along the Italy-Tunisia route, there is indeed a rise in the inclusion of coarsewares in North African shipments to Rome into the 4th century. Coarsewares were readily manufactured in Tunisia (see for example Hayes, 1976; Peacock *et al.*, 1990) and the surplus traded in markets throughout the western Mediterranean. Ikäheimo (2005) argues that increased development in Tunisian agricultural supplied the kiln fuel necessary for the increase in coarseware production, and, moreover, the nature of the wares' utility provided a competitive advantage over those produced in other areas of the central and western Mediterranean. This cargo item is small, often stackable, easily obtainable, and relatively robust. Its inclusion within an *annona* shipment, of which the Levanzo I wreck offers a probable example, provided a low-risk private cargo providing a reasonable profit given reduced transport and customs costs. These reduced shipping costs on the *annona* route, even below the normal advantage that shipping had relative to land transport, was certainly a factor in imported coarseware's distribution being largely limited to coastal sites (Ikäheimo, 2005: 514). Similarly, glass was a potentially profitable cargo and made more so given reduced shipping costs along the Italy-Tunisia route. Less is known about the glass trade in the Roman era, but its presence on the Levanzo I wreck indicates its inclusion as secondary cargos on overseas shipments. Given the probable higher profit margin of glass compared to coarseware or construction materials, more akin to wine, it could also be shipped to Tunisian ports with the idea of reaching the extended market of Rome. Although raw glass was produced in Iberia and Gaul then shipped for shaping in secondary locations (Pliny, XXXVI.194; Degryse and Schneider, 2008), completed vessels themselves may have been shipped to Tunisia along the Iberia-Tunisia route and/or vessels were shaped in Tunisian workshops.

Once considered solely as ballast on return journeys, construction materials (brick and tile) commonly served as profitable primary cargoes delivered particularly to newly-established Roman population centres (Royal, 2012). However, such imports dwindled in favour of local production, as the profit margin cannot typically offset even low overseas shipping costs. These construction materials were included in cargoes from central Italy to North Africa, particularly along the Italy-Tunisia route, as the number of subsidized voyages made additional shipping costs inconsequential. The evidence provided by the vaulting-tubes on the Levanzo I site suggests at least one type of construction materials was included in mixed cargoes as a profitable trade item moving from Tunisia towards Italy on the primary *annona* 'trunk' route. Vaulting-tubes were used in a specific method of vault/dome construction which was widely used during the 2nd century in North Africa (Rakob, 1982; Wilson, 1992;

Tomasello, 2005) and their use was slowly adopted during the 3rd-4th century in Italy (Arslan, 1965). Established kiln-sites producing vaulting-tubes in Tunisia could produce a modest surplus for the small, but growing, markets in Sicily and Italy. Their ability to enter these markets was aided by their low cost when included as small private consignments along with *annona* shipments, due in large part to negligible overseas transport costs.

The merchantman which ended up as the Levanzo I wreck-site departed from Tunisia, probably Carthage, to Italy, but sank while travelling through the Egadi Islands. Its cargo reflects the redistribution of western- and central-Mediterranean goods established within the *annona* system, as well as providing an example

of wider Mediterranean goods moving within the network of overseas routes. Among the wreck's known cargo items were oil from Tunisia and Dacia, fish products from Spain and possibly North Africa, wine from Calabria/Sicily, North Africa and possibly the Eastern Mediterranean, probably North African grain, as well as coarse tableware, some glass vessels, and construction materials from North Africa. Each of these goods is consistent with imports at Ostia in the 4th century, both primary goods associated with *annona* contracts and secondary/tertiary goods associated with private shipments. They also attest to Tunisia serving as an extended market for Rome, whereby routes connecting Tunisia to other parts of the Mediterranean were sustained over time.

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