

The reuse of transport amphoras as packaging containers in the Roman world: an overview

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1. Introduction

In this contribution I present a general overview of the reuse of amphoras as packaging containers in the Roman world. After discussing various background considerations relating to the reuse of amphoras as packaging containers I review first the archaeological and then the textual evidence for this practice. I then consider three significant questions raised by the reuse of amphoras as packaging containers, indicate research that might be undertaken with a view to improving our understanding of the practice, and conclude by drawing some general conclusions regarding both its incidence and its significance for amphora studies.

2. Background considerations

I begin by defining what I mean by the reuse of an amphora as a packaging container. Here what I have in mind is the use of an amphora to hold some substance so that it could be transferred from that substance's point of production or collection or from some point further along from this in a distribution chain (in cases in which the substance in question had been packaged in some other container at its point of production/collection) to some other location further along in a distribution chain. I assume that amphoras were produced by their manufacturers and acquired by their initial users (if the two were not the same) principally to serve as packaging containers, although in some instances they would have been manufactured and/or acquired for some other purpose. For example, some newly manufactured amphoras (the incidence is impossible to estimate) were presumably employed as storage containers, that is, to hold some substance with the intent that it remain at or very close to the point of filling (e.g., on the same or a neighboring property). After its initial use as a packaging container (which might have involved the protracted storage of the filled and stoppered vessel at its final destination or at some other point) an amphora normally would have been emptied of its content and treated in one of three different ways: it would have been reused – either as a container or for one of a wide variety of other applications (many of which involved some more or less substantial physical modification to the vessel) (Peña 2007a: 61-192); it would have been recycled by being reduced to sherds or smaller-size particles for use as a raw material (Peña 2007a: 250-71); or it would have been discarded (Peña 2007a: 272-318).

One of the ways in which an amphora might have been reused was as a packaging container. This might have involved the vessel's refilling with a content - here termed a *reuse content* - identical or similar to its initial content – here termed its *prime-use* content - or with some significantly different substance. A vessel might have been reused as a packaging container one or more times before being reused for some other purpose, recycled, or discarded. The reuse of amphoras as packaging containers in any locale at any particular time might have been a *regular* practice and/or an *intensive* practice, that is, one that involved the continuous reuse of amphoras and/or one that involved the reuse of large numbers of amphoras.

Refilled amphoras might have been employed to transfer their content to locations situated at varying distances from the point where they were filled. In this regard we can recognize three more or less distinct kinds of transfers: *local transfers*, involving a supply chain that began and ended within the service area of the central place (however defined) where the amphora was filled (and also probably – although by no means necessarily – where its content originated); *peri-local transfers*, involving a supply chain where the end-point lay in one of the central place service areas that bordered on this territory; and *export transfers*, involving a supply chain where the end point lay somewhere beyond this cluster of service areas. As will be considered below, the type of transfer in question might have played a significant role in the specific practices involved in the reuse of amphoras as packaging containers.

The reuse of amphoras as packaging containers raises potentially significant problems regarding our efforts to employ the amphora record to evaluate the geography, chronology, and intensity of the production, distribution, and consumption of the various substances packaged in amphoras. It has been widely assumed that the vessels belonging to a specific amphora class were normally employed in their initial use for the packaging of a single, specific substance that was generally produced or collected in the specific locale or broader region within which that class originated. This content is here termed that class's *principal content*, with any other kind of content characterized as an *irregular content*. Based on this assumption, scholars have evaluated the amphoras from shipwreck sites to gain insights into the mechanisms and geography of the distribution of the substances known or posited to have been the primary content of the classes represented. They have also carried out qualitative and quantitative analyses of amphora assemblages from consumption sites to gain insight into geographic and diachronic patterns in the provision to and consumption of these substances at these locations. If, however, amphoras were regularly and/or intensively reused as packaging containers, this would weaken the validity of the assumptions that undergird studies of this kind, since the containers that are the focus of this work might have held a reuse content different from that class's principle content and/or that originated outside the locale or region where the class originated. For this reason it would be helpful if we were able to expand our general knowledge of the practice of reusing amphoras as packaging containers, determine the degree to which it was associated with specific amphora classes or kinds of content, and establish whether there were any specific institutional, geographic and/or chronological patterns in its incidence.

Besides considerations of shape, size, weight, and robustness, the suitability of an amphora for reuse as a packaging container would have been conditioned by the extent to which its opening and emptying in any antecedent use had produced damage that limited its general utility for such a purpose, and/or the presence of a pitch lining or content residues that limited its suitability for the packaging of particular substances.

The reuse of amphoras as packaging containers would have involved the acquisition and reconditioning of amphoras that had been emptied of their content. The reconditioning procedure might have involved checking the vessel for overall soundness and specific defects; cleaning to remove precipitates and absorbed residues, followed by drying; reworking the mouth, when this had been subject to damage; pitching (or re-pitching); and, finally, the removal of *tituli picti* or other labels that had served to identify the vessel's antecedent content, owner and/or intended recipient. It was presumably to some extent advantageous if the vessels to be employed belonged to one or at most a limited set of classes that were reused on a regular basis, as this would have simplified reconditioning, filling/stoppering, storage, and transport operations, while also perhaps limiting any confusion that may have arisen regarding the identity of the vessels' content. Where the reuse

of amphoras as packaging containers was a regular and/or intensive practice we may suppose that it was facilitated by brokers who specialized in the collection and perhaps also the reconditioning of used containers and the provision of these to the various sorts of entities that had need of them.

The reuse of amphoras as packaging containers might have occurred in a variety of different economic contexts, including the distribution and sale of substances on the market, the internal transfer of substances in connection with elite self-supply, and the mobilization of substances for a state or ecclesiastical supply initiative of some kind. Export transfers may well have differed from local and peri-local transfers in certain fundamental ways in that they more often involved complex distribution chains that entailed one or more changes in possession and/or ownership of the filled containers. Among other things, concerns regarding the identity and quality of the amphoras' content stemming from the fact that they were reused containers may have been more of an issue in export transfers, as potential end-users would have tended to be less familiar with the individuals and entities that made up the supply chain.

3. Archaeological evidence

We can begin our consideration of the **archeological evidence for the reuse of amphoras** as packaging containers by considering the markers that either indicate with certainty or raise the possibility that an amphora was reused as a packaging container. We can identify five of these:

Marker 1: the presence on an amphora of **multiple labels** (*tituli picti* or graffiti) indicating two or more instances of filling.

Example: Dressel 2-4 from the Casa del Menandro at Pompeii (Stefani 2003: 211). This container bears three distinct *tituli picti* (CIL 4.9325). The first two, executed in white paint, appeared one above the other on one side of the vessel's neck (Figure 1). The first of these is a four-line text that indicates a content consisting of *metellianum vinum*, a variety of wine from the area of Surrentum that was placed in the container in AD 62, that is, 16-17 years prior to Pompeii's destruction. The second, limited to a single line, appears immediately below the first in letters of a different size executed in a different hand. It indicates a content of *acetum alexandrinum*, that is Alexandrian vinegar. The third text, which consists of a single line executed in red paint, appears on the other side of the amphora's neck and indicates that the amphora and its contents were the property of a certain Titus Claudius Anthus. The first of the three texts likely relates to the amphora's prime-use, the second to an episode of reuse, and the third to one or the other of these. Whether the episode of reuse involved the amphora's use as a packaging container or a storage container is unclear.

Marker 2: the presence on an amphora of **damage** (and also possibly **repair**) that indicates either two or more instances of filling or notably protracted use.

Example: Late Roman 1 from the Yassiada shipwreck (Van Alfen 1996: 202-3). This container bears three vertical gouges on the inner surface of its rim and the upper part of its neck, evidently produced when its stopper was removed with a sharp instrument. This suggests that the amphora was filled, stoppered, then unstoppered and emptied of its content at some point prior to its filling with the content that it held at the time that it was brought aboard the ship.

Marker 3: the presence in an amphora of **content remains** that indicate two or more different contents or of a pitch lining and **content remains that are incompatible with a pitch lining**.

Example: Keay 62A from the La Palud 1 shipwreck (Garnier 2007: 27-9). Organic residue analysis carried out on this amphora demonstrated that it had a pine pitch lining and had once contained olive oil. Since olive oil is generally held to be incompatible with the presence of a pitch lining (see Section 5 below) this suggests that the container had been used to hold some other substance, presumably either wine or a processed fish product of some kind, **prior** to being filled with oil.

Marker 4: the presence on an amphora of a **label** or in an amphora of content remains that indicate that it was filled with an irregular content or with a content that originated at some distance from the container's point of origin.

Example: Keay 35A reused as construction fill in the San Lorenzo Maggiore ecclesiastical complex in Milan (Bocchio 1990: 146; Peña 2007a: 112). While this class of amphora, which originated in Tunisia, is generally regarded as an olive oil container (Bonifay 2004: 135; Bonifay 2007: 14, 24), the example in question bears a *titulus pictus* in Greek indicating a content of wine, along with a Christian religious slogan. This suggests that the container was reused as a packaging or storage container, quite possibly in connection with an ecclesiastical supply initiative of some kind.

Marker 5: the presence in the mouth of an amphora of **a stopper produced using a method that differs from the standard method employed for stoppering the class in question** or a method that employed materials that originated at some distance from the amphora's point of origin.

Example: Dressel 2-4 from Quseir al-Qadim (ancient Myos Hormos) (Thomas 2011: 15, 16, 27, 31). This vessel, the fabric of which indicates that it originated outside Egypt – perhaps in Cilicia or Cyprus - was found with its stopper preserved in situ (Figure 2). This was fabricated by forcing a piece of textile into the upper part of the vessel's neck and the inserting a plug made up of a mixture of sherds and plaster. The upper surface of the plug was smoothed, impressed with a sealing, and then painted with red pigment. The sealing bears the name of a man who was presumably a merchant who owned the amphora and its content along with an indication that this was wine. The sherds used in the fabrication of the stopper were of Egyptian origin, indicating that it was produced somewhere in Egypt. This suggests that the amphora was imported into Egypt, emptied of its content - almost certainly wine - then filled with a reuse content - certainly wine, presumably of Egyptian origin - and then re-stoppered. The fact that the amphora found its way to Quseir al-Qadim - far from any center of wine production - indicates that this episode of reuse involved the employment of this amphora as a packaging container for an export transfer.

To date, markers of the kinds just described have been documented for only modest numbers of amphoras, and, by themselves, these vessels provide only limited insights into either the broader patterns or specific practices involved in the reuse of amphoras as packaging containers. In a small number of instances, however, more or less sizable sets of amphoras bearing one or more of these markers have been recovered as cargo at a shipwreck site, and occurrences of this kind have the potential to provide important insights into both broader patterns and specific practices.

The list of such sites includes the following:

Heliopolis 2 – Nord Levant: the remains of merchantman that sank off the Mediterranean coast of France between the end of the 3rd and the 2nd quarter of the 2nd century BC (Parker 1992: 211, 291). Among the ship's cargo were *c.* 60 examples of the Greco-Italic amphora (a wine container from Tyrrhenian Italy) that contained pitch (Joncheray and Long 2002). These displayed a high degree of heterogeneity in terms of origin and date, and several showed conspicuous damage (e.g., handles and spikes broken away), indicating that they were very probably reused containers.

Sud-Caveaux 1: the remains of a merchantman that sank off the Mediterranean coast of France *c.* 30-20 BC (Cibecchini 2013). This ship was carrying *c.* 100 amphoras, for the most part examples of the Lamboglia 2 and the Dressel 6A (both wine containers from Adriatic Italy) that were filled with pine pitch. These displayed a high degree of heterogeneity in terms of origin and date, strongly suggesting that they were reused containers. The ship was presumably bound for Marseilles with pitch destined for supply to one or more shipyards and/or amphora production workshops. It most likely took on its cargo either at a port in Catalonia or at Narbonne (Roman Narbo Martius).

Pisa San Rossore B: the remains of a merchantman that sank in the harbor at Pisa (Roman Pisae) in 7 BC or shortly thereafter (Bruni 2000: 42-3). A total of 17 amphoras was recovered from the wreck, including seven Lamboglia 2s, six Dressel 6As, two examples of the Dressel 9 (a fish products container from coastal southern Spain), and two examples of the Haltern 70 (a probable wine container from Spain). The Lamboglia 2s and Dressel 6As contained a variety of irregular substances that are thought to be reuse contents, including fruits (peaches, cherries, plums), nuts (walnuts, chestnuts), and inorganic materials (ocher, arsenic sulfide, volcanic sand) (Pesavento Mattioli *et al.* 2000). The amphoras were found shimmed in place in the vessel's hold with chunks of volcanic rock originating in the Bay of Naples, raising the possibility that they were filled and brought aboard the ship somewhere in this region.

Cala Culip 4/D: the remains of a merchantman that sank off the coast of northeastern Spain in the AD 60s or 70s (Parker 1992: 157). This ship was carrying at least 76 examples of the Dressel 20 (an olive oil container from southern Spain) (Nieto Prieto *et al.* 1989: 61-74). The majority of these were closed with highly irregular stoppers cut from sherds rather than the purpose-made stoppers often associated with this class, raising the possibility that they were filled and stoppered on more than one occasion. This ship appears to have been engaged in cabotage trading along the Mediterranean coast of Spain and the adjacent coast of France.

Grado ('Julia Felix'): the remains of a merchantman that sank near the head of the Adriatic Sea in the middle decades of the 2nd century AD (Parker 1992: 197). The amphora cargo of this ship is discussed in detail below.

Yassiada B: the remains of a merchantman that sank off the coast of Anatolia *c.* 625-630 AD (Parker 1992: 454-5). This ship was carrying *c.* 900 amphoras, including at least 103 Late Roman 1s and 819 Late Roman 2s (van Alfen 1996; van Alfen 2015; Ward 2015; van Doorninck 2015: 206-8). The excavators believe that the ship may have been operated by an ecclesiastical establishment, and that at the time of its sinking it was engaged in the delivery of foodstuffs under the *annona militaris* to troops of the Byzantine state campaigning in the Levant, with the some of the containers filled with olive oil and some probably filled with wine. A notably high degree of variability in form and fabric within both groups of amphoras, the presence of two examples of the Late Roman 1 that exhibited damage indicative of an earlier episode of use, and the presence of several examples of the Late Roman 2 bearing graffiti indicating a content of lentils led the excavators to infer that these containers were in

significant measure of reused amphoras, perhaps assembled in the context of a military emergency.

Of these occurrences, the **Grado shipwreck** warrants detailed discussion, as it provides unusually informative evidence regarding certain aspects of the practices involved in the reuse of amphoras as packaging containers. In this instance, the excavators were able to recover effectively the entire preserved portion of the ship's cargo. This included at least 566 amphoras belonging to four different classes, among which were 204 examples of the African 1 (an oil container from Tunisia), 23 examples of the Tripolitanian 1 (an oil container from Tripolitania), 154 examples of the Knossos 19/Dressel 5 (a wine container from the Aegean), and 185 examples of the Grado 1 (a fish products container from the upper Adriatic) (Auriemma 2000; Toniolo 2002-2003; Auriemma and Pesavento Mattioli 2009). These were arranged in the hold by class, with the African 1s placed amidships, the Tripolitanian 1s towards the bow, the Knossos 19s towards the stern, and the Grado 1s arranged in various free spaces that remained near both the bow and the stern. This arrangement suggests that all of the containers were brought aboard the ship at the same time, perhaps as a single, unitary cargo. The ship was also carrying a substantial quantity of glass fragments apparently destined for recycling, and was probably also outfitted with a large salt-water tank that served for the transport of live fish.

Toniolo (2002-2003: 115-16) reports mean capacities in liters for the sets of containers belonging to each of the four classes of amphoras represented among the ship's cargo as follows: African 1: 43l; Tripolitanian 1: 85l, Knossos 19: 26l; Grado 1: 17l.¹ The Knossos 19s and Grado 1s bore a pitch lining, while the African 1s and Tripolitanian 1s presented no evidence of such a lining. Several of the African 1s, Knossos 19s, and Tripolitanian 1s contained macro-remains, and the analysis of these revealed that the first two of these classes held salted whole sardines, while the third held Atlantic chub mackerel. The stoppers for all three of these classes involved the use of disks cut from sherds belonging to one or another other of these same classes. At least 24 of the Grado 1s preserved traces of a *titulus pictus* on the neck. While the reading of these presents difficulties, in nine cases it is clear that the text indicates a content of *liquamen flos*, that is, top-quality *liquamen*, and in six cases there is a line consisting of the letter A or B followed by the letters XX and a symbol resembling a radiate crown. The letters XX, if a weight figure, likely report the empty weight of the container in pounds.² As one would expect for amphoras containing *liquamen*, none of the Grado 1s yielded macro remains.

The contents of all four classes presumably originated somewhere around the head of the Adriatic, an important center for the confection of fish products. The Grado 1s were almost certainly the only prime use containers among the ship's cargo, with the other three classes consisting of reused containers. The distribution of the Grado 1 is limited to northern Italy, both shores of the Adriatic, and the interior of Pannonia and Illyria, suggesting that the ship

¹ Toniolo terms these figures the *capacità media* for each of the four sets of amphoras. She does not indicate the method employed to calculate vessel capacities, the number of examples of each of the four classes for which a measurement was taken, the capacity measurement for any individual amphora, or the standard deviation figure for any of the four classes.

² With a median capacity of 17l the examples of this class would have weighed something on the order of 20 Roman pounds and been capable of holding at least c. 40-50 Roman pounds of *liquamen*. See Bernal *et al.* 2014: 227 for comparative data for a set of Dressel 21-22s, which, with capacities on the order of 15-18l, had empty weights that ranged from 23 to 32 Roman pounds and were filled with from 53 to 80 Roman pounds of fish sauce.

had sailed from a port somewhere in the upper Adriatic and was probably bound for another port along the shores of this same body of water (Toniolo 2002-2003: 125).

Toniolo (2002-2003: 130) considered the practices that lay behind this noteworthy instance of the reuse of amphoras as packaging containers. Observing that the three classes of reused containers display a considerable chronological spread, she concluded that these vessels were not collected on a casual basis, but rather were deliberately assembled by the owner of the ship with particular aims in mind and curated by him over a substantial period of time, acquiring replacements as individual examples reached the end of their use life. In her view, the characteristic of these containers that made them of interest to the ship owner was not the size of their mouths (which would have rendered them more or less suitable for the introduction and removal of whole salted sardines or mackerel), but rather their overall size and shape, which would have allowed him both to arrange cargo aboard his vessel according to a set of well-established procedures and to sell his merchandise in standardized amounts according to weight. Interesting in this regard is the existence of a set of regular capacity relationships among the four sets of containers. The relevant data, presented in Figure 3, suggest that the mean capacity of the Grado 1s - 17l - corresponds to a module equal to two-thirds of an *amphora* (that is, the *amphora* as a standard measure of volume equal to one *quadrantal* or cubic foot, divisible into 48 *sextarii*) or, perhaps more conveniently, two *modii*, a measure equal to one-third of an *amphora* that was widely employed in the Roman world for dry measures. The capacities of the Knossos 19s, African 1s, and Tripolitanian 1s, in turn, would be equal to three, five, and ten *modii*, respectively. These four amphora sizes combine to form an additive sequence, with the values of the two smallest containers summing to equal the value of the next largest container, and the values of these three containers summing to equal that of the largest container. The existence of this structured set of relationships, which would not seem to be a random occurrence, re-enforces Toniolo's conclusion that the suite of amphoras aboard the Grado ship were carefully selected with specific aims in mind.

As already alluded to in relation to the Heliopolis 2, Sud-Caveaux 1, and Yassiada B shipwrecks, in some instances sets of amphoras from a shipwreck display a notably high degree of heterogeneity in terms of form, size/volume, manufacturing technique, fabric, and/or epigraphy that suggests that they represent a group of reused containers. An interesting example of this kind of indicator is presented by the Cabrera 3 shipwreck, the remains of a merchantman that sank off Cabrera, one of the Balearic Islands, in or shortly after AD 267 (Parker 1992: 81). In this case, the excavators were able to document only a moderate portion of the ship's cargo that had been stowed in the hold amidships. This included 124 amphoras, among which were 34 Dressel 20s, 16 examples of the Dressel 23 (an olive oil container from southern Spain), 19 examples of the Almagro 50, 16 examples of the Almagro 51C, and seven examples of the Beltrán 72 (all fish products containers from Portugal) and 32 examples of the African 2 (a fish products container from Tunisia) (Bost *et al.* 1992: 117-77; Bombico 2015: 28). These were arranged in the hold by class in a way that led the excavators to conclude that all had been loaded aboard the ship at the same time. Several other shipwrecks in the western Mediterranean dating to the second half of the 3rd and the 4th century AD have produced similar suites of African 2s and Portuguese fish products amphoras, and scholars have found it difficult to infer the trade patterns that would have generated cargoes of this kind.

Worth considering in this connection are the strongly contrasting levels of homogeneity/heterogeneity displayed by, on the one hand, the set of African 2s and, on the other, two of the three classes of Portuguese fish products amphoras, namely the Almagro 50s

and the Beltrán 72s. The relevant data are presented in Figure 4. The African 2s included examples of three different variants - the 2A, 2C, and 2D - that have been thought to represent three discrete moments in the diachronic development of this class, and were manufactured in at least two different fabrics. Thirteen of the 34 vessels bore a stamp, each produced with a different die and representing at least ten and perhaps as many as 13 different stamping entities. All of the vessels bore a pitch lining, suggesting a content of fish products, and whereas two were found to contain remains of fish products, another two contained large numbers of olive pits, pointing to a content of olives. In contrast, 17 of the 19 Almagro 50s bore a maker's stamp, with these produced using just four different dies representing only two different workshops, while three of the seven Beltrán 72s bore a maker's mark, with these all produced using the same die as that employed to stamp one of the Almagro 50s.

From the location of the shipwreck and the likely points of origin of the ship's cargo the excavators surmised that the vessel likely sank in the course of voyage from Spain to Italy, most likely departing from Cádiz (Roman Gades) and bound for Ostia/Portus. The set of African 2s and combined set of Almagro 50s/Beltrán 72s from Cabrera 3 clearly had substantially different histories before being brought aboard the ship. The former appear to have been subject to a complex set of operations that resulted in the extensive mixing of sets of containers manufactured and presumably initially filled at multiple locations, perhaps at substantially different times, while the latter appear to have been subject to a relatively simple set of operations that saw groups of containers originating and presumably initially filled at the same locus at the same time remaining together. While it cannot be excluded that the African 2s were prime-use containers bound for Italy in the context of a triangular trade that involved shipping cargoes of African fish products and olives to Spain before then sending these on to Italy, a plausible alternative interpretation is that African fish products were shipped from Tunisia to Spain, where they were consumed, with their empty containers reused for the packaging of Spanish fish products and olives destined for export to Italy (Peña 2007a: 76-80).

Also informative regarding the practice of reusing amphoras as packaging containers is a small number of packaging/distribution facilities that have yielded sizable sets of amphoras that appear to have been placed in storage for reuse after having been emptied of their content. Four such facilities have been uncovered at Pompeii and its environs and one at Corinth.

The Pompeian sites include the following:

Casa del Vinario (9.9.6-7): a modest atrium house that appears to have been converted for use as a facility for the storage and sale of foodstuffs, including wine, olive oil, and fish products (Jashemsky 1974; 1979: 233-42; Peña 2007a: 94-6). One room on the premises (Room O) held 29 amphoras stored in inverted position that presumably had been emptied of their content and set aside for reuse. Fifteen of these bore a *titulus pictus*, including one example of the Schöne 6 (a small fish products container of local origin), one amphora classified as a Schöne 12 (most likely a Dressel 2-4), and 13 examples classified as a Schöne 11, one of which was probably a Tripolitanian 1, and the remainder most likely examples of the Form 2020 amphora, a class that has been identified as a wine container from eastern Sicily (Peña 2007b) and more recently as an olive container from Tunisia (Bonifay *et al.* 2015). We have no information regarding the other 14 amphoras from this room.

Casa di Q. Mestrius Maximus/Caupona di Amarantus complex (1.9.11-12): a modest *atrium* house joined with a small structure of unclear type that were converted for use as a facility for the storage and sale of wine and perhaps other foodstuffs (Berry 1997; Fulford 1998; Peña 2007a: 88-94;). In the southeast corner of the garden of the Caupona di Amarantus was a group of several (probably 12-16) amphoras set in inverted position, perhaps in two tiers, that presumably had been emptied of their content and set aside in storage for reuse. These included one Gaza amphora (a wine container from Gaza or Lower Egypt), one Cretan wine amphora, and two containers identified as Aegean amphoras (probable wine containers from the Aegean), with most or all of the remaining containers Dressel 2-4s of Campanian origin. The *impluvium* of the Casa di Mestrius Maximus contained c. 15-20 amphoras lying on their side in a disorderly fashion. These included nine examples of the Cretan 2 (a wine container from Crete), two examples of the Pseudo-Koan amphora (a wine container from the Aegean), and one example of the Dressel 21-22 (fish products amphoras from southern Italy or Sicily). These may have been placed in the *impluvium* to soak in water as part of the reconditioning process for reuse after having been emptied of their content.

Officina del Garum degli Umbrici (1.12.9): a modest *atrium* house that was converted for use as a facility for the confection and sale of fish products and perhaps also the sale of wine (Curtis 1979; Peña 2007a: 82-8; Bernal *et al.* 2014). This facility had over 200 amphoras being held in storage in Room 13, a rear courtyard, a large portion of which had likely been emptied of their content and set aside for reuse. These containers, which were segregated into groups by content, included a set of 80 Italian fish products amphoras stacked upside down in the north corner of the courtyard in a four-tiered arrangement, with the mouths of the vessels in tiers two to four set over the spike of a container in the tier below. These included four examples of the Dressel 21/Botte 1, from western Sicily, 69 examples of the Dressel 22/Botte 2, from the Peloritan/Calabrian massif of northeast Sicily and Calabria, and seven examples of the Dressel 22/Botte 3, from the west coast of Italy between Etruria and Campania. Macro remains of fish products were recovered from the interiors of these containers, the pavement beneath the mouths of the containers in the lowest tier, and the exteriors of the spikes of the containers in the lower three tiers, where these had come into contact with the mouths of the containers in the tier above them. This suggests that these amphoras were stacked in this area immediately after having been emptied of their content. More than a dozen olive oil amphoras of African origin, including examples of the Tripolitanian 1, Ostia 59, and Maña C1 and C2, were being stored in the west corner of the courtyard. These were apparently set in inverted position, and had thus presumably been emptied of their content. Approximately 20 wine containers of Campanian origin, including examples of the Dressel 2-4 and the flat-bottomed Dressel 2-4, were stored in right-side up position in the east corner of the courtyard. The orientation of these raises the possibility that they were filled at the time of the town's destruction, although it cannot be excluded that they too had been emptied of their content and set aside for reuse. This array and arrangement of containers may represent the initial step in a set of procedures for the collection of a set of used amphoras of various discreet sizes for use as packaging containers similar to the set of procedures employed to assemble the suite of amphoras aboard the Grado ship.

Oplontis, Villa B: a warehouse/wine bottling facility located on the shore of the Bay of Naples at Oplontis, c. 3.2km north-northwest of Pompeii (Fergola 2004a; 2004b; Peña and McCallum 2009: 191; Lagi 2015; Thomas 2015). At the time of its destruction this facility contained at least 1200 amphoras, c. 90 percent of which were Dressel 2-4s. The ground-floor peristyle contained at least c. 400 amphoras stacked in upside down position in a three-tiered arrangement similar to the one attested at the Officina del Garum degli Umbrici. Also in this space were two stoves, a bronze vessel containing pine pitch residue, and a block of pitch that

all might have served for the pitching of amphoras. According to Lagi, the amphoras stored in the peristyle consisted for the most part of locally-manufactured Dressel 2-4s - though also included numbers of used containers that had previously held either *Falernum* or *Surrentinum* - again presumably Dressel 2-4s - with this inference presumably based on the presence of *tituli picti* on these containers. Also present was a small number of Spanish fish products amphoras. While it is not clear what proportion of the locally-manufactured amphoras were used, it would appear that a substantial number of these showed evidence of previous use. In Lagi's view, the amphoras stored in this part of the facility consisted of used containers collected at Pompeii and its environs that were destined for refilling with locally-produced wine for local distribution, more distant distribution being excluded by the fact that the containers in question had been used. The apparent scale of the facility's wine bottling operations and its seaside location, however, suggest that a substantial portion of the wine bottled there would have been loaded aboard ships for export transfer.

Turning to Korinth, Building 7, a modest commercial structure located immediately to the East of the theater, contained a room (Room 4) that at some point during the second half of the 3rd century AD housed a facility for the packaging and perhaps also processing of some unidentified substance (Slane 2004). Several more or less complete amphoras were recovered in this room, including eight examples of the Kapitän 2 (a probable wine container from the Aegean), two examples of the Middle Roman 4 (a probable wine container from the south coast of Anatolia and perhaps also Cyprus), two examples of the Rhodian amphora (a wine container probably from Rhodes), three examples of the Cretan 4 (a wine container from Crete), one or two examples of the Forli amphora (a wine container from the Adriatic coast of Italy), and at least two and perhaps as many as five Korinthian amphoras. Slane has conjectured that these were used containers that were assembled on the premises so that they could be employed to package the substance being produced there.

4. Textual Evidence

A variety of texts, including papyri, literary works, and inscriptions point in a more or less definitive fashion to the regular and/or intensive reuse of amphoras as packaging and/or storage containers.

An extensive corpus of papyri indicates that it was a common practice in Hellenistic, Roman, and Byzantine Egypt to refer to specific types of amphoras by a geographic name that referred to that container's point of origin (Kruit and Worp 2000; Hickey 2012: 186-97). In many cases it is possible to link these denominations to known amphora classes and to infer the standard content of the container in question. In several instances papyri refer to one or more examples of one of these container types as holding an irregular content, including foodstuffs such as cheese, sweetmeats, legumes, or grain (Mayerson 1992). In many cases - particularly those involving amphoras that originated outside Egypt - these would appear to constitute instances of reuse, although whether this was as a packaging container or a storage container is often unclear.

In a limited number of cases papyri either make clear reference to or suggest the intensive reuse of amphoras for the bottling of new wine at locations in the Fayum. From the Hellenistic period we can cite *PCairZen.* 4.59741 and *PSI.* 8.859, a pair of papyri belonging to the Zenon Archive that probably date to the period 256-248 BC. Together, these two documents constitute an account for the transport of 3200 amphoras from Kerke to the neighboring town of Philadelphia (a distance of *c.* 10km) by donkey and wagon for pitching (Kruit and Worp 2000: 71; Grace and Empereur 1981: 425). Among these were 1793 six-

chous capacity amphoras of what was presumably Egyptian origin and 1407 imported amphoras, termed *Kouriaká*, *Páphia*, *Pária*, and *Chía* - presumably amphora types associated with the cities of Kourion and Paphos on Cyprus and the islands of Paros, and Chios, respectively. While the specific purpose of this undertaking is not indicated, it presumably involved the preparation of amphoras for the packaging or storage of a large quantity of a liquid or liquids of some kind. That this was probably new wine is suggested by the fact that the operation was being carried out during the second half of *Payni* (i.e., the first half of May), shortly after the vintage. The imported amphoras referred to in the documents were almost certainly used containers, as might have been some or all of the Egyptian amphoras.

From the Roman period we have *Pland.* 99, dating to the early 3rd century AD (Rathbone 1983: 90-1). This document is concerned with operations relating to the management of the wine being held on an agricultural estate at some unknown location in the Fayum, most likely in the Oxyrhynchite nome. It refers first to the tasting of the wine produced on the estate, which it indicates was bottled in *xenikokerámia*, that is, imported amphoras. As was the case with the documents from the Zenon Archive, these were presumably used containers. The document then addresses the need to replenish the stock of imported wines being held by the estate, indicating that these were bottled in containers termed *Hadriánai*, *Aminaíai*, and *Tmolítikai*. These are presumably amphora types associated with *Hadrianum*, a wine from the Adriatic coast of Italy, *aminaeum*, a quality of wine grown in various regions, though particularly associated with Sicily, and *Tmolítes*, a wine from the Mount Tmolos region of western Anatolia. It seems reasonable to assume that one, two, or all three of these container types were among the *xenikokerámia* employed for the bottling of the wine produced on the estate.

Finally, from the Byzantine period we can cite *POxy.* 55.3804, which can be dated to AD 566. This is the annual account of Theodorus, the estate steward of the Apion family, which had extensive holdings of agricultural land in the Oxyrhynchite nome. Among other things, it records a lot of 1100 containers termed *koûpha palaía* ('old empty jars' – i.e., used amphoras) that had been purchased and delivered to vine dressers for the bottling of new wine.

Turning to literary works, a passage in Pliny the Elder's *Naturalis historia* (19.41.142) states that a type of cabbage known as *halmyrídia* that grows in unspecified sea-side regions remains green even for a lengthy sea voyage if it is packaged in *cadi olei* (oil amphoras) that have been 'dried'. If, as appears likely, the drying of these containers refers to the removal of residues of a prior content of oil, this points to the reuse of oil amphoras (rather than the use of new ones) for the packaging of cabbages. Unclear, however, is whether this would have been for the commercial distribution of these cabbages, including in some cases export transfers by sea, and thus perhaps both a regular and intensive practice, or simply for the occasional provisioning of ships' crews.

In the realm of epigraphical evidence, three inscriptions from Rome may point to the regular and/or intensive reuse of amphoras, presumably as packaging and/or storage containers. An epitaph on an altar tomb set up outside the *Porta Salaria* that can be dated to the 2nd century AD (*CIL* 6.9488) commemorates a certain Gaius Commissius Succesus, whose occupation is given as *negotians Port Vinario lagonaris*, (jug/small amphora trader at the *Portus Vinarius*). The most plausible interpretation of this occupational designation is that the man in question worked as an amphora broker in the city's *Portus Vinarius* wine trading district, apparently located in Trastevere. His activities might have involved purchasing amphoras (particularly small ones?) that had been emptied of their content and reselling these to wholesalers,

retailers, and/or consumers who required empty containers into which they could transfer the content of large-size amphoras, damaged amphoras, large-size casks, skin containers, sacks, basketry containers, and so forth. A second epitaph from Rome, in this case from the Catacombs of Praetextatus, thus dating to the late 2nd century AD or later (*CIL* 6.9488/*ICUR* 5.15389), is for a certain Leontia, whose is termed an *ad Porta(m) Trigemina(m) lagunara* (jug/small amphora [?] woman at the Porta Trigemina) – here again perhaps a person whose work was in some fashion connected with the collection and/or distribution of used amphoras, in this case based in the vicinity of the Porta Trigemina.

Finally, a fragmentary monumental inscription of the late 4th century AD found in the area of San Silvestro in Capite in the northeastern Campus Martius (*CIL* 6.1785=31,931) preserves part of what appears to be an edict issued by the *Praefectus Urbi* that fixed the amounts of gratuities that landowners were obliged to pay various classes of functionaries upon the consignment of wine being collected by the state as tax in kind under the land tax at the *Ciconiae*, a landing facility on the left bank of the Tiber River, most likely in the vicinity of the Tor di Nona. While this complex and fragmentary text is open to differing interpretations, one possibility is that the *ampullae* that it specifies were to be returned to the taxpayer following the completion of the *degustatio* (tasting) were small-size amphoras in which the wine in question had been transported to Rome (Peña 1999: 177-8; Vera 2006). If this was the case, it is plausible to infer that the taxpayers transported these containers back to their estates and employed them for the packaging of subsequent consignments of tax wine.

5. Questions raised by the reuse of amphoras as packaging containers

We may now turn to a consideration of three significant questions raised by the reuse of amphoras as packaging containers.

The first of these is the extent to which the presence in an amphora of the remains of its prime-use content or an antecedent reuse content or the presence of a pitch lining would have rendered it unsuitable for reuse for the packaging of certain substances.

As shown above, there is copious evidence that amphoras that had been employed for the packaging of wine (which in many cases would have been provided with a pitch lining) were reused for the packaging and/or storage of wine. This includes the amphora assemblage from Oplontis Villa B and the papyri from the Fayum noted above. Further, that amphoras that had held wine could be reused for the packaging of fish products is demonstrated by the Knossos 19s from Grado, that they could be reused for the packing of fruit, nuts, and various inorganic materials is indicated by the amphoras from San Rossore B, and that they could be reused for the packaging of pitch is demonstrated by the amphoras from Heliopolis 2 and Sud-Caveux 1. Wine amphoras that had been provided with a pitch lining were probably not as a rule employed to hold oil, as oil dissolves pitch, meaning that any oil placed in a pitched amphora would have suffered some degree of adulteration (Bonifay 2007: 11-14).

There is considerably less evidence for the reuse of amphoras that had held oil as packaging and/or storage containers. The African 1s and Tripolitanian 1s from Grado, however, demonstrate that these could be reused for the packaging of fish products, while the Dressel 20s from Cala Culip 4 may provide evidence that they were reused for the packaging of oil, and the passage from Pliny the Elder noted above may indicate that they were reused for the packaging or storage of cabbages. The oil amphoras from the Officina del Garum degli Umbrici presumably were set aside for refilling with some substance or other, and while we have no evidence regarding what this might have been, processed fish products seems the best conjecture. The Key 35A reused in the construction of San Lorenzo in Milan noted

above suggests that containers that had held oil could also on at least some occasions be employed for the packaging and/or storage of wine. It seems possible that this practice would have produced some adulteration of the wine, however, and it should be noted that this container might well have been reused in the context of an ecclesiastical charitable initiative of some kind, in which issues of quality of content were perhaps less significant than in other circumstances, particularly those associated with market distribution.

There is also fairly limited evidence for the reuse of amphoras that had held fish products as packaging containers. As with the oil amphoras from this establishment, the Dressel 21s and 22s from the *Officina del Garum degli Umbrici* had presumably been set aside for refilling with some substance or other, while the African 2s from *Cabrera 3* may have been reused for the packaging of fish products and olives. Finally, the *Keay 62* from *La Palud 1* noted above was reused for the packaging of oil. This somewhat unexpected instance of the reuse of an amphora with a pitch lining for the packaging of oil emphasizes that, while there may have been standard practices in the reuse of amphoras as packaging and/or storage containers, in some instances these were not observed, presumably in the interest of expediency.

The second question is the extent to which the employment of used amphoras for the packaging of foodstuffs would have represented an advantage of some sort. In terms of cost, it is worth noting that the *Edictum de Pretiis*, issued in AD 301, sets the price for a *lagona* with a capacity of one half-*amphora* – perhaps meaning a small-size amphora - at a figure equal to between 1.67 and 6.25 percent of the price that it sets for one half-*amphora* of the various grades of wines listed in this same document (Peña 2007a: 28). This suggests that for low-grade wine the cost of a new container might have represented a significant, if still minor fraction of the value of the wine. On the other hand, the *Heroninos Archive*, a set of papyrus documents pertaining to the management of an estate in the Fayum during the period AD 249-268, shows that new, locally manufactured amphoras wholesaled for between 0.5 and 1.3 percent of the wholesale cost of the wine bottled in them (Rathbone 1991: 167). This substantially lower figure may represent more accurately true wholesale as opposed to retail costs, or it may reflect the situation in the Fayum, where the regular and intensive employment of used amphoras for the bottling of new wine as suggested by the papyri noted above worked to hold down the price that could be charged for new amphoras.

With regard to convenience, it is not clear that it would have been more convenient for an establishment that required containers for the packaging of some substance to meet this need by gathering used containers through its own efforts or by purchasing these from a broker than it would have been to obtain new amphoras directly from one or more pottery workshops. Indeed, the acquisition of new amphoras might have offered considerable advantages, since the establishment could have contracted for the delivery of the exact number of containers that it required in specific sizes, rather than having to settle for what happened to be available on the second-hand market. On the other hand, in many places at many times the regular consumption of large quantities of the substances regularly packaged in amphoras would have generated very large supplies of used containers the disposal of which would have represented something of an inconvenience for wholesalers, retailers, and/or consumers, and it might have been a relatively straightforward process for such establishments to acquire sizable sets of specific kinds of amphoras that suited their purposes in a condition suitable for reuse as packaging containers as these were needed. There would have been a regular incentive for this practice in areas in which for some reason or other the local pottery industry was incapable of manufacturing a sufficient number of suitable containers and where there was no industry capable of providing some alternate type of container, such as casks or skin containers. There may also have been occasional, short-term

incentives for this in instances in which there was some interruption of the supply chain for amphoras or in which there was a sudden and/or an unexpected increase in the production of the substances normally packaged in amphoras.

The third and final question regards the extent to which the reuse of amphoras as packaging containers might have raised problems regarding the identification of the containers' contents. As noted above, the papyrological evidence makes clear that in Roman Egypt people regularly referred to many different kinds of amphoras by specific names. Interesting in this regard is a passage in Pliny the Elder's *Naturalis historia* (14.66) in which he states that, when packaged in *lagonae* – that is, small amphoras - *Tauromenitanum*, the wine from Tauromenium, was often passed off as *Mamertinum*, the wine from Messana, immediately to the north. This suggests that some individuals – perhaps consumers at Rome – tended to associate this form of container with *Mamertinum*, presumably a wine thought superior to *Tauromenitanum*, and that unscrupulous sellers – presumably retailers at Rome – took advantage of this by selling inferior wine to incautious buyers at an elevated price. On the basis of evidence like this scholars have generally inferred that individuals across the empire were not only able to recognize a wide array of amphoras, but also associated some of these with a particular kind of content. The question, then, is whether the reuse of amphoras as packaging containers would have caused confusion on this score, creating problems at the moment of wholesale sale, retail sale, consignment to the state or church in the context of a supply initiative, and/or the levying of customs duties by the state.

The answer, it seems, is that the reuse of amphoras as packaging containers need not have raised problems of this kind. Whatever people's ability to recognize different kinds of amphoras and their tendency to associate these with a particular substance, it was a regular practice to provide an amphora with a *titulus pictus* that identified its content. While it is unclear precisely how widespread this practice was, and in some cases these labels were written in a cryptic fashion that might have rendered them difficult to interpret for persons extraneous to the packaging and distribution process, recent research at Pompeii, where the preservation of *tituli picti* tends to be exceptionally good, has indicated that a large percentage of amphoras, and, in some instances, perhaps effectively all of those in a particular group were provided with a *titulus pictus* (Bernal *et al.* 2014: 224; Timby 2004: 386). This suggests that it was generally thought necessary to provide some indication of its content on the exterior of a sealed amphora.³ If such was the case, the problem of identifying the content of an amphora being reused as a packaging container would not have been fundamentally different from that of an amphora in prime use, save that it would have been necessary or desirable to remove a *titulus pictus* or other type of label referring to its prime-use content in order to avoid confusion.

I am not aware of any instance in which there is evidence for the removal of a *titulus pictus* from an amphora with a new label executed in its place, although an operation of this kind need not have left traces that would be readily apparent. I know of two cases from Rome and four from Pompeii in which an amphora bore two *tituli picti* identifying different contents, thus instances in which the prime-use label was not removed when a container was refilled,

³ The content of a sealed amphora may have been attested by some means other than a *titulus pictus* that is never or only very rarely preserved, such as a lead or wooden tag attached to one of the handles or a stamped, inked or painted indication on the vessel's stopper. See, for example, Thomas 2011: 23-4, where it is suggested that the layer of red paint regularly applied to the upper surface of many of the amphora stoppers from Quseir al-Qadim may have indicated that the vessel's content was wine, and that the cobra symbol frequently stamped into this surface along with the name of a merchant may have indicated that the content was a product of the Fayum.

although in none of these is the presence of two labels apt to have caused confusion as to the nature of the container's reuse content.

In cases in which amphoras were not provided with a label indicating their content, merchants involved in the wholesale distribution of these might have relied on accompanying documents that indicated what this was. One example of such a document is *TPSulp.* 80, a *tabella cerata* from Pompeii's Murecine Archive, probably dating to the period *c.* 26-61 AD. This document, which appears to be a shipping manifest, lists sets of amphoras being consigned by a certain Theophilus to a certain Aphrodisias that had been brought to a port in Italy – presumably Puteoli – aboard a ship known as the *Octavia*, indicating for each set the number and the nature of the containers and their content (Camodeca 1999: 184; Peña 2007b: 251-2; Purpura 2014: 134; Terpstra 2013: 90-2). As another example of a document of this kind we can cite *OBer.* 1.87, an ostrakon from Berenike probably dating to the period *c.* 33-70 AD. This document, which was a customs pass, lists by type a set of amphoras being transported by camel, indicating for each type its name, the number of containers, and their content.

Frier (1983: 291-4), in tracing the evolution of juridical thought in relation to the problem of vinegar sold as wine, concluded that by the imperial period the wine trade had taken on the forms of mature mercantilism, in which merchants understand that it is to their advantage to comport themselves in such a way as to be perceived as honest partners. It seems fair to assume that the trade in the other foodstuffs commonly packaged in amphoras came to be governed by a similar ethos. If so, during the imperial period the cases of the deliberate misrepresentation of the content of sealed amphoras probably would have been uncommon at the wholesale level. Merchants regularly involved in the importing and exporting of foodstuffs would also have seen it as being in their interest to establish a reputation for honest dealing with customs officials. We may suspect that deception of this kind was more common in the context of retail sale, particularly in larger towns, and perhaps also in connection with the consignment of foodstuffs levied by the state as tax in kind.

6. Further research

There are various kinds of research that we might pursue in order to improve our understanding of the reuse of amphoras as packaging containers in the Roman world. First, a systematic and comprehensive review of the papyrological evidence would provide us with an enhanced understanding of how and to what degree amphoras were reused for the packaging and storage of foodstuffs and other substances in Roman Egypt. Second, the detailed characterization of amphora cargoes from additional shipwreck sites would perhaps furnish us with additional clear instances of this practice, thereby providing us with more information regarding the circumstances in which it occurred and what this involved. Work of this kind would also provide us with useful information about patterns in the homogeneity/heterogeneity of amphora cargoes, positioning us to better interpret possible evidence for this practice, such as that from Cabrera 3 discussed above. Finally, programs of research aimed at identifying the remains of amphora contents and documenting *tituli picti* will doubtless provide new information regarding practices of and patterns in the reuse of amphoras as packaging containers.

In this connection I would like to note that starting in June, 2016 the Pompeii Artifact Life History Project (PALHIP) – a research project that I direct at Pompeii (Peña 2014; Peña and Cheung 2015) - will initiate a collaboration with the University of Texas team working at Oplontis Villa B (Thomas 2015), undertaking a study of the set of *c.* 1200 amphoras

recovered at this facility, which, as noted above, consist in large part of used containers. Among the project's goals will be the characterization of the class, morphology, manufacturing technique, capacity, fabric, epigraphy, and use alterations (including traces of stoppering and damage caused by unstoppering) of a sizable and representative sub-set of these containers, along with a program of residue analysis (to be undertaken by A. Pecci) aimed at the identification of their contents. This will represent a unique opportunity to obtain a detailed picture of one apparently clear and unambiguous instance of the intensive reuse of amphoras as packaging containers from a packaging facility, and should serve as an informative complement to the evidence obtained from shipwrecks.

7. Conclusion

In the current state of our knowledge it seems fair to say that the evidence for the reuse of amphoras as packaging containers in the Roman world is scattered, uneven, and less than substantial. Specifically, the evidence available to us at present from shipwreck sites does not give us reason to believe that this practice was commonplace for transfers that involved ships. However, more detailed analysis of amphora cargoes focusing on content residues, *tituli picti*, stoppers, use alterations, and the homogeneity/heterogeneity of groups of containers may change this picture. Where other kinds of evidence are available to us - papyrological evidence from the Fayum, sets of amphoras from packaging facilities at Pompeii and its environs - this suggests that used amphoras - both locally manufactured and - in the Fayum, at least - those imported from further afield - were employed - perhaps regularly and intensively - for the packaging of wine and perhaps also other substances, including fish products and oil. One possibility is that the incidence of this practice was greater for - perhaps even largely restricted to - substances destined for local or peri-local transfer, where the distance between the bottler and the person who opened and emptied the amphora of its content - perhaps a retailer, perhaps a consumer - was less in both geodesic terms and in terms of number of transactions. Indeed, for transfers of this kind there may have been substantially relaxed expectations regarding the nexus between a type of amphora and its content, with, for example, some understanding that local/regional amphoras and perhaps even certain kinds of imported amphoras also did duty as a sort of general, all-purpose packaging container.

If the more careful evaluation of sets of amphoras from packaging facilities and individual amphoras and sets of amphoras from consumption sites winds up validating a scenario more or less along these lines, and if the fuller and more careful analysis of amphora cargoes from shipwrecks suggests that the reuse of amphoras as packaging containers for export transfers was substantially more common than can be demonstrated at present, then we will have to rethink our ideas regarding the value of amphoras as evidence for the geography, mechanisms, and intensity of the production, distribution, and consumption of the foodstuffs and other substances commonly packaged in these containers.

Bibliography

Auriemma, R. 2000. Le anfore del relitto di Grado e il loro contenuto. *Mélanges de l'École française de Rome - Antiquité* 112: 27-51.

Auriemma, R. and Pesavento Mattioli, S. 2009. I *tituli picti* delle anfore di Grado. In *Olio e pesce in epoca romana. Produzione e commercion nelle regioni dell'alto Adriatico. Atti del Convegno (Padova, 16 febbraio 2007)*. Antenore Quaderni 15: 275-80. Rome, Quasar.

- Bernal, D, Cottica, D, García-Vargas, E, Toniolo, L., Rodríguez-Santana, C. G., Acqua, C., Marlasca, R., Sáez, A. M., Vargas, J. M., Scremin, F. and Landi, F. 2014. Un contesto exceptional en Pompeya: la pila de ánforas de la Bottega del Garum (I.12.8). Avance de un studio interdisciplinar. *Rei cretariae romanae fautorum acta* 43: 219-32.
- Berry, J. 1997. Household artefacts: towards a re-interpretation of Roman domestic space. In R. Laurence and A. Wallace-Hadrill (eds), *Domestic Space in the Roman World: Pompeii and Beyond*, Journal of Roman Archaeology Supplementary Series 22: 183-95. Portsmouth, Journal of Roman Archaeology.
- Bocchio, S. 1990. Frammenti anforari. In *Milano capitale dell'impero romano 286-402 d.C.*: 146-8. Milan, Silvana.
- Bombico, S. 2015. Salted fish industry in Roman Lusitania: trade memories between *Oceanus* and *Mare Nostrum*. In F. Themudo Barata and J. Magalhães Rocha (eds), *Heritages and Memories from the Sea. 1st International Conference at the UNESCO Chair in Intangible Heritage and Traditional Know-How: Linking Heritage 14-16 January 2015. Évora, Portugal Conference Proceedings*: 19-39. Évora, University of Évora.
- Bonifay, M. 2004. *Etudes sur la céramique romaine tardive d'Afrique*. British Archaeological Reports International Series 1301, Oxford, Archeopress.
- Bonifay, M. 2007. Que transportaient donc les amphores africaines? In E. Papi (ed.), *Supplying Rome and the Empire. The Proceedings of an International Seminar Held at Siena-Certosa di Pontignano on May 2-4, 2004 on Rome, the Provinces, Production and Distribution*. Journal of Roman Archaeology Supplementary Series 69: 9-31. Portsmouth, Journal of Roman Archaeology.
- Bonifay, M., Botte, E., Capelli, C., Contino, A., Djaoui, D., Panella, C. and Tchernia, A. 2015. Nouvelles hypothèses sur l'origine et le contenu des amphores africaines *Ostia* LIX et XXIII. *Antiquités africaines* 51: 189-210.
- Bost, J. P., Campo, M., Colls, D., Guerrero, V. and Mayet, F. 1992. *L'épave Cabrera III (Majorque): échanges commerciaux et circuits monétaires au milieu du IIIe siècle après Jésus-Christ*. Paris, Centre Pierre Paris.
- Bruni, S. (ed.) 2000. *Le navi antiche di Pisa: ad un anno dall'inizio delle ricerche*. Florence, Polistampa.
- Camodeca, G. 1999. *Tabulae Pompeianae Sulpiciorum (TPSulp.)*. Edizione critica dell'archivio puteolano dei Sulpici. Vetera 12, Rome, Quasar.
- Carlson, D., Leidwanger, J. and Kampbell, S. (eds) 2015. *Maritime Studies in the Wake of the Byzantine Shipwreck at Yassiada, Turkey*: 17-34. College Station, Texas A&M University.
- Cibecchini, F. 2013. Sud Caveaux 1 – épave de navire. *Altas PALM* (http://www.atlaspalm.fr/fr/s7_sudcaveaux1.html) (consulted 15 December 2015).
- Curtis, R. 1979. The garum shop of Pompeii (I.12.8). *Cronache Pompeiane* 5: 5-23.

- Fergola, L. 2004a. La villa B e il suo proprietario. In L. Fergola (ed.), *Oplontis e le sue ville*: 100-11. Pompei, Flavius.
- Fergola, L. 2004b. I reperti della Villa B. In L. Fergola (ed.), *Oplontis e le sue ville*: 114-27. Pompei, Flavius.
- Frier, B. 1983. Roman law and the wine trade: the problem of vinegar sold as wine. *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte* 100: 258-95.
- Fulford, M. 1998. The House and Bar of Amarantus (I.9.11-12). In J. Berry (ed.), *Unpeeling Pompeii: Studies in Region I*: 62-8. Milan, Electa.
- Garnier, N. 2007. Analyse du contenu d'amphores africaines. In E. Papi (ed.), *Supplying Rome and the Empire. The Proceedings of an International Seminar Held at Siena-Certosa di Pontignano on May 2-4, 2004 on Rome, the Provinces, Production and Distribution*. Journal of Roman Archaeology Supplementary Series 69: 25-9. Portsmouth, Journal of Roman Archaeology.
- Grace, V. and Empereur, J. Y. 1981. Un group d'amphores ptolémaïque estampillées. *Bulletin de l'Institut français d'archéologie orientale* 81s: 409-26.
- Hickey, T. 2012. *Wine, Wealth, and the State in Late Antique Egypt: the House of Apion at Oxyrhynchus*. Ann Arbor, University of Michigan.
- Kruit, N. and Warp, K. 2000. Geographical jar names: towards a multi-disciplinary approach. *Archiv für Papyrusforschung* 46.1: 65-146.
- Jashemski, W. 1967. A Pompeian *vinarius*. *Classical Journal* 5.2: 193-204.
- Jashemski, W. 1979. *The Gardens of Pompeii, Herculaneum and the Villas Destroyed by Vesuvius*. New Rochelle, Caratzas Brothers.
- Joncheray, J. P. and Long, L. 2002. L'épave profonde Héliopolis 2 - Nord Levant (Var, -80 m). Une fouille d'épave à l'aide de plongeurs à saturation et d'un sous-marin d'observation. *Cahiers d'archéologie subaquatique* 14: 131-59.
- Lagi, A. 2015. Un *horreum* nel suburbia pompeiano. In C. Parisi Presicce and O. Rossini (eds), *Nutrire l'impero. Storie di alimentazione da Roma e Pompei*: 96-98. Rome, 'L'Erma' di Bretschneider.
- Maiuri, A. 1933. *La Casa del Menandro e il suo tesoro di argenteria*. Rome, Libreria dello Stato.
- Mayerson, P. 1992. The Gaza 'wine' jar (*Gaziton*) and the 'lost' Ashkelon jar (*Ashkalônion*). *Israel Exploration Journal* 42: 76-80.
- Nieto Prieto, J., Jover Armengol, A., Izquierdo Tugas, P., Puig Griessenberger, A. M., Alaminos Exposito, A., Martin Menendez, A., Pujol Hamelink, M., Palou Miquel, H. and Colomer Marti, S. 1989. *Excavacions arqueològiques subaquàtiques a Cala Culip I*, Centre

d'Investigations Arqueològiques de Girona, Sèrie Monogràfica 9, Girona, Centre
d'Investigations Arqueològiques de Girona.

Panella, C. 1974-75. Per uno studio delle anfore di Pompei: le forme VIII e X della tipologia di R. Schoene. *Studi Miscellanei* 22: 151-62.

Parker, A. J. 1992. *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*. British Archeological Reports International Series 580, Oxford, Tempus Reparatum.

Peña, J. T. 1999. *The Urban Economy during the Early Dominate: Pottery Evidence from the Palatine Hill*. British Archaeological Reports International Series 784, Oxford, Archaeopress.

Peña, J. T. 2007a. *Roman Pottery in the Archaeological Record*. Cambridge, Cambridge University.

Peña, J. T. 2007b. A reinterpretation of two groups of *tituli picti* from Pompeii and environs: Sicilian wine, not flour and hand-picked olives. *Journal of Roman Archaeology* 20: 233-54.

Peña, J. T. 2014. The Pompeii Artifact Life History Project: conceptual background and first season's results. *Rei cretariae romanae fautorum acta* 43: 297-304.

Peña, J. T. and Cheung, C. 2015. The Pompeii Artifact Life History Project: conceptual basis and results of first three seasons. In C. Gambardella (ed.), *Heritage and Technology. Mind, Knowledge Experience. Le Vie degli Mercanti XIII Forum Internazionale di Studi*. Fabbrica della conoscenza 56: 2115-23. Aversa, Dipartimento di Architettura e Disegno Industriale Luigi Vanvitelli.

Peña, J. T. and McCallum, M. 2009. The production and distribution of pottery at Pompeii: a review of the evidence. Part 2, the material basis for production and distribution. *American Journal of Archaeology* 113: 165-201.

Pesavento Mattioli, S., Mazzochin, S. and Pavoni, M. 2000. Anfore della Nave B. In S. Bruni (ed.), *Le navi antiche di Pisa: ad un anno dall'inizio delle ricerche*: 131-47. Florence, Polistampa.

Purpura, G. 2014. Il χειρέμβολον e il caso di Saufeio: responsabilità e documentazione nel trasporto marittimo romano *Annali del seminario giuridico dell'Università degli Studi di Palermo* 57: 129-52. Palermo, Università degli Studi di Palermo.

Rathbone, D. 1983. Italian wines in Roman Egypt. *Opus* 2: 81-98.

Rathbone, D. 1991. *Economic Rationalism and Rural Society in Third-Century AD Egypt*. Cambridge, Cambridge University.

Slane, K. 2004. Amphoras - used and reused - at Corinth. In J. Eiring and J. Lund (eds), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29, 2002*. Monographs of the Danish Institute at Athens 5: 361-9. Athens, Danish Institute at Athens.

Stefani, G. 2003. Produzione fittile: attività, consumi, commerci. In G. Stefani (ed.), *Menander: La Casa del Menandro di Pompei*: 210-33. Milan, Electa.

Terpstra, T. 2013. *Trading Communities in the Roman world: a Micro-Economic and Institutional Perspective*. Columbia Studies in the Classical Tradition 37, Leiden-Boston, Brill.

Thomas, M. 2015. Oplontis B: a center for the distribution and export of Vesuvian wine. *Journal of Roman Archaeology* 28: 403-11.

Thomas, R. 2011. Roman vessel stoppers. In D. Peacock and L. Blue (eds), *Myos Hormos – Quseir al-Qadim. Roman and Islamic Ports on the Red Sea. Volume 2: Finds from the Excavations 1999-2003*. British Archaeological Reports International Series 2286/University of Southampton Series in Archaeology 6: 11-34. Oxford, Archeopress.

Timby, J. 2004. Amphorae from excavations at Pompeii by the University of Reading. In J. Eiring and J. Lund (eds), *Transport Amphorae and Trade in the Eastern Mediterranean. Acts of the International Colloquium at the Danish Institute at Athens, September 26-29, 2002*. Monographs of the Danish Institute at Athens 5: 383-92. Athens, Danish Institute at Athens.

Toniolo, A. 2002-2003. Uso e commercio di oggetti da riutilizzare nel antichità. Un caso nordadriatico. *Archeologia veneta* 25-26: 109-48.

van Alfen, P. 1996. New light on the 7th-c. Yassi Ada shipwreck: capacities and standard sizes of LRA 1 amphoras. *Journal of Roman Archaeology* 9: 189-213.

van Alfen, P. 2015. The restudy of the LR 2 amphoras from the seventh-century Yassiada shipwreck: preliminary evidence for standardization. In D. Carlson, J. Leidwanger and S. Kampbell (eds), *Maritime Studies in the Wake of the Byzantine Shipwreck at Yassiada, Turkey*: 17-34. College Station, Texas A&M University.

van Doorninck Jr., F. 2015. The seventh- century Byzantine ship at Yassiada and her final voyage: present thoughts. In D. Carlson, J. Leidwanger and S. Kampbell (eds), *Maritime Studies in the Wake of the Byzantine Shipwreck at Yassiada, Turkey*: 205-16. College Station, Texas A&M University.

Vera., D. 2006. Un iscrizione sulle distribuzione pubbliche di vino a Roma (CIL VI, 1785 = 31931). In M. Silvestrini, T. Spagnuolo Vigorita and G. Volpe (eds), *Studi in onore di Francesco Grelle*. 303-17. Bari, Edipuglia.

Ward, C. 2015. Plant remains from the old wine jars on the Byzantine ship at Yassiada. In D. Carlson, J. Leidwanger and S. Kampbell (eds), *Maritime Studies in the Wake of the Byzantine Shipwreck at Yassiada, Turkey*: 55-62. College Station, Texas A&M University.

Figure 1: Upper part of Dressel 2-4 from the Casa del Menandro at Pompeii bearing three *tituli picti* (two visible) indicating that it was filled at least two times (Maiuri 1933 Figure 187).



Figure 2: Neck of Dressel 2-4 of non-Egyptian origin from Quseir al'Qadim with stopper made of plaster and potsherds of Egyptian origin. Left: photo of upper surface of stopper; center: view of stopper from underside showing sherds; right: profile drawing (Images courtesy of Ross Thomas).



Figure 3: Volumetric data and content information for the four sets of amphoras from the Grado shipwreck. The mean capacity figures presented in Column 2 (on which the figures presented in Columns 3-6 are based) are presumably rounded and approximate.

Class	Capacity Liters	Capacity modules	Capacity <i>sextarii</i>	Capacity <i>amphorae</i>	Capacity <i>modii</i>	Content
Grado 1	17	1	32	2/3	2	<i>liquamen</i>
Knossos 19	26	1.5	48	1	3	sardines
African 1	43	2.5	80	1 2/3	5	sardines
Tripolitanian 1	85	5	160	3 1/3	10	mackerel

Figure 4: Data for sets of African 2, Almagro 50, and Beltrán 72 amphoras from the Cabrera 3 shipwreck. * Same die/stamping entity as one of those attested for Almagro 50s.

Class	Number documented	Sub-classes	Fabrics	Number stamped	Number entities	Number dies
African 2	32	3	2	13	10-13	13
Almagro 50	19	1	1	17	2	3
Beltrán 72	7	1	1	3	1*	1*