

Rome in Spain, Spain in the Americas: Amphoras, Olive Jars & the Economics of Long-Distance Trade

Sean A. Kingsley

Wreck Watch Int., London, UK

Michael J. Decker

*Maroulis Professor of Byzantine History & Orthodox Religion,
Department of History, University of South Florida, Tampa, USA*

Ellen Gerth

Odyssey Marine Exploration, Tampa, Florida, USA

Andalusia's fertile landscape has been the source of two of history's best known storage jar traditions. Both the Roman Dressel 20 amphora and colonial Spanish olive jar originated along the banks of the River Guadalquivir Valley between Seville and Cordoba. These vessel forms are frequently identified as lineal descendants, which can be examined as microcosms of comparative exchange patterns and economics.

Analysis of respective contents, distribution and economic structures indicates that such a correlation is an historical misconception. The Dressel 20 amphora was a single-use container used exclusively to distribute olive oil in vast volumes to Rome and the military frontiers of Germany and Britain as a key part of imperial economic policy. The Roman emperors used the *annona civica* and *annona militaris* to provide free and subsidized foodstuffs to pacify the public and maintain military morale. Surplus produce re-circulated commercially on the open market.

Olive jars, by contrast, provided Spanish sailors and colonists across the Americas with familiar home comforts of oil, wine, vinegar and honey, amongst a wide range of other commodities. *Botijas* circulated within a commercial trade network embedded within the Crown's mercantilist policy geared towards exploitation largely of the industrial riches of the New World. They may be envisioned as purely commercial by-products, rather than engaged cogs, in Habsburg Spain's protectionist colonial ambitions.

© Odyssey Marine Exploration, 2014

1. Introduction

The discovery of 209 Spanish olive jars on the Tortugas shipwreck in the Straits of Florida, dated to 1622 (Figs. 1, 2), generated interest in interpreting their function as cargo or ship's stores and, ultimately, as expressions of colonial mercantilist policies (Kingsley *et al.*, 2014). The *botijas*' origins in the same Andalusian landscape that sustained a far earlier tradition of Roman amphora production permit comparative analyses of economic similarities and differences within separate world orders.

Just as the amphora was the ubiquitous shipping vessel of the Roman world, the clay olive jar or *botija* was omnipresent across Spain's colonial territories. Parallels are frequently drawn between the form and function of both traditions. Goggin's pioneering study of *botijas* (1960: 5) proposed that the form was "undoubtedly brought to Spain by Greek colonists, continued in use through Roman times, and persisted with various modifications to the present".



Fig. 1. Olive jars excavated from the Tortugas shipwreck (Type 1: back row and center front; Type 2: front row, sides).
Photo: © Odyssey Marine Exploration.

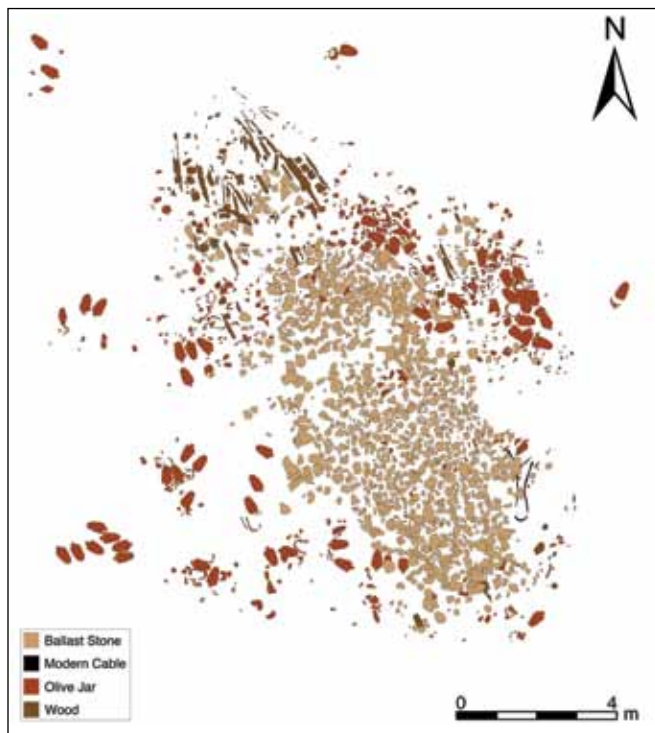


Fig. 2. Site plan of the Tortugas wreck showing the position of surface olive jars. The ship sank in the Straits of Florida en route from Havana to Spain in September 1622. Photo: © Odyssey Marine Exploration.

James (1988: 43) has suggested that the “amphora-like shape of the jars indicates that they are lineal descendants of a pottery tradition that originated in early eastern Mediterranean civilizations.”

To Marken (1994: 41) these “jars bear an unmistakable similarity to Greek and Roman amphorae common throughout the Mediterranean and are most likely direct lineal descendants.” After comparing the olive jar to Mediterranean amphoras dated between the Canaanite and Byzantine periods, Avery (1997: 86) concluded that “Regarding function, the post-medieval olive jar pattern appears to mirror the Roman pattern. As with the Roman amphoras, a laundry list of commodities were shipped in olive jars but the primary contents were wine and olive oil. Olive jars shapes were also associated with contents – elongate for wine, globular for olive oil.”

Both civilizations recycled amphoras and olive jars in the structural vaultings of large buildings (Lister and Lister, 1981). The lineal concept linking both storage vessel traditions continues post-medieval perception. The *Novísimo Diccionario de la Lengua Castellana*, published in Paris in 1878, misunderstood the Spanish word *arroba* to be a derivative of ‘amphora’ that referred to the weight and volume/storage unit used by ancient Greeks and Romans (Grivetti and Shapiro, 2009: 1780).

More specifically, since both the Dressel 20 Roman amphora and Spanish olive jar traditions emerged from Andalusian soils to become the definitive calling card of the respective civilization’s long-distance maritime exchange networks, similarities and differences in function, distribution and consumption may be used as a springboard to explore comparative underlying economic structures. How different were their economies, markets and mercantile philosophies? The following dialogue frames a debate about whether correlations between Rome and Spain are valid or unfounded. It is argued that in scale and political orientation the Roman Empire’s exploitation of Baetican olive oil in Dressel 20 amphoras was far more complex, extensive and politicized than under Colonial Spain.

2. Andalusian Production

The production of Dressel 20 amphoras and Spanish olive jars were restricted to the same catchment area of Andalusia. Whereas an enormous volume of Roman data have been obtained from over a century of field survey and excavation, almost no archaeological evidence exists for the *haciendas* and kilns where *botijas* were manufactured and filled. Despite both traditions’ geographic overlap, it must be concluded that production was dissimilarly structured.

The Dressel 20 amphora (Fig. 4) produced from at least the AD 40s until the AD 260s is one of the most distinctive expressions of Roman commerce (Carandini *et al.*, 1973: 622, 627, no. 16; Peacock and Williams, 1986: 136-40; Sciallano and Sibella, 1991; Dyczek, 2001: 93; Funari, 2005: 33). Manufacture can be tied unequivocally to southern Spain by direct archaeological evidence and wider epigraphical data. The type’s origins along the Guadalquivir Valley, ancient Baetis (Figs. 3, 5), have been known since 1889-1901, when G.E. Bonsor’s (1931: 2) river bank surveys recorded this container form associated with pottery kilns, stamps and agricultural installations, observing in the process that “Wherever there is abundant clay on the river banks, the remains of workshops are still found with the debris of the pottery covering the ground. Among these shards were found amphora handles marked with the name of the shop or *fundus* of the potter or owner.”

Stretching 680km from the river source in the Sierra de Segura down to Cadiz, the Guadalquivir Valley and its miocenic clays were perfect for wheat, wine, olive cultivation and, of course, the pottery industry (Funari, 1994: 88). Subsequent surveys and analyses have identified 94 Roman sites along the Guadalquivir Valley associated with oleiculture, characterized by the remains of olive presses, grinding stones, workshops and villas. Amphora kilns are associated with 56 sites (Étienne and Mayet, 2004: 43-9).

Very general calculations estimate that the 2,500km² rural territory between Corduba, Ecija and Seville may have contained 5 million olive trees in the Roman period, assuming 10% land use, or 12.5 million trees at 25% land use. The former percentage would have yielded 20,000 metric tons of olive oil a year, capable of satisfying the annual subsistence needs of a million people (Mattingly, 1998a: 38).

Pottery kilns such as at La Catria could have produced over 1,400 amphoras of 70-liter capacity over a five-month firing season. Considering that at least 50-75 sites operated multiple kilns, the region's total estimated 150-200 kilns possessed a hypothetical annual output of 200,000 to 300,000 amphoras in the mid-2nd century AD (Mattingly, 1988a: 41-2). Recent surveys and excavations along the Guadalquivir Valley have started to correlate Dressel 20 handle stamps to specific estates and kiln sites and have revealed the technology used by the potters, such as holding basins used for throwing (Bautista *et al.*, 2008: 149; Millet, 2008).

Some Dressel 20 amphoras immediately confirm their Spanish origins through the inscriptions they carried, with an example post-dating AD 197 from Monte Testaccio in Rome reading '*fisci rationis patrimonii provinciae Baeticae*' ('treasury of the imperial estates of Baetica') (Callender, 1965: 91, no. 245). Others specify the loci of production around Seville.

Juxtaposed alongside the abundant data for Roman Dressel 20 amphora production, the almost total absence of comparable archaeological information for the colonial Spanish olive jar is an unexplained anomaly. An Andalusian origin has long been assumed based on Seville's status as the homeport of the Americas fleets, which disseminated *botijas* en masse to its colonial territories (Goggin, 1960: 5). Fairbanks (1972: 144) pointed out that historical references to *botijas de vino* correlated to Aljarafe, Cadiz and Cazalla may reflect the geography of jar and product origins.

Attempts to determine the specific provenance of the *botija* over time have been compounded by the dearth of published data for Andalusia compared to an abundance of examples across the Americas. Olive jar sherds excavated from one kiln at *Calle Pureza* in Triana, Seville, and wasters found in church renovations within the same city, have confirmed logical theories of production in the city that was home to the Casa de Contratación economic powerhouse (Gutiérrez, 2000: 58-60).

The link between Seville and olive jar manufacture was only confirmed in the 1980s by petrological analysis. A considerable variety in coarseware fabrics suggests that a number of unidentified localities co-produced olive jars between Seville and the coast (Gutiérrez, 2000: 58-60).

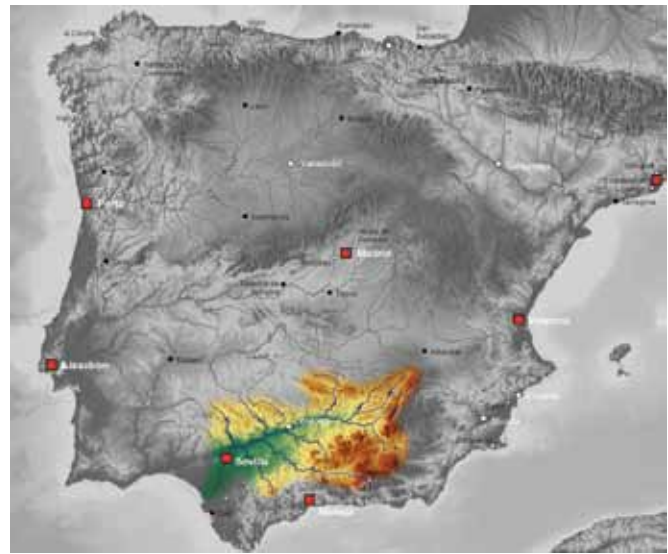


Fig. 3. The Guadalquivir Valley (highlighted) in southern Spain, the source of the olive oil and Dressel 20 amphoras in which it was packaged.

Hughes' (2014) Inductively-Coupled Plasma Spectrometry (ICPS) examination of the Tortugas shipwreck's olive jars confirmed their origins within a broad Andalusian orbit: the Type 1 olive jars (Middle Style A) derived from the Cordoba region, 121km northeast of Seville, while the Type 2 *botijas* (Middle Style B) exhibit the chemical signature of Seville clays.

Since the productive landscapes of Dressel 20 amphoras and Colonial-period olive jars overlap, but archaeological surveys have only yielded evidence for Roman agriculture and industry, both vessels are likely to have originated in different manufactory structures. It is tempting to suggest that while Dressel 20 amphoras were produced and packaged in rural estates, colonial olive jars were thrown and filled in more centralized urban contexts with wines and oils carted into town markets.

In line with Casa de Contratación regulations, ships sailing for the Americas were stocked with sufficient victuals for entire round journeys, including *botijas* and their contents. Peru, south-central Chile and western Argentina were exceptions to Seville's monopolization over production, where wine cultivation was permitted due to regional remoteness and high transport costs. The development of large-scale grape cultivation in the Moquegua Valley of southern Peru, where wine was distilled into brandy and transported by llama pack-trains to the silver-mining regions of Potosi and towns high in the Andes (Rice, 1996a: 797), is an important case study for examining comparative production due to excellent archaeological preservation.

The reconstructed evidence for *botija* manufacture in two main centers in south-central coastal and southern

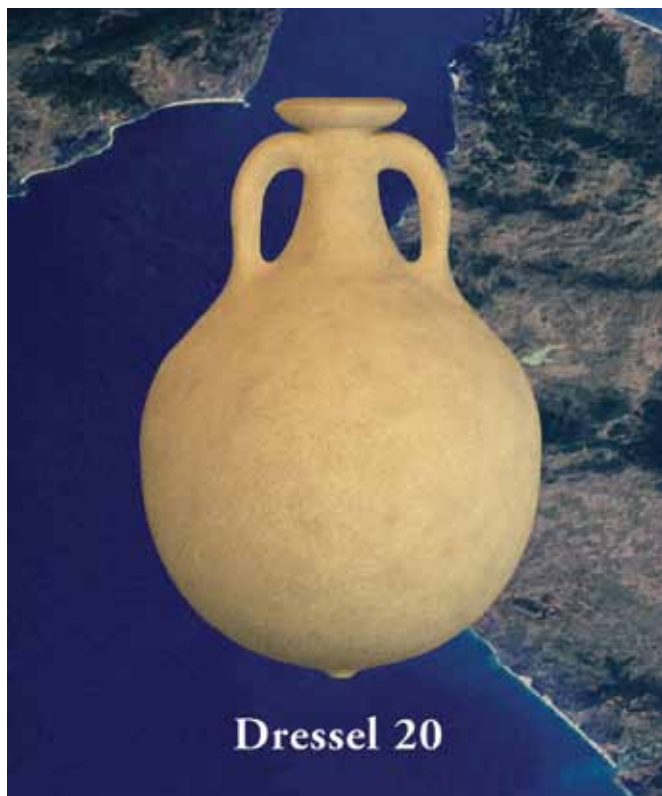


Fig. 4. Computer-generated 3D image of a Dressel 20 amphora. Photo: © Odyssey Marine Exploration.

coastal Peru serves as the optimum comparative data accessible to understand the structure of estate economies (Rice, 1994; 1996a; 1996b; 2011: 192-237). Colonial wine production began in Peru in the 1550s to alleviate chronic scarcities for religious and secular consumption. Despite ineffectual prohibitions from the Spanish crown and regional boom-and-bust cycles, vineyards and viticulture expanded and prospered between c. 1570 and the late 20th century.

Surveys conducted between 1985-90 identified 130 wine *hacienda* sites, averaging as little as 15-21 hectares, across the hillside margins of the Moquegua Valley. The well-preserved industrial landscape contains the remains of *lagar* tanks for crushing grapes, storage rooms holding *tinaja* earthenware jars for fermenting and storing wine, pottery kilns and wooden press screws and barrel fragments.

Production was nevertheless impressive. Late 16th-century archival documents suggest that 4,000 vines were cultivated per hectare. The owner of the large Cupina *hacienda* of 300 *fanegadas* (around 480 hectares) planted 50,000 vines and an additional 60,000 vines on a second property at a later date that would have taken up around 10% of the estate, leaving the rest of the land cultivated by wheat, maize and alfalfa. Such estates owned by absentee landlords were worked by native Andean and African slaves.

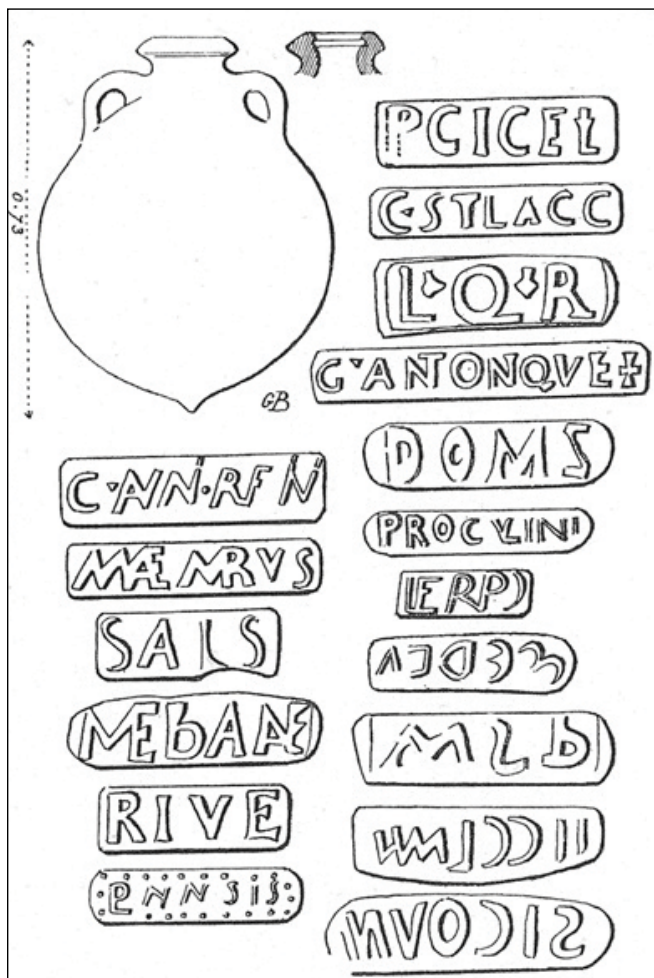


Fig. 5. A Dressel 20 amphora and makers' stamps from broken jars found during G.E. Bonsor's survey along the Guadalquivir River, Spain, in 1889-1901 (from Bonsor, 1931: plate XL).

Wine was fermented and stored in *tinajas* of around 350-400-liter capacity in the late 16th century. Inscriptions painted onto clay vessel shoulders prior to firing identify dates, saints' names, crosses, other numbers, words and phrases particularly religious in nature. Some seem to relate to saints' feast days to which the contents were dedicated. Rather than relying on imported Andalusian *botijas* for transport, examples of 24.5 liters, some bearing maker's marks, were manufactured locally within the wineries. Around 26 round, updraft kilns built of unfired adobe bricks have been identified. Local tax records and analyses of *hacienda* production facilities suggest that the Moquegua Valley could have produced seven million liters of wine annually at the height of the 18th-century brandy boom – far more than would have been required for the estimated 8,000 inhabitants of the town (Rice, 1994: 326-27; 1996a; 1996b: 188; 2011: 192-237). Chemical analyses demonstrate that these Peruvian products penetrated as

far as the Solomon Islands in the late 16th century (Kelloway *et al.*, 2014). Even by Roman standards, such cultivation, management and trade are highly impressive.

3. Vessel Contents

The nature of the contents of Dressel 20 amphoras and Spanish *botijas* were fundamentally different. Whereas the Roman jar was conceived exclusively to hold olive oil, the colonial counterpart was a far more flexible storage vessel. Beneath a most common content tier of wine, olive oil and vinegar, *botijas* could contain myriad dry and liquid foodstuffs from almonds and hazelnuts to raisins, honey, liqueur, capers, figs, rice, brine, fish, lard, as well as turpentine, gunpowder and pitch (Lister and Lister, 1987: 128; Pleguezuelo-Hernandez, 1993: 48).

In the Roman period Andalusia produced numerous different styles of amphoras that were similar multi-content containers, bearing in mind that the dominant local products were olive oil and numerous varieties of fish sauce. Garum-related products were typically stored for export in Dressel 7-12 containers manufactured in the Iberian Peninsula in kiln sites identified at Algeciras, Almeria, Cadiz, Cerro de los Mártires, Granada, Malaga, Paso A Nivel, Puerto Real and Villanueva, where production began in the late 1st century BC (Peacock, 1974: 236, 239, 241; Peacock and Williams, 1986: 117-9; Carreras Monfort, 2000: 422; Trakadas, 2004: 7-8).

Unlike Dressel 20 vessels, the content of Dressel 7-12 forms was more flexible. While Dressel 12 containers from the Titan wreck off southern France contained the scales, bones and even heads and tails of tunny, as well as shellfish, other Spanish amphoras contained almonds (Tailliez, 1965: 76, 82-3; Tchernia, 1969: 496-99; Parker, 1992: 424-5, 432). Some Dressel 9 vessels from the Sud-Perduto B wreck of *c.* AD 1-15 off southern France held grape pips indicative of a wine content (Parker, 1992: 415-16). Haltern 70 amphoras produced in the Guadalquivir Valley and Algeciras either contained *defrutum* (boiled wine) or olives preserved in *defrutum* (Haley, 2003: 42).

Production crossed the Straits of Gibraltar to Thamuisida, modern Sidi Ali ben Ahmed, in Morocco (Teichner and Pujol, 2008: 306). Inspired by the heavily traversed sealanes converging on southern France for transshipment to the military frontiers of the Lower Danube and east to Rome, between the Augustan period and the 2nd century AD the kilns of Lyon imitated the Dressel 10 form (Type 3A and 3B in Armand and Dangréaux, 1997: 74, fig. 22). Dressel 10 amphoras are associated with fish-based products. Dressel 20 amphoras, however, were uniquely dedicated to olive oil.

4. Distribution & Consumption

Dressel 20 amphoras and colonial olive jars alike were shipped en masse to overseas territories. Geographic distribution and consumption contexts differed markedly. The strong maritime function of the *botija* is evident from dominant coastal deposition around southern Spain. No wrecks containing olive jar cargos are reported from Andalusia or the Western Mediterranean, an index of the unlikelihood of an outward-bound ship choosing an inopportune weather window to embark that might cause an immediate sinking.

Olive jars such as the assemblage associated with the Tortugas wreck were relied on to feed crews and passengers using containers that were more readily accessible than the sealed wooden barrels favored for bulk commercial transport. The geographic penetration of 16th- and 17th-century *botijas* was far greater than for Roman Dressel 20 amphoras, although the respective vessel traditions possessed different exchange structures. In one economic pattern that may be termed the ‘Colonial Spine’, olive jars penetrated every settlement and outpost under Spanish control – irrespective of function – across the Americas. They are strongly attested on the earliest settlements, from the smallest frontier oyster ranches of Margarita in northeast Venezuela to the major urbanized centers of Havana and St. Augustine in Florida (Willis, 1976: 123-24; King, 1984: 78-9). Spanish missionaries, monasteries and cathedrals used Andalusian olive jars from Florida to Guatemala (Deagan, 1972: 34-5; Weisman, 1993: 164; Carruthers, 2003). At the furthest extremes of colonial power, *botijas* were shipped as far as Nagasaki in Japan (Kawaguchi, 2011).

In a second ‘Commercial Spine’, Middle and Late Style olive jars were traded in purely financial transactions outside Spanish environments across northwest Europe to England, Ireland, the Low Countries, and even Scandinavia and Poland (Hurst, 1995: 46; Dąbal, 2010). Examples have been recorded on the wrecks of ships owned by varied European nationalities from the English *Sea Venture* lost off Bermuda in 1609 (Wingood, 1982: 341) to the Danish merchant ship the *Sainte Dorothea* sunk off southern France in 1693 (L’Hour, 1993: 310-13), and a Baltic trader wrecked off the island of Jutholmen, Sweden, *c.* 1700 (Ingelman-Sundberg, 1976: 61, fig. 6). *Botijas* purchased in England were shipped in significant volumes to English colonies in Virginia (Hume and Hume, 2001: 329, fig. 33.4). Thus, the Virginia Company Records of June 1623 described how Robert Bennett acknowledged the arrival of “750 jarse of oylle” from Spain (Kingsbury, 1935: 220). Nine olive jars recorded in Fermeuse Harbour, Newfoundland, which were probably tied to the triangular trade in English ships

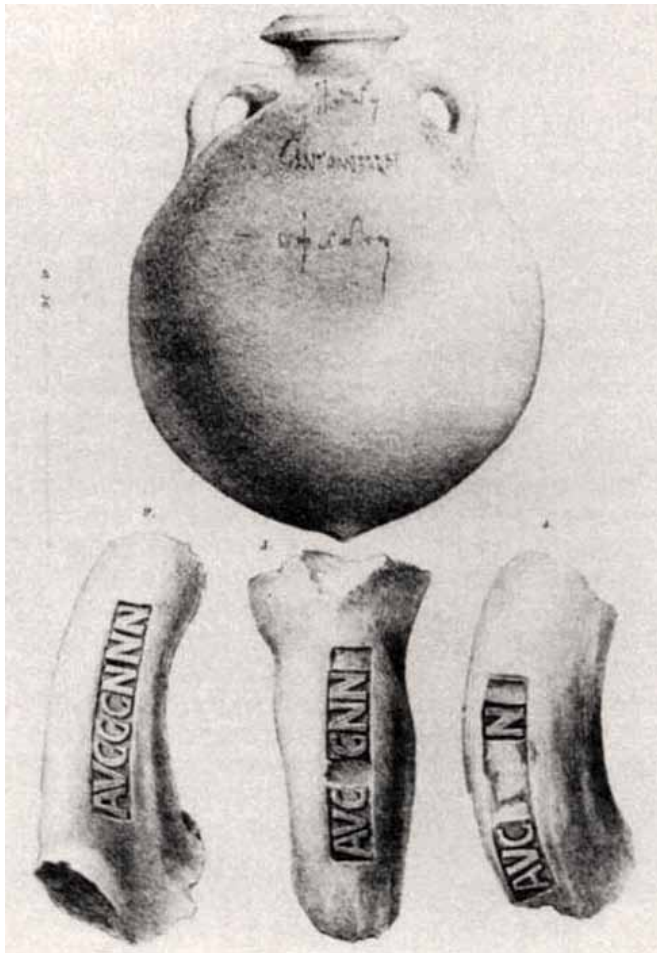


Fig. 6. Roman tituli picti on a Dressel 20 amphora from Monte Testaccio, Rome, above potter's maker's stamps. From H. Dressel, *Ricerche sul Monte Testaccio* (1878), pl. L.

between Newfoundland, Spain, and Bideford and Barnstaple in North Devon, England (Carter, 1982), are the most northerly deposits related to this Commercial Spine.

The distribution of Baetican Dressel 20 amphoras, by contrast, was narrower. Minor quantities reached Athens, Corinth, Antioch in Syria, Alexandria in Egypt and Berenice in Libya as semi-luxury commodities (Riley, 1979: 162; Dyczek, 2001: 96). Closer to home the form circulated across the Western Mediterranean in huge volumes, evident from the 56 Dressel 20 wrecks recorded off Spain, southern France and Italy (Figs. 8-9). Losses peaked at 29 wrecks between the reigns of Claudius and the Flavian dynasty (tabulated from Parker, 1992 and Étienne and Mayet, 2004: 237).

Consignments were predominantly composite in nature, including a variety of commercial produce transported in merchant vessels of varying magnitudes. Cargo sizes ranged from small ships to supertankers, such as a 25 x 12m site of c. AD 60-85 off Chiessi, Italy, which



Fig. 7. The Roman amphora rubbish dump of Monte Testaccio, Rome, due east of the River Tiber.

contained what was described as a “cathedral” of 5,000-7,000 amphoras, mainly Beltrán 2A amphoras alongside lesser quantities of Beltrán 2B, Dressel 20 and Haltern 70. Other cargos were far more eclectic. The 100,000 artifacts within the 8.25 metric ton cargo of c. AD 70-80 recovered from the 9-10m x 3m Culip D wreck off Spain included at least 76 Dressel 20 amphoras alongside a large consignment of 1,500 Baetican fineware cups and beakers, at least 42 lamps manufactured in Rome, 2,000 plain wares and over 750 decorated *terra sigillata* wares from the kilns of La Graufesenque in southern Gaul. This cosmopolitan cargo included products from Baetica, Latium and Gallia Narbonensis and was seemingly assembled in the entrepôt of Narbonne in France. The St. Gervais C wreck of AD 149-154, sunk off southern France with a main cargo of Beltrán 2B storage jars and Dressel 20 amphoras, all bore painted inscriptions that confirmed the ship's olive oil was processed at Astigi, modern Écija, along the River Genil at Seville (Parker, 1992: 81, 103, 140, 157, 373-4).

Dressel 20 amphoras were closed with terracotta stoppers (Capo Graziano C, Italy, c. AD 1-10) and sealed with *pozzolana* mortar (Villepey, southern France, c. AD 110-160). Vessels could be cushioned in ships' holds from breakage by bundles of heather (Port-Vendres B, southern France, c. AD 42-48) or brushwood dunnage, including *Erica scoparia* (Chiessi, Italy, c. AD 60-85). The Dressel 20 amphoras on a vessel wrecked near Lucentum, Alicante, in AD 50-80 were packed between vine shoots and straw (Izquierdo *et al.*, 2007: 231).

Foodstuffs and finewares accounted for just one conspicuous component of the mixed nature of Roman Spain's commercial exports, in which metal shipments were an equally vital component of cargos stowed alongside Dressel 20 amphoras. Copper and lead ingots were shipped on the Lavezzi A wreck of c. AD 25-50 off southern France. Some 11 copper ingots were recorded on a Dressel 20

wreck located near Lucentum, Alicante, lost in AD 50-80 (Izquierdo *et al.*, 2007: 237). About 50 truncated lead ingots counter-stamped 'IMP. CAES' and 'VESPAVG' from the Ses Salines site of AD 70-80 off Majorca are powerful indications of imperial control over Spain's mines and Baetica's metallic maritime commerce. The 23.8m-long Sud-Lavezzi B wreck of AD 10-30 off southern France exemplifies the intimate relationship between Dressel 20 amphoras and metallic cargos: Haltern 70, Dressel 7-11 and Dressel 20 amphora bases were set between 95 lead ingots, each weighing 51-54kg, arranged in 11 rows and mold marked 'MINVCIORVM'. The hull held 237 copper ingots, each of 20kg, stacked in piles fore and aft of the lead (Parker, 1992: 238-9, 378-9, 414-5).

One major rationale underlying Dressel 20 exports was purely commercial, typified by examples from Pompeii, which represent 16% of all the town's combined wine, oil and fish-sauce amphoras *c.* AD 1-50 and 22% *c.* AD 50-79 (De Sena and Ikäheimo, 2003: 307, 309). Of all the wine, oil and fish-sauce amphoras quantified in a Flavian deposit at Lyon in France, Dressel 20 comprised 100% of the oil containers, compared to 11 forms of wine amphoras and three for fish products (Dangréaux and Desbat, 1987-88: 114, 117).

The greatest gravitational pull linked Spain with Rome, Britain and Germany. Studies of amphora stamps from Britannia, Gallia and Germania have revealed at least two supply routes to these provinces via the Atlantic and the Rhône valley (Carreras Monfort, 1998: 163). The lighthouse at Corunna is believed to have been built to deliberately guide ships carrying Spanish oil towards Britain and Germany's legions via the Atlantic maritime route (Naviero, 1986: 42). Dressel 20 amphoras are especially conspicuous in Britain and Germany, where Baetican oil was imported in spectacular volumes. Overall, the type accounts for an estimated 60-70% of all storage jars imported into Britain during the Principate (Carreras Monfort, 1998: 160, 163), while at the Roman garrison town of Colonia Ulpia Traiana (Xanten) in Germany they formed 76% of sherds from Insula 39 (Carreras Monfort, 2006: 32, 37).

5. The Political Economy

If the export of Spanish olive jars was conditioned by commercial and colonial currents, the most conspicuous exchange structure for the Dressel 20 amphora was within the Roman political economy. This transport jar type was a major tool in pacifying the population of Rome and the army in far-flung lands, a sensitive issue micro-managed by obsessive administration and through trackable stamps and painted notations.

The prominence and rich variety of 2,000 stamps associated with Dressel 20 type jars, at least 700 of which provide data on production centers and consular dates (Dyczek, 2001: 96), are unparalleled on any other amphora type from classical antiquity. The same is true for this amphora class's painted inscriptions (Funari, 2005: 33).

Stamps present on handles or upper shoulders and necks often bear the names of the potteries that produced the amphora, although the interpretation of many marks remains uncertain (Rodríguez, 1998: 190). The prevailing view is that they comprise the *tria nomina* of oil-producing landowners, many of whom derived from prominent Roman families, including the imperial line of the emperors Trajan and Hadrian (Haley, 2003: 136ff). The most complex information painted in *tituli picti* noted the weight of amphora contents, providing an initial representing a record of the fiscal district from where the amphora was exported, a consular date, name of *ponderator* or *acceptor* and the name of the producing amphora workshop or kiln (Rodríguez, 1998: 190, 192).

Secondary inscriptions, written in cursive script below the handles to the right of and at right angles to the capital inscription, defined the strict and compulsive control imposed on production and export. The first line usually stated that the amphora had been registered for the payment of dues at a Customs and Excise office located in Hispalis, Astigi or Corduba and sometimes included the phrase '*ad Port(um)*', indicating receipt at a municipal warehouse. The first line repeated the mathematical calculations of the capital inscription, thus verifying that the full weight of the vessel and its contents had been checked and confirmed. The second line commonly cited the estate or locality of the olive oil manufactory, while the third confirmed the personal name in the genitive case of the producers, who were sometimes freedmen, slaves or women (Callender, 1965: 21; Haley, 2003: 87-8).

These detailed notations served as high-level administrative imperial control. The largest deposit of Dressel 20 amphoras known from the Roman Empire are perhaps unexpectedly not a shipwrecked cargo, but are located on dry land at Monte Testaccio in Rome (Figs. 6-7). The 50m-high purely artificial 'Sherd Mountain' adjoining the River Tiber is a colossal Roman rubbish dump – the largest known from the ancient world. The hill covers more than 1km in circumference and contains approximately 550,000 cubic meters of amphora sherds, or 24,750,000 broken amphoras. Of these, Dressel 20 olive oil vessels manufactured along the Guadalquivir Valley comprise at least 80% of the total imported and discarded between the Julio-Claudian and Severan eras, *c.* AD 1-235 (Carreras Monfort, 1998: 160).

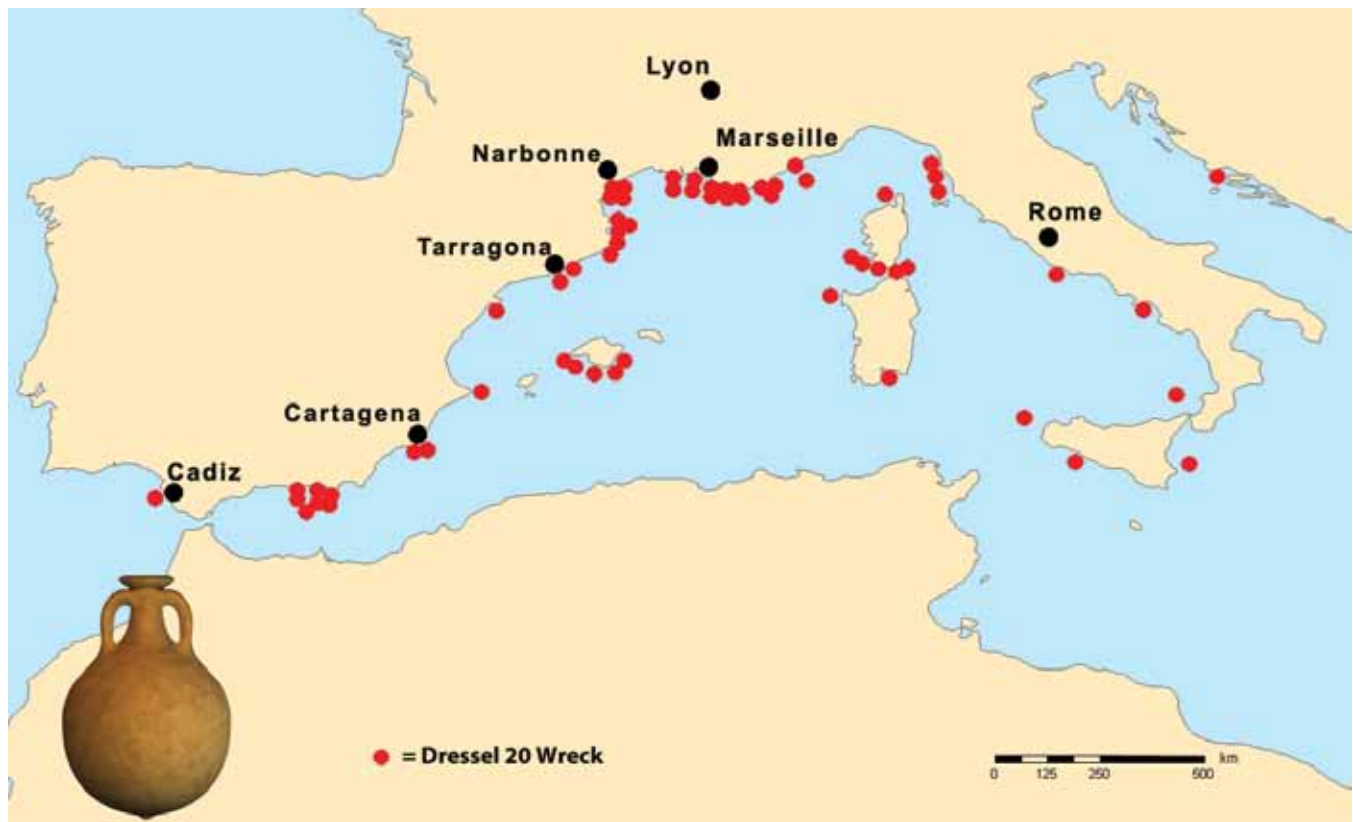


Fig. 8. Distribution map of Dressel 20 amphora shipwreck cargos in the Mediterranean Sea and Atlantic Ocean (tabulated after Étienne and Mayet, 2004: fig. 60). Map: Odyssey Marine Exploration.

Between the reigns of the emperors Augustus and Galienus, these amphoras were ferried en masse up the Tiber from the port of Ostia for temporary storage and processing in riverside *horrea* (warehouses). In total, Testaccio's amphoras once contained about 1,732,500,000kg of olive oil, the equivalent of a staggering seven million kilograms deposited annually. Based on an estimate of 1kg of olive oil consumed per person per month, Dressel 20 imports to Rome could have sustained one million inhabitants for seven months each year (Rodríguez, 1998: 193, 197). For the period covering the Augustan period up to AD 146, some 385,000 cubic meters of Dressel 20 amphoras were discarded on Monte Testaccio, weighing 885,500 tons and capable of storing 24,714,000 liters of Baetican olive oil (Étienne and Mayet, 2004: 34).

Such large-scale production and compulsive control over distribution is unparalleled in the classical world, and the Dressel 20 amphora is most commonly perceived to be a more sophisticated economic tool than solely a container for commercial produce sold on the open market. It is a symbol of the wheels of imperial politics in action. The emperor Augustus's powerbase hinged on the allegiance of the army and support of the plebs, whose combined loyalty was assured by free, discounted and price-regulated

distributions of basic foodstuffs (Rodríguez, 1998: 198) – a potent strategy to prevent civil unrest and imperial unpopularity. In a world where land was the primary expression of wealth, Rome encouraged the provinces to pay their stipendium taxes at least partly in kind. Some of this 'natural tax' was used to feed Rome, while the State sold surpluses for profit.

Rome was a gargantuan consumer that outstripped its hinterland's agricultural capacity: an estimated 150 million tons of grain, 167 million liters of wine, 20 million liters of olive oil and 22 million liters of fish-sauce were imported into the Eternal City each year, figures which dwarf the consumer realities of Colonial Spain. While the hinterland supported 4.7 million liters of the oil and wine consumed annually in the capital between AD 100 and 150, a hypothesized further 3.2 million liters had to be procured from Africa Proconsularis, 300,000 liters from Tripolitania, but by far the greatest quantity, 11.8 million liters, from Baetica (De Sena, 2005: 2, 9). Monte Testaccio stands as a towering physical manifestation of the Roman emperors' political control of the Baetican olive oil industry.

In a second major functional role, Dressel 20 amphoras are a similar index of the appeasement of the far-flung Roman army, which hankered after home comforts. In an



Fig. 9. A cargo of Dressel 20 amphoras in situ on a deep-sea shipwreck in the Western Mediterranean. Photo: Odyssey Marine Exploration.

army estimated at consisting of around 150,000 soldiers in the later 1st century AD, each legion of 6,000 men would have required an estimated 1,370 amphoras a year or 288,000lbs of oil per annum (Blázquez, 1992: 176). Baetican Dressel 20 vessels occur in northern and western Britain in volumes that exceed those registered close to the production nodes in northern Spain (Funari, 1996). Both Wales and the region around Hadrian's Wall were centers of military contingents from the early stages of conquest and were transformed into extensive consumers of Baetican olive oil.

Dressel 20 amphoras followed the oscillating routes of the army. For the Julio-Claudian period, Baetican stamps cluster in southeastern sites, such as Colchester, Richborough and London, where the army was preoccupied with peacekeeping. Under the Flavian emperors, Dressel 20 was concentrated at Richborough, the headquarters of the *Classis Britannicae* naval fleet, while an even higher density of stamps has been recorded in Wales, Lincolnshire, Lancaster and Yorkshire at the time of the campaign of the emperor Agricola. In the early 2nd century, Dressel 20 stamps are known predominantly from Hadrian's Wall and later along the Antonine Wall. This pattern of olive oil amphora consumption in military contexts is unique in Britain, where numerous other amphora types appear in civilian sites. The British evidence, based on 1,800 Dressel 20 amphora stamps, is considered confirmation of the existence of distinctive military distribution, the *annona militaris*, that reinforces the image of a non-commercial redistributive system geared towards the supply of bulk olive oil to the western Roman frontier (Carreras Monfort, 1998: 161-62).

Archaeological data point towards a similar pattern for the high concentration of Dressel 20 amphoras on military sites in Germania, which entered the Roman orbit just after the pacification of Hispania and remained a military zone until the age of Domitian. The principal importers of Baetican olive oil in Dressel 20 amphoras were the military camps in and around the town of Cologne, where shipments peaked between AD 141 and 161 (Blázquez, 1992: 174). As in Roman Britain, Baetican Dressel 20 olive oil amphoras represent more than 90% of all amphoric epigraphy known in Germany. In the single year AD 125, the five Rhine legions used an estimated 6,850 Dressel 20 amphoras or up to 520,000 liters of imported oil (Blázquez, 1992: 176).

6. Conclusion

The similarities commonly drawn between the Spanish colonial olive jar and Roman Dressel 20 amphora are an overstated historical presumption forged by the return to a clay storage tradition in early 16th-century Andalusia and by the *botijas'* strong visibility in the archaeological record of the Americas, indicative of large-scale long-distance maritime transport. The Latin word amphora derives from the Greek *amphiphoreus*, a compound word that combined *amphi* ('on both sides') and *phoreus* ('carrier'). Morphologically the absence of two handles on olive jars immediately distances them from the amphora tradition.

Not only are the two vessel forms functionally different, they circulated in radically different world orders. Dressel 20 amphoras were designed to contain olive oil, whose processing on estates was stimulated and tightly controlled by imperial decree. Metrologies seem to have been carefully standardized within any single shipment (Port Vendres 2 wreck: H. 72cm, weights 28-30kg, capacities 65-70kg; Colls *et al.*, 1977: 23). A constant stream of taxable product assumes surplus production, and a significant percentage of Baetican olive oil was traded on the open market. The vast scale of production, however, was linked to the political currents of the army and populace of Rome through the *annona civica* and *annona militaris*. Colossal volumes of oil were shipped to the Eternal City and military frontiers through redistribution entrepôts and non-commercial exchange networks. Dressel 20 was a single-use vessel, wastefully crushed after being emptied.

The Spanish *botija* of the 16th and 17th centuries, by contrast, contained a wide array of products. A major stimulus for their production was to store staple foodstuffs required by ships' crews sailing to the Americas, ultimately for purposes of resource exploitation and to collect goods subject to royal *quinto* taxation to keep the Crown afloat. Olive jars were sold commercially in significant numbers



Fig. 10. Dressel 20 amphoras (top right) depicted on a 2nd-century AD wall relief of a shop in the Roman port of Ostia. Photo: © Bridgeman Art Library.

and continued to be reused time after time, as exemplified by the Tortugas shipwreck assemblage and thus explaining their wide capacity differentiations from 14.2-26.9 liters for Type 1 and 2.8-8.1 liters for Type 2 (Kingsley *et al.*, 2014: 5-6, 32). Production and sale never came close to attaining the scale of the Roman Empire.

Rome was a colossal united empire with great cities, relatively peaceful seas smoothed over by the *pax romana* that left Rome as the sole hegemon of the greater Mediterranean world (Bang, 2007: 47), massive commercial needs and a nascent middle class. Guestimating population numbers is notoriously problematic within the limits of the ancient evidence for measurements of mortality, fertility and migration, which determine the age structure of a population (Scheidel, 2001: 13). The tendency to specify Spanish populations according to *vecinos* (numbers of heads of households), without defining numbers of dependents per household unit, creates a methodological black hole for 16th- and 17th-century Spain. Contemporaries usually multiplied the number of *vecinos* by five people to estimate the average household size, a figure that included the nuclear family, dependents and servants (Markman,

1984: 10; McAlister, 1984: 116), although six people per household is typically applied to the Americas (Sánchez-Albornoz, 1986: 18).

Bearing these methodological issues in mind, Rome was inhabited by up to one million people, and Italy by at least 2,325,000 people. On average in Italy the major ports held 60,000 people, regional centers like Capua 30,000 people, a further 15,000 people dwelt in about 25 major cities, and around 2,000 people in 400 minor cities (Morley, 2011: 144). Scheidel (2001: 53) estimates the total population of Roman Italy under Augustus at as high as four to five million. The entire population of the Eastern and Western Roman Empire ranged from a minimum of 55-60 million to a high count of around 75 million (Wilson, 2011a: 192-93). Roman Egypt alone contained a staggering 7.5 million inhabitants (Bowman, 2011: 341). The army accounted for up to 400,000 conscripts at any one time (Lo Cascio, 2007: 633). Sources do not specify numbers of slaves in communities, let alone for the Empire as a whole, although census figures for Egypt indicate that they represented close to 15% of urban residents and 8% of villagers (Scheidel, 2012: 91).

Seville in its heyday of 1588, by contrast, possessed 25,986 *vecinos* in 29 parishes (Pike, 1972: 12), or the equivalent of 129,930 people – 13% the size of Rome. The population of Spain's united monarchy amounted to about 8.5 million in the 1590s (Payne, 1973: 267) – 15.4% of the lower estimate for the Roman Empire. A total of 300,000 Spaniards are estimated to have left the Iberian Peninsula for the New World between 1492 and 1600 (Kent, 2006: 87). The average annual number of people leaving Spain for the Americas in the 16th century was 2,600 and 3,900 in the first half of the 17th century (Sánchez-Albornoz, 1986: 15).

For the wider colonies, Juan López de Valasco wrote in his *Geografía y descripción de las Indias* of 1574 that 225 Spanish cities and towns existed in America, which contained 25,000 *vecinos* or legal residents, who on average supported six dependents in each household. Fifty years later the Carmelite monk Antonio Vázquez de Espinosa recorded the presence of a minimum of 75,000 *vecinos* in his *Compendio y descripción de las Indias occidentales* of c. 1628 (Sánchez-Albornoz, 1974: 69; 1986: 18). These figures equate to populations of 150,000 Spaniards living in the Americas in 1574 and 450,000 in 1628, which in the simplest of terms represent a mere 0.3-0.8% of the total population of the Roman Empire or 2-6% the population of the province of Roman Egypt alone.

Whereas Rome absorbed new citizens under the 'friendly client king' model (Braund, 1984), Spain treated indigenous populations as expendable cheap labor.

The pre-conquest population of central Mexico, for instance, fell from 25 million in 1519 to 2.65 million in 1568, Peru's population similarly dropped from 9 million in 1532 to 1.3 million by 1570, Colombia's native population shrank by a quarter in the first three decades after the conquest, and only a few hundred indigenous Indians survived on Hispaniola by 1570 (Elliott, 1986: 202; Sánchez-Albornoz, 1986: 5). Spain may have envisioned itself as drawing on the Roman ideal of the municipality, *civitas*, as an instrument for civilizing rural peoples within a Universal City of Mankind, combined with the Augustinian notion of a perfect Christian City of God (Morse, 1986: 70), but this Iberian perception was a myth. The driving force of 'God, gold and glory' underlying the Spanish conquest was a very different strategy (Menzel, 2004: 2).

Turning to the maritime realm, the port infrastructure of Roman Ostia was monumental compared to the primary colonial Spanish Main ports of Cartagena and Havana (Fig. 10). In 1574 Cartagena possessed 250 *vecinos*, while Havana was far larger at 500-800 *vecinos* in 1608-1610 (Hoffman, 1980: 263; de la Fuente, 2008: 107), which suggests a rough combined population of 11,250 people. This represents 18% of the 60,000 who lived in Ostia or 32% combined for the lowest estimate of 35,000 for the population of the port of Caesarea Maritima in Roman Palestine, which in reality may have reached as high as 100,000 inhabitants (Patrich, 2011: 94). With its artificial basins and breakwaters, dry docks, warehouses, temples and recreational delights, high-end ports like Ostia and Caesarea were technological and urban colossi, the epitome of the extraordinary monumental port infrastructure through which Rome maintained *mare nostrum* (Houston, 1988).

By comparison Havana and Cartagena were typical post-medieval ports founded around natural bays. Whereas working and living in Ostia was a lifestyle choice that sustained broad-based livelihoods and entertainment extravaganzas, "Havana's grandeur was not to be displayed in the magnificence of its temples but in the weight of its ordnance, the size of its garrison, and the capacity of its shipyards" (de la Fuente, 2008: 108). The principal port of call for the Americas fleet did not even possess potable water, but in Roman style relied on the *zanja* aqueduct.

The approximately 730 shipwrecks recorded across the Roman provinces dating from 100 BC to AD 200 (cf. Wilson, 2011b: 35, fig. 2.3) add substance to the image of gargantuan consumer demands in a world where hinterlands were frequently incapable of meeting the agricultural needs of urban cores. The far fewer 70 suspected Spanish wrecks dating between 1500 and 1700 (Vieira de Castro, 2008: 9-14) are largely indices of the colonial hunger for imperial wealth.

Arguably more importantly for economic sustainability, Rome encouraged agriculture and industry, while Spain mined colonial territories into exhaustion. The Roman army established potteries, when not at war, turning out construction materials (pipes and roof tiles) and both fine and coarsewares (Twentieth Legion in Chester and the *Classis Britannica*, England: De la Bédoyère, 2004: 10-11, 62; Tenth Legion in Jerusalem: Arubas and Goldfus, 2006), which stimulated local provincial demand and transformed cultural tastes towards the Roman ideal. Coin mints established across the Empire from Rome to London, Alexandria and Antioch-on-the-Orontes fostered commercial expansion, surplus production and, ultimately, streams of taxes to fill the imperial coffers.

Colonial Spain centralized its Americas' coin production in seven mints between 1536 and 1622 (Cartagena, Lima, Mexico, Panama, Potosi, Sante Fe de Bogata, Santo Domingo), of which the output of Mexico and Potosi was by far the largest (Menzel, 2004). All were controlled through an iron fist Crown policy. Bullion and coinage were largely shipped backed to Spain for use in European commercial and military arenas after the Crown siphoned off its 20% *quinto* tax and 1.0-1.5% assay charge. The 11.4 million kilograms of registered bullion imported into Spain between 1581 and 1630 increased silver circulation in Europe by some 300% and gold by about 20% (Payne, 1973: 274, 281).

Ultimately this contributed little to the growth of the colonies, which were the nuclei of artificial economies where the indigenous populations were either enslaved or driven off the most fertile lands (Sánchez-Albornoz, 1974: 57). "At the center of every cultural clash", argue Breen and Hall (2004: 50), "was a struggle to preserve, augment, or acquire access to such resources as land, game, and trade goods." Spain's dominance rested on precious metals extracted from New World sources: gold and silver from Mexico and Peru represented as much as 20% of the total Spanish crown revenue in 1598 (Vassberg, 1984: 219). Rome's success, by contrast, was firmly rooted in the values of and profits secured from working the fields.

In the final analysis, Andalusian olive jars were shipped en masse to the Americas because Spaniards wanted to eat in their customary manner with olive oil and red wine accompanying bread and fresh lamb. Spain strove to Europeanize the New World landscape even though prices were high: imported wine "cost the very eyes on your face", wrote the governor of Florida, Pedro Menéndez, to King San Agustín in 1578, which did not prevent an average of 100,000 *arrobos* of wine (around 6,200 *botijas*) being exported to the Indies each year between 1592 and 1600. Whereas the Roman experience was entrepreneurial – *ubi bene ibi patria*,

“home is wherever one is happy” – for most Spaniards travel away from home was a deeply unpleasant experience (Earle, 2012: 55, 62, 68, 72).

Both civilizations naturally experienced an inevitable fall. Rome lost its rich breadbasket of Tunisia and was overrun by barbarian hordes in the early 5th century. In the late 16th century, Colonial Spain ended up consumed by doom and despair as crops failed across Castile, taxes escalated to devastating levels, and virulent epidemics swept the land (Vassberg, 1984: 22).

Peering back in time at both empires provides equal snapshots of the good, the bad and the ugly. Both were perpetuated by rampant inequality and entitlement. Life expectations at birth in the Roman Empire ranged from 20-30 years, peaking at approximately 32 years amongst the upper classes of early 3rd-century AD southern Italy (Duncan-Jones, 1990: 103). A life expectancy of 33 years under Colonial Spain was equally grim by modern standards (Drelichman and Voth, 2007: 41).

Certainly Diego Velazquez's still life masterpieces are far more celebrated today than Pompeii's wall paintings, and Miguel de Cervantes's *Don Quixote* of 1605 has left a deeper literary legacy than Juvenal's *Satires*. But how much of society enjoyed these works? Although literacy rates could be as high as 30-40% in European cities (Lis and Soly, 2012: 363), illiteracy still stood at 85-90% in rural Castile by the end of the 18th century (Maynes, 1985: 15). Rome had recreational opportunities for all from taverns and brothels to amphitheaters and bathhouses. Its legionaries were infamously efficient, but would have been quickly wiped out when confronted by a Spanish arquebus or the firepower of cannon.

Within the economic realm, however, Roman imperial peace created unprecedented opportunities for growth through a global monetary system and by vigorously promoting the long-distance market exchange of staple goods. Olive oil was not solely relied on for cooking and eating, but was used extensively for fuel in lighting ceramic and metallic lamps and as a core base for medicaments, soaps, skin oils, perfumes and cosmetics (Mattingly, 1988b: 22; Decker, 2009: 149-52). Colonial Spain's mercantilist policy, government-controlled and protected by the Casa de Contratación and through the Carrera de Indias annual trade fleets (Deagan, 2003: 6), by contrast did not invest in economic infrastructure, but sought to maximise profits as swiftly as possible, in many ways turning the Americas into a string of banana republics.

Both the imperial administration and the Crown exercised tight controls over metal production in Rome and Colonial Spain through state enterprise operated by free market mine leasing, processing and shipping

environments (Bakewell, 1986: 133-34; Hirt, 2010: 264). Spanish American mines provided 25,000-30,000 tons of silver to the Atlantic world and beyond from c. 1560-1686 (Garner, 1988: 899). Iberia's mine capacity was equally massive. Strabo's *Geography* describes an early 1st-century AD Iberian goldrush, where “Up to the present moment, in fact, neither gold, nor silver, nor yet copper, nor iron, has been found anywhere in the world, in a natural state either in such quantity or of such good quality” (Jones, 1923: 3.2.8).

The 231 gold mines of Asturia, Gallaecia and Lusitania in northwestern Tarraconensis yielded 20,000 pounds of gold a month according to Pliny the Elder (Keay, 1988: 64), and Rio Tinto in Andalusia is estimated to have produced two million tonnes of silver ore in antiquity (Keay, 1988: 65). Its Iberian Pyrite Belt extending over 250 x 35km of southern Portugal and southwest Spain was Europe's most important ancient metallogenic province for iron, copper, silver and gold (Rothenberg and Blanco-Freijeiro, 1981: 33, 111).

While the Habsburg monarchy invested enormous funds in people and ships to asset-strip the gold and silver mines of Colombia, Peru and Mexico, it is an historic irony that Rome successfully found its own El Dorado within the same soils of Andalusia where the jars and oil used to stock Colonial Spain's Americas-bound ships originated. The Dressel 20 Baetican amphora and colonial Spanish olive jar are both microcosms of vastly different economic exchange networks.

Bibliography

- Armand, D. and Dangréaux, B., ‘La production d’amphores à Lyon’, *Gallia* 54 (1997), 73-104.
- Arubas, B. and Goldfus, H. (eds.), *Excavations on the Site of the Jerusalem International Convention Centre (Binyanei Ha’Uma): The Pottery and Other Small Finds* (JRA Suppl. 60, 2006).
- Avery, G., *Pots as Packaging: the Spanish Olive Jar and Andalusian Transatlantic Commercial Activity, 16th-18th Centuries* (Ph.D. Thesis, University of Florida, 1997).
- Bakewell, P., ‘Mining in Colonial Spanish America’. In L. Bethell (ed.), *The Cambridge History of Latin America. Volume II. Colonial Latin America* (Cambridge University Press, 1986), 105-52.
- Bang, P.F., ‘Trade and Empire - In Search of Organizing Concepts for the Roman Economy’, *Past & Present* 195 (2007), 3-54.
- Bautista, J.S.B., Bautista, J.L.B., Siles, J.S. and Díaz, J.M., *Figlina Scalensia: de ánforas Dressel 20 de la Bética* (University of Barcelona, 2008).

- Blázquez, J.M., 'The Latest Work on the Export of Baetican Olive Oil to Rome and the Army', *Greece & Rome* 39.2 (1992), 173-88.
- Bonsor, G.E., *The Archaeological Expedition Along the Guadalquivir, 1889-1901* (New York, 1931).
- Bowman, A., 'Ptolemaic and Roman Egypt. Population and Settlement'. In A. Bowman and A. Wilson (eds.), *Settlement, Urbanization, and Population* (Oxford University Press, 2011), 317-58.
- Braund, D., *Rome and the Friendly King. The Character of the Client Kingship* (London, 1984).
- Breen, T.H. and Hall, T., *Colonial America in an Atlantic World. A story of Creative Interaction* (New York, 2004).
- Callender, M.H., *Roman Amphorae with Index of Stamps* (Oxford University Press, 1965).
- Carandini, A., Fabbriotti, E., Palma, B., Pucci, G. and Semeraro, T., *Ostia III, Parte Seconda. Le Terme del Nuotatore. Scavo degli ambienti III, VI, VII* (Studi Miscelanei 21, Rome, 1973).
- Carreras Monfort, C., 'Britannia and the Imports of Baetican and Lusitanian Amphorae', *Journal of Iberian Archaeology* (1998), 159-70.
- Carreras Monfort, C.C., 'Producción de Haltern 70 y Dressel 7-11 en las inmediaciones del Lacus Ligustinus (Las Marismas, Bajo Guadalquivir)'. In *Conservas, Aceite y Vino de la Bética en el Imperio Romano. Congreso Internacional Ex Baetica Amphorae Vol. 1* (Écija, 2000), 419-37.
- Carreras Monfort, C., 'A Quantitative Approach to the Amphorae from Xanten: a More Comprehensive View of the Long-Distance Roman Trade', *Xantener Berichte* 14 (2006), 25-39.
- Carruthers, C., 'Spanish Botijas or Olive Jars from the Santo Domingo Monastery, La Antigua Guatemala', *Historical Archaeology* 37.4 (2003), 40-55.
- Carter, J., 'Spanish Olive Jars From Fermeuse Harbour, Newfoundland', *Revue de la Culture Matérielle* 16 (1982), 99-108.
- Colls, D., Étienne, R., Lequément, R., Liou, B. and Mayet, F., 'L'épave Port-Vendres II et le commerce de la Bétique a l'époque de Claude', *Archaeonautica* 1 (1977), 7-143.
- Dąbal, J., 'Dzbany na oliwę ze stanowiska przy ul. Szafarnia w Gdańsku. Przyczynek do badań nad funkcją naczyń ceramicznych importowanych do Gdańska z terenów Iberyjskiego'. In B. Bobowski (ed.), *Archeologia Dolnego Miasta w Gdańsku. Północno-zachodnia część kwartału ulic Długie Ogrody, Szafarnia, Angielska Grobla, Św. Barbary* (Lodz, 2010), 53-71.
- Dangréaux, B. and Desbat, A., 'Les amphores du dépotoir Flavien du Bas-de-Loyasse à Lyon', *Gallia* 45 (1987-88), 115-53.
- De la Bédoyère, G., *Pottery in Roman Britain* (Princes Risborough, 2004).
- De la Fuente, A., *Havana and the Atlantic in the Sixteenth Century* (University of North Carolina Press, Chapel Hill, 2008).
- De Sena, E.C., 'An Assessment of Wine and Oil Production in Rome's Hinterland: Ceramic, Literary, Art Historical and Modern Evidence'. In B. Santillo Frizell and A. Klynne (eds.), *Roman Villas around the Urbs. Interaction with Landscape and Environment. Proceedings of a Conference Held at the Swedish Institute in Rome, September 17-18, 2004* (Rome 2005), 1-15.
- De Sena, E.C. and Ikäheimo, J.P., 'The Supply of Amphora-Borne Commodities and Domestic Pottery in Pompeii 150 BC-AD 79: Preliminary Evidence from the House of the Vestals', *European Journal of Archaeology* 6.3 (2003), 301-21.
- Decker, M., *Tilling the Hateful Earth. Agricultural Production and Trade in the Late Antique East* (Oxford University Press, 2009).
- Deagan, K.A., 'Fig Springs: The Mid-Seventeenth Century in North Central Florida', *Historical Archaeology* 6 (1972), 23-46.
- Deagan, K., 'Colonial Origins and Colonial Transformations in Spanish Americas', *Historical Archaeology* 37.4 (2003), 3-13.
- Drelichman, M. and Voth, H-J., *The Sustainable Debts of Philip II: A Reconstruction of Spain's Fiscal Position, 1560-1598* (London, 2007).
- Duncan-Jones, R., *Structure and Scale in the Roman Economy* (Cambridge University Press, 1990).
- Dyczek, P., *Roman Amphorae of the 1st-3rd Centuries AD Found on the Lower Danube* (Wydawnictwa Uniwersyteku Warszawskiego, 2001).
- Earle, R., *The Body of the Conquistador. Food, Race and the Colonial Experience in Spanish America, 1492-1700* (Cambridge University Press, 2012).
- Elliott, J.H., 'The Spanish Conquest and Settlement of America'. In L. Bethell (ed.), *The Cambridge History of Latin America. Volume I. Colonial Latin America* (Cambridge University Press, 1986), 149-206.
- Étienne, R. and Mayet, F., *L'huile Hispanique* (Paris, 2004).
- Fairbanks, C.H., 'The Cultural Significance of Spanish Ceramics'. In I. Quimby (ed.), *Ceramics in America* (University of Virginia Press, 1972), 141-74.
- Funari, P.P.A., 'Baetica and the Dressel 20 Production. An Outline of the Province's History', *Dialogues d'Histoire Ancienne* 20 (1994), 87-105.
- Funari, P.P.A., *Dressel 20 Inscriptions from Britain and the Consumption of Spanish Olive Oil* (BAR British Series 250, Oxford, 1996).

- Funari, P.P.A., 'The Economic History of Roman Britain: the Olive Oil Contribution to the Debate,' *História e Economia* 1 (2005), 29-46.
- Garner, R.L., 'Long-Term Silver Mining Trends in Spanish America: A Comparative Analysis of Peru and Mexico,' *American Historical Review* 93.4 (1988), 898-935.
- Goggin, J., *The Spanish Olive Jar. An Introductory Study* (Yale University Press, 1960).
- Grivetti, L.E. and Shapiro, H-Y., *Chocolate. History, Culture, and Heritage* (Hoboken, New Jersey, 2009).
- Gutiérrez, A., *Mediterranean Pottery in Wessex Households (13th to 17th Centuries)* (BAR British S306, Oxford, 2000).
- Haley, E.W., *Baetica Felix. People and Prosperity in Southern Spain from Caesar to Septimius Severus* (University of Texas Press, 2003).
- Hirt, A.M., *Imperial Mines and Quarries in the Roman World. Organizational Aspects 27 BC - AD 235* (Oxford, 2010).
- Hoffman, P.E., *The Spanish Crown and the Defense of the Caribbean, 1535-1585* (Louisiana State University Press, 1980).
- Houston, G.W., 'Ports in Perspective: Some Comparative Materials on Roman Merchant Ships and Ports,' *American Journal of Archaeology* 92.4 (1988), 553-64.
- Hughes, M.J., *The Chemical Analysis by Plasma Spectrometry (ICPS) of Pottery from the Tortugas Shipwreck (Florida Keys, 1622)* (OME Papers 40, Tampa, 2014).
- Hume, I.N. and Hume, A.N., *The Archaeology of Martin's Hundred. Part II: Artifacts Catalogue* (Williamsburg, Virginia, 2001).
- Hurst, J.G., 'Post-Medieval Pottery from Seville Imported into North-West Europe'. In D.R. Hook and D.R.M. Gaimster (eds.), *Trade and Discovery. The Scientific Study of Artefacts from Post-Medieval Europe and Beyond* (British Museum Occasional Paper 109, London, 1995), 45-54.
- Ingelman-Sundberg, C., 'Preliminary Report on Finds from the Jutholmen Wreck', *International Journal of Nautical Archaeology* 5.1 (1976), 57-71.
- Izquierdo, A.F., Millet, P.B. and Martin, A.A., 'El pecio romano de la Albufereta (Alicante): un documento de época pre-flavia'. In J.P. Ballester and G. Pascual (eds.), *Actas V Jornadas Internacionales de Arqueología Subacuática, Gandía 8 a 10 noviembre de 2006* (Valencia, 2007), 231-46.
- James, S.R., 'A Reassessment of the Chronological and Typological Framework of the Spanish Olive Jar', *Historical Archaeology* 22.1 (1988), 43-66.
- Jones, H.L., *The Geography of Strabo, Vol. II* (Harvard, 1923).
- Kawaguchi, Y., 'The Newly Found Olive Jars in Japan and their Historical Significance', *Sokendai Review of Cultural and Social Studies* 7 (2011), 123-32.
- Keay, S.J., *Roman Spain* (University of California Press, 1988).
- Kelloway, S.J., Craven, S., Pecha, M., Dickinson, W.R., Gibbs, M., Ferguson, T. and Glascock, M.D., 'Sourcing Olive Jars Using U-Pb Ages of Detrital Zircons: A Study of 16th Century Olive Jars Recovered from the Solomon Islands', *Geoarchaeology* 29 (2014), 47-60.
- Kent, R.B., *Latin America. Regions and People* (New York, 2006).
- King, J., 'Ceramic Variability in 17th Century St. Augustine, Florida', *Historical Archaeology* 18.2 (1984), 75-82.
- Kingsbury, S.M., *The Records of the Virginia Company of London, Volume IV* (Washington, 1935).
- Kingsley, S.A., Flow, J., Gerth, E. and Lozano Guerra-Librero, C., *Spanish Olive Jars from the Tortugas Shipwreck, Florida (1622)* (OME Papers 38, Tampa, Florida, 2014).
- L'Hour, M., 'The Wreck of a Danish Merchant Ship, the Sainte Dorothea (1693)', *International Journal of Nautical Archaeology* 22.4 (1993), 305-22.
- Lis, C. and Soly, H., *Worthy Efforts. Attitudes to Work and Workers in Pre-Industrial Europe* (Leiden, 2012).
- Lister, F.C. and Lister, R.H., 'The Recycled Pots and Potsherds of Spain', *Historical Archaeology* 15.1 (1981), 66-78.
- Lister, F.C. and Lister, R.H., *Andalusian Ceramics in Spain and New Spain: a Cultural Register from the Third Century BC to 1700* (University of Arizona Press, Tucson, 1987).
- Lo Cascio, E., 'The Early Roman Empire: the State and the Economy'. In W. Scheidel, I. Morris and R. Saller (eds.), *The Cambridge Economic History of the Greco-Roman World* (Cambridge University Press, 2007), 619-50.
- Marken, M.W., *Pottery from Spanish Shipwrecks 1500-1800* (University Press of Florida, 1994).
- Markman, S.D., *Architecture and Urbanization in Colonial Chiapas, Mexico* (Philadelphia, 1984).
- Mattingly, D.J., 'Oil for Export? A Comparison of Libyan, Spanish and Tunisian Olive Oil Production in the Roman Empire', *Journal of Roman Archaeology* 1 (1988a), 33-56.
- Mattingly, D.J., 'The Olive Boom. Oil Surpluses, Wealth and Power in Roman Tripolitania', *Libyan Studies* 19 (1988b), 21-41.
- Maynes, M.J., *Schooling in Western Europe. A Social History* (New York, 1985).
- McAlister, L.N., *Spain and Portugal in the New World, 1492-1700, Volume 3* (University of Minnesota Press, 1984).

- Menzel, S., *Cobs, Pieces of Eight and Treasure Coins. The Early Spanish-American Mints and their Coinages 1536-1773* (New York, 2004).
- Millet, P.B., *Epigrafía anfórica de la Bética. Nuevas formas de análisis* (University of Barcelona, 2008).
- Morley, N., 'Cities and Economic Development in the Roman Empire'. In A. Bowman and A. Wilson (eds.), *Settlement, Urbanization, and Population* (Oxford University Press, 2011), 143-60.
- Morse, R.M., 'The Urban Development of Colonial Spanish America'. In L. Bethell (ed.), *The Cambridge History of Latin America. Volume II. Colonial Latin America* (Cambridge University Press, 1986), 67-104.
- Naviero, 'Informe: el comercio marítimo en el noroeste durante la época romana a través de las ánforas', *Revista de Arqueología* (1986), 40-5.
- Parker, A.J., *Ancient Shipwrecks of the Mediterranean & the Roman Provinces* (BAR Int. S580, Oxford, 1992).
- Patrich, J., *Studies in the Archaeology and History of Caesarea Maritima* (Leiden, 2011).
- Payne, S.G., *A History of Spain and Portugal. Volume 1* (Madison, Wisconsin, 1973).
- Peacock, D.P.S., 'Amphorae and the Baetican Fish Industry', *Antiquaries Journal* LIV (1974), 232-43.
- Peacock, D.P.S. and Williams, D.F., *Amphorae and the Roman Economy* (London, 1986).
- Pike, R., *Aristocrats and Traders. Sevillian Society in the Sixteenth Century* (Cornell University Press, Ithica, 1972).
- Pleguezuelo-Hernandez, A., 'Seville Coarsewares, 1350-1650: a Preliminary Typological Survey', *Medieval Ceramics* 17 (1993), 39-50.
- Rice, P.M., 'The Kilns of Moquegua, Peru: Technology, Excavations, and Functions', *Journal of Field Archaeology* 21.3 (1994), 325-44.
- Rice, P.M., 'Peru's Colonial Wine Industry and its European Background', *Antiquity* 70 (1996a), 785-800.
- Rice, P.M., 'The Archaeology of Wine: The Wine and Brandy Haciendas of Moquegua, Peru', *Journal of Field Archaeology* 23.2 (1996b), 187-204.
- Rice, P.M., *Vintage Moquegua. History, Wine, and Archaeology on a Colonial Peruvian Periphery* (University of Texas Press, 2011).
- Riley, J.A., 'The Coarse Pottery from Berenice'. In J.A. Lloyd (ed.), *Excavations at Sidi Khrebish Benghazi (Berenice). Volume II* (Tripoli, 1979), 91-467.
- Rodríguez, J.R., 'Baetican Olive Oil and the Roman Economy'. In S. Keay (ed.), *The Archaeology of Early Roman Baetica* (JRA Suppl. 29, Rhode Island, 1998), 183-99.
- Rothenberg, B. and Blanco-Freijeiro, A., *Studies in Ancient Mining and Metallurgy in South-West Spain* (London, 1981).
- Sánchez-Albornoz, N., *The Population of Latin America. A History* (University of California Press, 1974).
- Sánchez-Albornoz, N., 'The Population of Colonial Spanish America'. In L. Bethell (ed.), *The Cambridge History of Latin America. Volume II. Colonial Latin America* (Cambridge University Press, 1986), 3-37.
- Scheidel, W., 'Progress and Problems in Roman Demography'. In W. Scheidel (ed.), *Debating Roman Demography* (Brill, Leiden, 2001), 1-81.
- Scheidel, W., 'Slavery'. In W. Scheidel (ed.), *The Cambridge Companion to the Roman Economy* (Cambridge University Press, 2012), 89-113.
- Sciallano, M. and Sibella, P., *Amphores. Comment Les Identifier?* (Aix-en-Provence, 1991).
- Tailliez, P., 'Titan'. In J. du Plat Taylor (ed.), *Marine Archaeology. Developments during Sixty Years in the Mediterranean* (London, 1965), 76-92.
- Tchernia, A., 'Recherches archéologique sous-marine', *Gallia* 27 (1969), 465-99.
- Teichner, F. and Pujol, P., 'Roman Amphora Trade Across the Straits of Gibraltar: an Ancient Anti-Economic Practice?', *Oxford Journal of Archaeology* 27.3 (2008), 303-14.
- Trakadas, A., 'Ancient Marine Resource Exploitation in the Western Mediterranean: the Contribution of the Fish-salting Industry of Mauretania Tingitana (Morocco)'. In *HMAP - Mediterranean Workshop, Institut de Ciències del Mar (CSIC), Barcelona, 20-22 September 2004* (Barcelona, 2004).
- Vassberg, D.E., *Land and Society in Golden Age Castile* (Cambridge University Press, 1984).
- Vieira de Castro, F., 'A Group for the Study of Iberian Seafaring.' In F. Vieira de Castro and K. Custer, *Edge of Empire* (Casal de Cambra, 2008), 7-22.
- Weisman, B.R., 'Archaeology of Fig Springs Mission, Ichetucknee Springs State Park.' In B.G. McEwan (ed.), *The Spanish Missions of Florida* (University Press of Florida, 1993), 165-92.
- Willis, R.F., *The Archeology of 16th Century Nueva Cadiz* (MA Thesis, University of Florida, 1976).
- Wilson, A., 'City Sizes and Urbanization in the Roman Empire'. In A. Bowman and A. Wilson (eds.), *Settlement, Urbanization, and Population* (Oxford University Press, 2011a), 161-95.
- Wilson, A., 'Developments in Mediterranean Shipping and Maritime Trade from the Hellenistic Period to AD 1000'. In D. Robinson and A. Wilson (eds.), *Maritime Archaeology and Ancient Trade in the Mediterranean* (Oxford, 2011b), 33-60.
- Wingood, A.J., 'Sea Venture. An Interim Report on an early 17th Century Shipwreck lost in 1609', *International Journal of Nautical Archaeology* 11.4 (1982), 333-47.