

THE OVOID AMPHORAE IN  
THE CENTRAL AND WESTERN  
MEDITERRANEAN

BETWEEN THE LAST TWO CENTURIES OF  
THE REPUBLIC AND THE EARLY DAYS OF THE  
ROMAN EMPIRE

Edited by

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ARCHAEOPRESS PUBLISHING LTD  
Summertown Pavilion  
18-24 Middle Way  
Summertown  
Oxford OX2 7LG  
[www.archaeopress.com](http://www.archaeopress.com)

ISBN 978-1-78969-296-9  
ISBN 978-1-78969-297-6 (e-Pdf)

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Cover: 'Mediterranean ovoid amphorae: a puzzling matter'. Author: Rui Roberto de Almeida

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Printed in England by Severn, Gloucester

This book is available direct from Archaeopress or from our website [www.archaeopress.com](http://www.archaeopress.com)

# Contents

## Prologue

|                    |      |
|--------------------|------|
| Introduction ..... | xiii |
|--------------------|------|

## Part I

### Ovoid amphorae production in the Mediterranean

|   |            |
|---|------------|
| <b>The ovoid amphorae from Aigion, in the north-west Peloponnese. The connections with Corinth and the Brindisi area .....</b>                                | <b>3</b>   |
| Konstantinos Filis  |            |
| <b>Produzioni di anfore ovoidi di area brindisina .....</b>   | <b>35</b>  |
| Daniele Manacorda   |            |
| <b>Late Republican and Early Imperial ovoid amphorae: the African production.....</b>   | <b>42</b>  |
| Alessia Contino and Claudio Capelli   |            |
| <b>Ovoid amphorae as the first Roman provincial repertoire in <i>Hispania Ulterior</i> (the Guadalquivir valley).....</b>                                     | <b>62</b>  |
| Enrique García Vargas, Horacio González Cesteros and Rui Roberto de Almeida   |            |
| <b>Ovoid amphorae production in the Bay of Cadiz and the southern coast of the <i>Ulterior/Baetica</i> (Late Republican and Early Imperial periods) .....</b> | <b>112</b> |
| Enrique García Vargas and Antonio M. Sáez Romero  |            |
| <b>Ánforas ovoides del noreste de la <i>Hispania Citerior Tarraconensis</i> en época tardorepublicana. Ensayo de síntesis.</b>                                | <b>148</b> |
| Jordi Miró Canals y Ramón Járrega Domínguez   |            |
| <b>The ‘early production’ of Roman amphorae in <i>Lusitania</i>. State of play of a universe (still) under construction .....</b>                             | <b>175</b> |
| Rui Roberto de Almeida and Carlos Fabião  |            |
| <b>De la producción de ánforas Ovoide 1 gaditanas: aportaciones del alfar de Verinsur.....</b>  | <b>191</b> |
| Darío Bernal-Casasola, José J. Díaz Rodríguez, María Luisa Lavado-Florido y Rosario García-Giménez  |            |

## Part II

### Ovoid amphorae throughout the Mediterranean: Case studies, commercial routes, consumption contexts and contents

|   |            |
|---|------------|
| <b>Ovoid Amphoras found in Hellenistic Southern Levant contexts: their chronology and need for proveniences.....</b>  | <b>215</b> |
| Gerald Finkielsztejn  |            |
| <b>Northern Peloponnesian amphorae with convex-concave rims from the Styra A shipwreck .....</b>                      | <b>228</b> |
| Lucie S. Vidličková   |            |
| <b>Ovoid African and Hispanic amphorae in Italy. Some examples from Ostia and Pompeii .....</b>                       | <b>237</b> |
| Alessia Contino, Lucilla D’Alessandro, Guillermo Pascual Berlanga and Albert Ribera i Lacomba                         |            |
| <b>The Italic ovoid amphorae in the Toulouse area at the end of the Iron Age (Midi-Pyrénées, France) .....</b>        | <b>274</b> |
| Laurence Benquet  |            |
| <b>The diffusion of south-Hispanic ovoid amphorae in Gaul, between the Late Republican and Early Empire times....</b> | <b>298</b> |
| Kevin Quillon and Max Luaces  |            |

|   |            |
|---|------------|
| <b>Distribution of ovoid amphorae in north-west Europe. Consumption contexts and main trade routes .....</b>  | <b>314</b> |
| Horacio González Cesteros   |            |
| <b>Amphorae of the Brindisi area in <i>Gallia Belgica</i>: The example of Titelberg (Luxembourg) .....</b>  | <b>337</b> |
| Debora C. Tretola Martinez  |            |
| <b>Ovoid amphorae in <i>Hispania Citerior/Tarraconensis</i>: consumption contexts and main trade areas .....</b>  | <b>346</b> |
| Daniel Mateo Corredor and Jaime Molina Vidal  |            |
| <b>La importación de ánforas ovoides en la <i>Tarraco</i> republicana .....</b>   | <b>367</b> |
| Moisés Díaz García  |            |
| <b><i>Are you Local?</i> Imported and locally produced amphorae in Alto Alentejo (Portugal) during the 1st century BC: three case studies at Soeiros, Rocha da Mina and Caladinho .....</b> | <b>376</b> |
| Rui Mataloto, Joey Williams and Conceição Roque   |            |
| <b>Preliminary organic residue analysis of Ovoid 1 and Ovoid 5 amphorae from the Guadalquivir valley.....</b>   | <b>391</b> |
| Darío Bernal-Casasola, Alessandra Pecci and Antonio M. Sáez Romero  |            |

### Epilogue

|   |            |
|---|------------|
| <b>Ovoid amphorae in the Mediterranean (2nd century BC- early 1st century AD). State of the play and future research perspectives .....</b> | <b>403</b> |
| The Editors   |            |



# Preliminary organic residue analysis of few Ovoid 1 and Ovoid 5 amphorae from the Guadalquivir valley

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**Abstract:** The determination of the contents of the ovoid amphorae remains one of the unsolved topics of the research on Roman amphorae. We present in this study the preliminary results of analyses of the organic residues found attached to the interior of a few specimens of ovoid amphorae from underwater contexts from the Autonomous City of Ceuta and San Fernando (Cadiz). The study allowed to confirm the presence of wine in two vessels of the types Ovoid 1 and Ovoid 5 produced in the Guadalquivir valley. This is the first solid outcome of archaeometric analysis applied to these containers produced in the *Ulterior/Baetica*, opening an interesting line of research into the wine content of some types of the ovoid series from southern Hispania.

**Keywords:** Ovoid 1; Ovoid 5; organic residue analysis; amphorae; wine.

**Resumen:** La determinación del contenido de las ánforas ovoides sigue siendo una de las temáticas pendientes de la investigación. Se presentan en este estudio análisis preliminares de los residuos orgánicos adheridos a la pared interna de algunos ejemplares de ánforas ovoides de contexto subacuático procedentes de la Ciudad Autónoma de Ceuta y de San Fernando (Cádiz), que han podido verificar la presencia de vino en dos envases del tipo Ovoid 1 y Ovoid 5 del valle del Guadalquivir. Constituyen éstas las primeras evidencias de analíticas arqueométricas aplicadas a estos envases producidos en la *Ulterior/Baetica*, abriendo una interesante línea de investigación sobre el contenido vinario de parte de los tipos asociados a la producción ovoides surhispánica.

**Palabras-clave:** Ovoid 1; Ovoid 5; análisis de residuos orgánicos; ánforas; vino.

## 1. Introduction: the undecided contents of the south Hispanic ovoid amphorae

Studies on the contents of the Roman amphorae are a critical research line in Hispano-Roman archaeology and, in general terms, of the ancient world. Despite countless decades of study based on the pioneering works of H. Dressel, many of the forms remain without clear attribution, as can be verified in the current reference repertoires. Examples can be found in the online database of the University of Southampton *Roman Amphorae: a digital resource* ([http://archaeologydataservice.ac.uk/archives/view/amphora\\_ahrb\\_2005/](http://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/)) or the Virtual Laboratory *Amphorae ex Hispania* ([amphorae.icac.cat](http://amphorae.icac.cat)). Further, we must remember that for a large part the current attribution of wine, olive oil or fish products to the Hispanic amphora series is based on indirect data – inferences derived from the typology, presence of resin, economic features of the provenance region, etc., and not on the empirical evidence – such as macroscopic faunal or botanic remains, *tituli picti* or archaeometric analyses. This latter is the most reliable, if no solid residues, nor *tituli picti* are preserved (Bernal-Casasola 2015: 63).

The study of amphorae contents has been one the main concerns that have propelled the development of residue analysis of ceramic vessels since the early 1970s (Condamin *et al.* 1976). After some years of little interest, mostly due to the then impossibility of detecting the chemical fingerprint of wine residues, the topic of amphorae content has gained again the attention of international scholarship since the first decade of the 21st century (i.e. Garnier 2003, 2007a, 2007b; Garnier, Silvino and Bernal-Casasola 2011; Garnier and Pecci forthcoming; Pecci 2009; Pecci and Cau Ontiveros 2010, 2014; Pecci, Salvini and Cantini 2010; Pecci *et al.* 2015, 2017, 2018; Romanus *et al.* 2009; Woodworth *et al.* 2015; Cau Ontiveros *et al.* 2018).

Regrettably, and specifically with regard to the ovoid amphorae groups, the problems remain unsolved as there is an almost total absence of direct information on the matter, as the publication of this monograph faithfully illustrates. Concerning the south Italic ovoid amphorae, one of the main and oldest producing regions, the dominant trend of the last decades has been to consider them all as olive oil transport vessels,

although there have been authors who have proposed a more diverse economic scenario, including wine as an alternative content (for instance, cf. Molina Vidal 1997: 140-141). However, the available archaeological basis for the interpretation of the contents of the amphorae from the south-Italic area is in fact almost non-existent, so most authors have repeated the received hypothesis on an oil content for the ovoid series of the late 2nd and 1st centuries BC (as suggested in Manacorda and Pallecchi 2012: 522-523).

A similar tendency can be recognised for the Hispanic ovoid series, a diverse group that includes both the northeast Iberian quadrant (Miró i Canals 1988) and the southern peninsular main river valleys and coasts. For the series produced in *Ulterior/Baetica*, which are the ones here analysed, until less than a decade ago only two main clusters were identified: the so-called ‘Ovoides Gaditanas’ (García Vargas 1998; cf. also García Vargas and Sáez Romero in this volume) and the popular ‘Lomba do Canho 67’ or ‘LC67’, first studied at the Portuguese site of that name by Carlos Fabião (1989). Currently, the typological division is much more diversified and well defined, thanks in particular to studies carried out in Santarém (Almeida 2008) and on those subsequently developed for the case of the Bajo Guadalquivir area (cf. especially García Vargas, Almeida and González Cesteros 2011).

Broadly speaking, the current state of the research for the contents of the ovoid amphorae of southern *Hispania* can be set out for several of the most prominent typological groups:

- ‘Ovoides Gaditanas’: Based on the evidence from the Bay of Cadiz, this has been generally accepted as a precursor of the Dressel 7/11 series, with which they share multiple features in their shapes and even workshops, that are located in the coastal area of *Ulterior/Baetica*. This available information has led to the *communis opinio* that both groups were normally used to transport fish by-products (*garum* and salted fish; cf. García Vargas 1998: 74-76, who originally included this series in his Group II).
- Precursory forms of the Dressel 20 series in the Guadalquivir valley: a group that is composed of the ‘Ovoid 6’, the ‘Ovoid 7’/Oberaden 83 and its successors (Haltern 71). Their morphological features and their connection with the later well-known Dressel 20 and 23 types – whose relationship with olive oil is broadly accepted, based on the evidence provided by workshops, stamps, *tituli picti*, chemical analyses of contents and many other historical facts, have led various authors to consider that olive oil could have been also the content of the previous ovoid series (García Vargas, Almeida and González Cesteros 2016a). This does seem to be arguable and the most feasible possibility, but needs more specific research to be confirmed.

- Antecedents of the type Haltern 70: specifically, the traditionally labelled ‘unusually small variant’, nowadays renamed as ‘Ovoid 4’, whose formal affinities with those well-known and mass-produced series of the Guadalquivir area (Haltern 70) have suggested wine and other grape derivatives as their most probable contents (García Vargas, Almeida and González Cesteros 2016b).
- Types connected with the ‘Lomba do Canho 67’ set: this group includes diverse productions that have a developed groove or ring under the rim and on the neck. At the moment, the two best identified variants are the ‘Ovoid 1’ of the Guadalquivir valley, for which olive oil has been proposed – although without rejecting wine and its derivatives (González Cesteros, Almeida and García Vargas 2016);<sup>1</sup> and also the ‘Ovoid 5’, which according to the most recent studies could ‘be assumed either as an oleic content or perhaps related to grape by-products’ (García Vargas, Almeida and González Cesteros 2016c). On this matter it is convenient to recall and consider the classic but barely used work of G. Chic García on the possible Ovoid 1 found off the coast at Punta del Nao (Cadiz); inside this complete vessel some grape seeds were found, and this fact led G. Chic García to identify grape juice or must as the original content (Chic García 1978). Taking into account this isolated find, the questions surrounding the contents of at least some of the early ovoid groups of the region can be connected with the well-known relation established between Haltern 70 type and the *defrutum/sapa* products.

Other series of Baetican ovoid amphorae are still insufficiently studied and technologically characterised, such as the so-called ‘Ovoid 2’ and ‘Ovoid 3’ (Almeida 2008: 83-88); no discussion is therefore remotely possible about their contents. A systematic review of previous opinions collected on the content of these transport containers can be very illustrative in demonstrating the present diversity among the published proposals: these range from two to many usages (Almeida 2008: 194-198).

In light of this situation characterised by the evident lack of definition for most of the types, we decided to focus our attention on the types with no available information, which are the most complex: Ovoid 1, 4 and 5. To that end, we decided to perform some organic residue analyses, in the hope of identifying the contents of at least some of the most prominent amphorae clusters. The results of these chemical analysis, in the absence of *tituli picti* and faunal or botanical remains, constitute for the moment the most solid indicator for the determination of the traded products (Garnier 2007a; Pecci and Cau Ontiveros 2010; Bernal-Casasola 2015; Garnier and Pecci forthcoming).

<sup>1</sup> To which we must add the recently identified ‘Ovoid 1 gaditana’ at the Verinsur workshop (Jerez de la Frontera, Cádiz); cf. Bernal-Casasola *et al.* in this volume.

## 2. Ovoid amphorae of the Guadalquivir valley from underwater contexts: some significant finds of the 'Círculo del Estrecho' area

The materials selected for sampling were in all cases found in underwater coastal sites, and they still preserve traces of their internal coating, with residues of resin or pitch easily visible without the need for microscopic study. Below, the contexts of provenance of the vessels are concisely described, coming from both shores of the Straits of Gibraltar, the first located not far from Ceuta and the second in the surroundings of the present-day beach of Camposoto-Sancti Petri in the southern area of the Bay of Cadiz (Figure 1). In addition, a few details and preliminary considerations are provided about the materials found in these two sites where the samples were collected.

### 2.1. Ovoid amphorae found at Camposoto Beach (San Fernando, Cadiz)

The two amphorae selected for this study have a similar typology (Ovoid 5) and were found in an unknown spot on the present-day Camposoto Beach, a wide sandy bar that extends to the south of what was in ancient times the island of *Kotinoussa*. This island area probably was a long beach front open to the Atlantic Ocean, located north of the main non-urban sanctuary of the city (in the area of Sancti Petri, dedicated to the cult of *Hercules Gaditanus*) and to the west of the so-called *Antipolis*, an area of many villa settlements in the insular territory of *Gades*. The beach should therefore have had an important economic role for the ancient city, with optimal conditions for the development of fishing and fish processing.

The amphorae were found by chance in the early 1980s and then donated to the local 'House of Culture', where they were exhibited until they were transferred to the Municipal Historical Museum of San Fernando during its creation between 1986 and 1989. No specific data are available on the circumstances of the find or its finders, although the presence of marine concretions on the surfaces of the two specimens, as well as the colour of the fabrics and the eroded edges of the fractures verify that both individuals were at least at some time exposed directly to the underwater or coastal tidal field. The fact that they do not show a dark or greyish colour seems to rule out a provenance in the nearby salt flats and marshes, which indirectly suggests that they were probably retrieved from the sandy layers of the coastal front of Camposoto.

The presence of Roman and pre-Roman material in the area is well known, and has already been analyzed in previous works (Sáez Romero, Montero Fernández and Díaz Rodríguez 2005; Sáez Romero and Díaz Rodríguez 2012; Díaz Rodríguez, Sáez Romero and Sáez Espligares 2012; Zamora López and Sáez Romero 2014). Accordingly, the two amphorae included in this article can tentatively be contextualised thanks to the indirect data provided in these publications, and by the study of

the geomorphologic evolution of this section of the coast. Some of these indicators, such as the remains of basins for fish processing and other amphorae, have made it possible also to assume the existence of kiln sites and fish-salting plants, since at least the late Republic to the Roman imperial period in this area, from Torregorda to Sancti Petri (cf. a synthesis in Sáez Romero 2014). Recent finds after the strong storms of 2009-2010 and 2018 have confirmed the presence of large-scale structures that were probably part of artisanal complexes dating to the Roman imperial era.<sup>2</sup> It is therefore very likely that such artisanal settings were connected with the ovoid amphorae found at Camposoto: perhaps the vessels were linked to some of these production infrastructures of the late Republican period, as part of the food supply for their workers. It cannot be verified if the two vessels were found on what was then dry land or if they could have come from a wreck located in the vicinity of the Roman buildings.

The two examples studied show similar fabrics, although not exactly alike, nor are their typological attributes quite the same. One of the specimens (Figure 2, above) shows a greenish fabric, darker in some areas of the exterior surface, which seems to neatly match the typical characteristics of the Guadalquivir area. Its morphology includes a clearly differentiated neck, a cylindrical tendency in the body profile and a notably projected and gouged out groove placed under the rim, features that are well preserved in spite of the marine erosion. The handles, of a near-oval section, show a longitudinal but not very deep groove on the outside; they describe a slightly angled L-shape in profile. The second amphora (Figure 2, below) displays a lighter colour (orange, regular throughout the preserved portion), which does not suggest a connection with any Guadalquivir workshops. It may well have a different provenance, perhaps from other kilns in areas such as Cadiz Bay itself. The typology has clear ties with the previous one, but in addition to a less developed rim, the fragment has a shorter neck and a less cylindrical body, and the handles, of a quasi-semi-circular section, are smaller in size and with a deeper longitudinal groove. It is therefore evident that each was manufactured in a different workshop and/or production area, although they can be identified as Ovoid 5 type, dating to the third quarter of the 1st century BC (García Vargas, Almeida and González Cesteros 2011: 225-228).

Another shared feature in the two amphorae is that they had visible residues of resin on their inside surfaces, in particular over a large portion of the body wall and part of the neck (preserved to a greater extent in the vessel with greenish fabric, Sample 1). Sampling was achieved by removing with a scalpel a small part of the residues adhered to the amphorae in an area less eroded by the sea.

<sup>2</sup>The first results were presented as closing paper in the "II Congreso de Jóvenes Investigadoras/es de la Prehistoria de Andalucía" (University of Cadiz, October 27-29, 2016), whose proceedings are still in press.



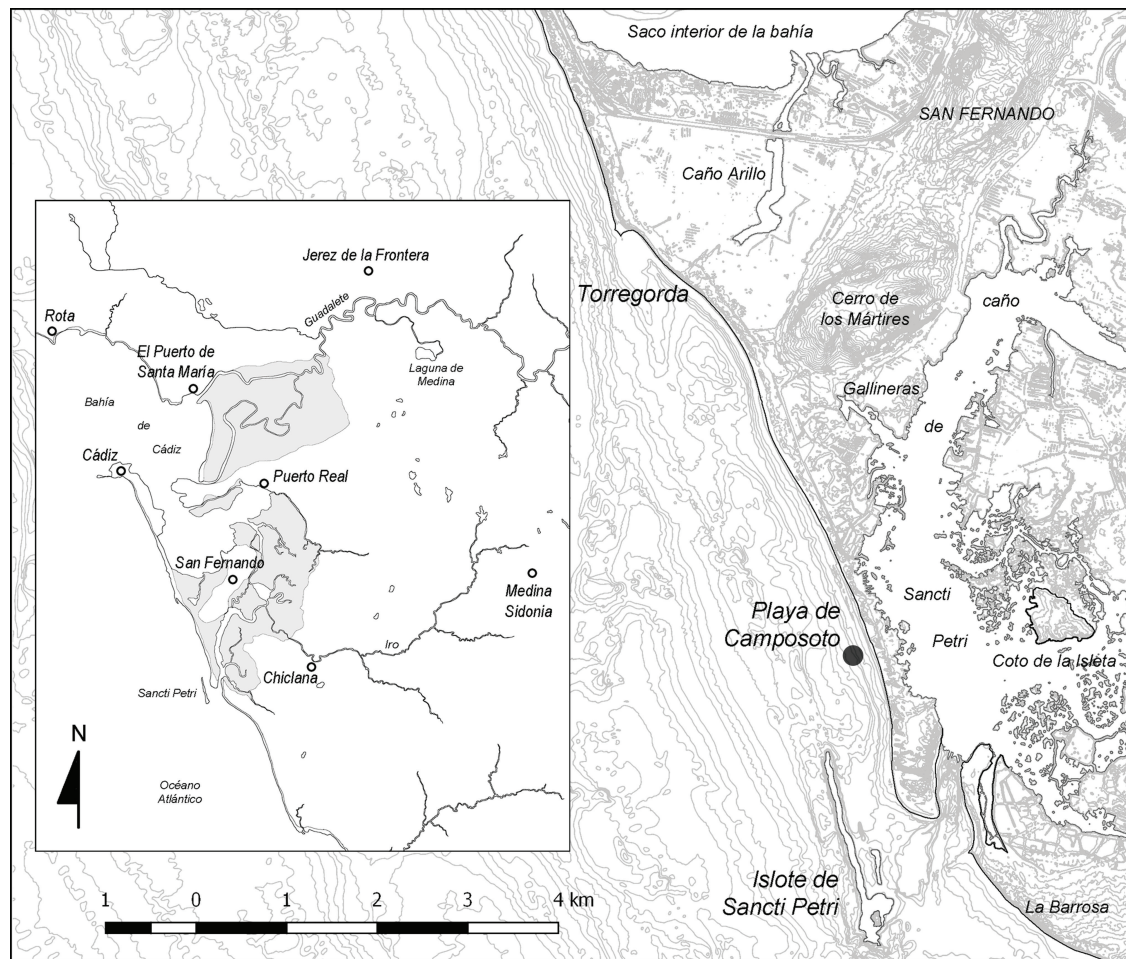
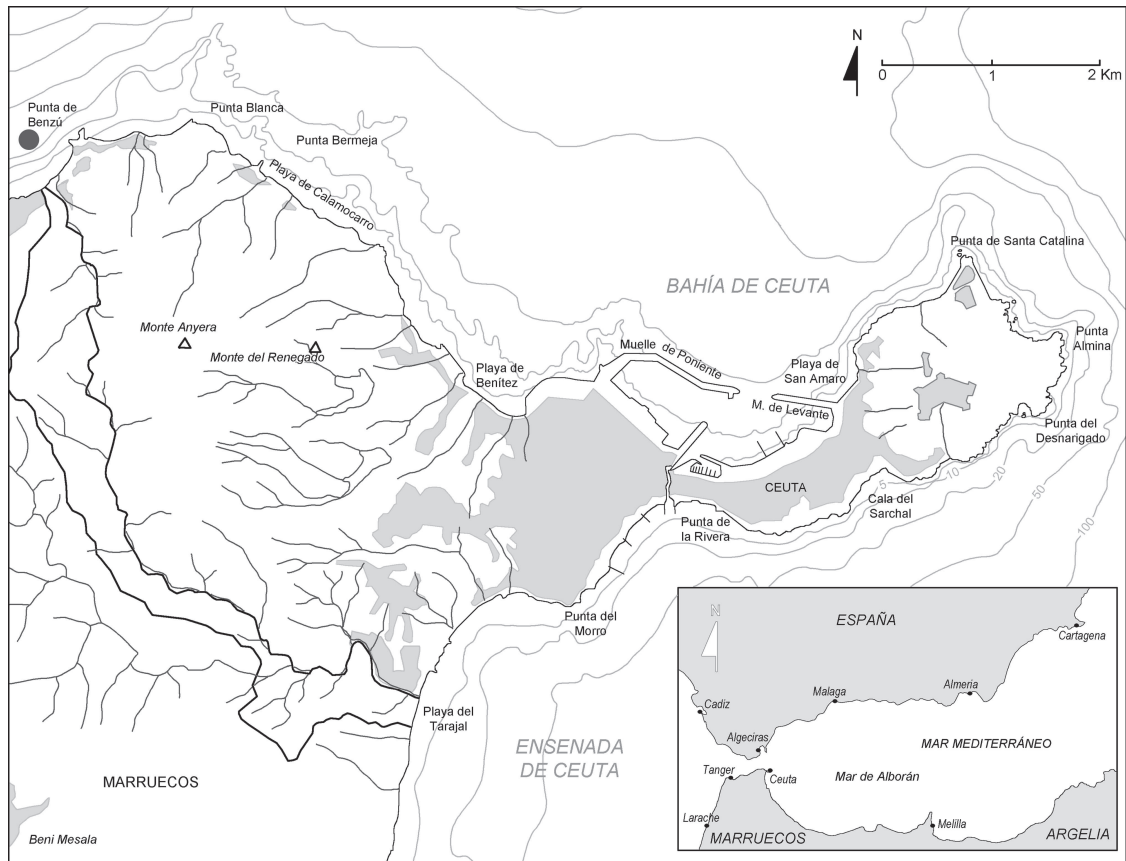


FIGURE 1. LOCATION OF THE BALLENERA BAY, CLOSE TO CEUTA (A) AND SANCTI PETRI - CAMPOSOTO BEACH IN THE SOUTHERN AREA OF CADIZ BAY (B).



FIGURE 2. ANALYSED OVOID 5 AMPHORAE FROM THE MHMSF (SAMPLE 2, ABOVE; SAMPLE 1 BELOW).

In both cases, a few grams of the substances not altered by the presence of marine concretions was retrieved.

### 2.2. Ovoid amphorae from the Ballenera Bay at Benzú (Ceuta)

The intense commercial activity of the ancient city of *Septem Fratres* (the current Autonomous City of Ceuta), on the African shore of the Straits of Gibraltar region, has been known since the mid-20th century from both terrestrial (Bernal-Casasola 2013) and underwater archaeological findings (Bravo and Muñoz 1965, 1968).

Studies carried out in the years 2000 and 2001 at the Museum of Ceuta have verified the existence of a large set of ovoid and Haltern 70 amphorae, complete and unpublished, coming from old exploration campaigns organised by sports divers and headed by Juan Bravo Pérez, in the area of the northern bay of Ceuta. Most of the vessels were probably found off the coast of the old whaling installation located in modern Benzú Bay,

according to the scrutiny of the maps, nautical charts and distribution plans of finds published by these research pioneers (Bravo and Muñoz 1965: 17; 1972a: 10, 19, 30; 1972b: 52, 61, 72). The fact that more than a dozen individuals of the same types and provenances appeared complete in a particular area not far from Ceuta made it possible a couple of decades ago to propose the presence of a Roman shipwreck in the bay (Bernal-Casasola 2000).

The material, which has remained unpublished up to now, adds up to 13 complete amphorae, from five different groups:

- Forms similar to the early variants of Haltern 70 type, with stylised bodies and small projecting rims (Figure 3, no. 1-4, 7 and 8), which seem to be the oldest variants of this form, prior to its final standardisation and mass production. The diversity of the features (section profiles) of the handles support an early imperial chronology, as some of them show sub-ovoid sections that can be

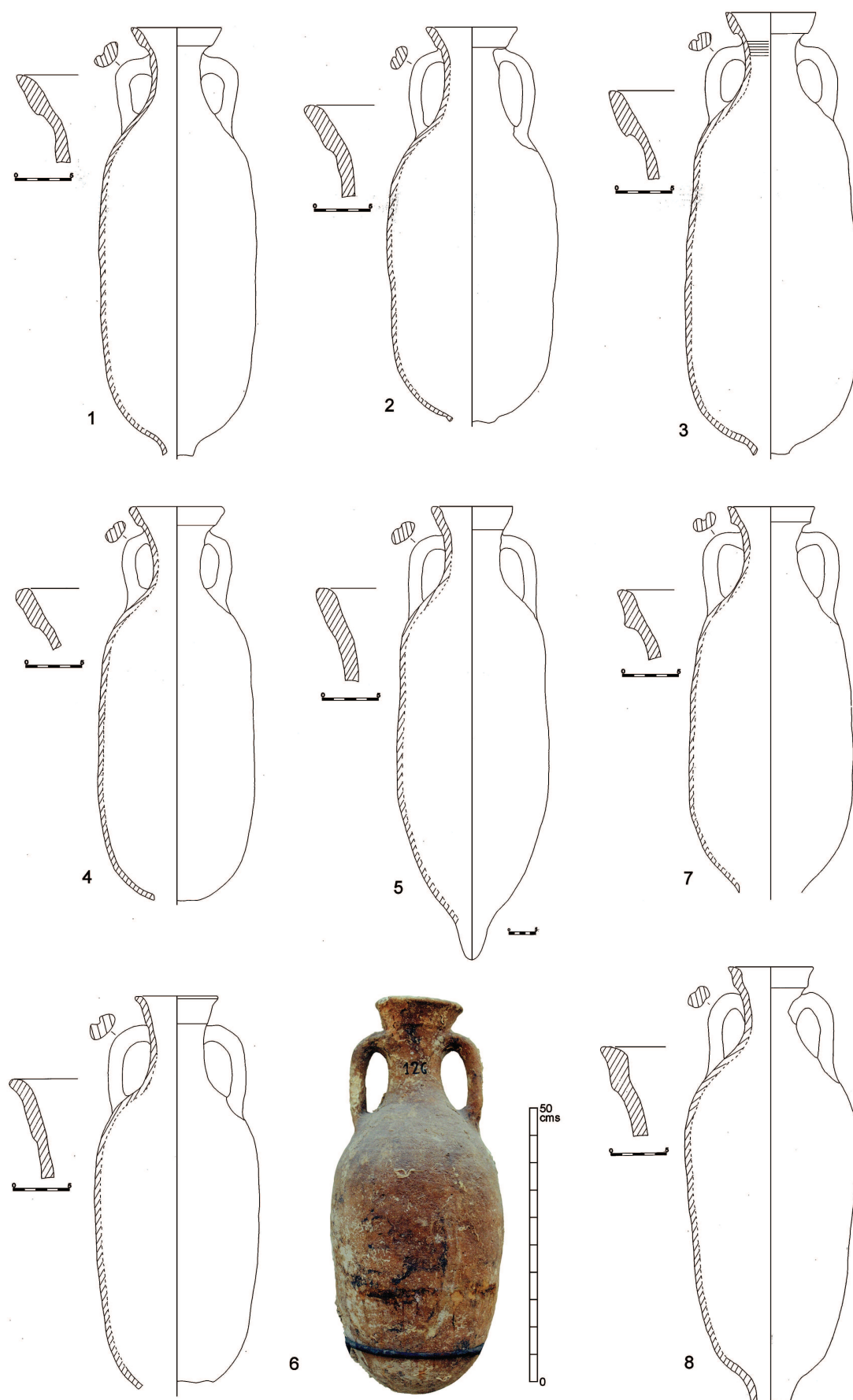


FIGURE 3. HALTERN 70 VESSELS FROM BALLENERA BAY NEAR CEUTA (1.- MUSEUM OF CEUTA #3206; 2.- MUSEUM OF CEUTA #3201; 3.- MUSEO CEUTA #3205; BRAVO #123; 4.- MUSEO CEUTA #3204; 5.- BRAVO #122; 7.- BRAVO #155; 8.- MUSEUM OF CEUTA #3203), AND ONE OF THE ANALYSED AMPHORAE (SAMPLE 6.- 6.- BRAVO #126).



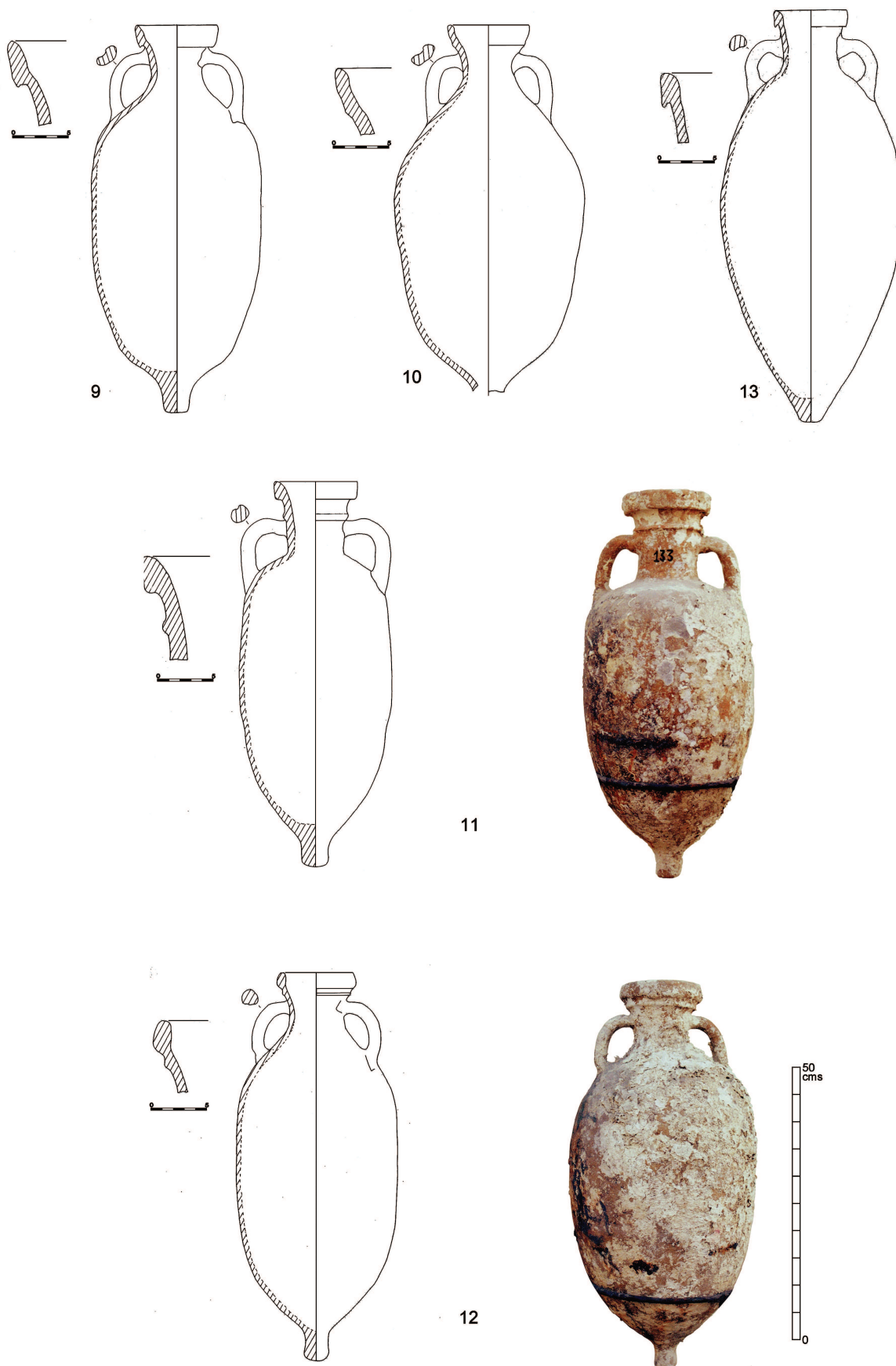


FIGURE 4. OVOID 4 TYPE (9.- MUSEUM OF CEUTA ¿#3345?; BRAVO #127; 10.- MUSEUM OF CEUTA #2330/3207; BRAVO ¿#126?), OVOID 5 (11.- BRAVO #133), OVOID 1 (12.- MUSEUM OF CEUTA #3217; BRAVO #179) AND SOUTH-ITALIC OVOID TYPE (13.- BRAVO #132) FROM CEUTA.

- considered an archaizing attribute (Figure 3, no. 8).
- Some Ovoid 4 pieces (Figure 4, no. 9-10), quite similar in technical details and fabrics to some of the vessels of the preceding group (Haltern 70), suggesting that they could come from the same area – or even workshops.
- Just one Ovoid 5 vessel (Figure 4, no. 11).
- A rare Ovoid 1, one of the few known complete examples of this type (Figure 4, no. 12).
- An Italic ovoid amphora (Figure 4, no. 13), related to the so-called Giancola 1 group (Manacorda and Pallecchi 2012: 103-108 and 143, fig. 3.3).

It has not been possible to verify the origin(s) of the amphorae and their possible connection with a single wreck, although the discovery of several intact individuals in the same geographical area near Ceuta points in that direction. If this hypothesis of a single source is correct, the possible coincidence of the first Haltern 70 with the ovoid types briefly described above suggests a date in the last decades of the 1st century BC (Augustan times?) for this set of amphorae.

With the exception of the south-Italic amphora (Figure 4, no. 13), which shows a very fine yellowish fabric and is quite distinctive, the rest present a remarkable chromatic homogeneity with colours that oscillate between brownish and grey (chiefly Munsell 7,54 YR 8/2; 7,5 YR 7/2, 7/4 u 8/2; 10 YR 7/2 or 7/3). In addition, all contain the characteristic metamorphic inclusions, and show the rough textures and irregular fractures indicative of a provenance from the Guadalquivir valley. The archaeometric studies conducted on these transport vessels include both mineralogical analysis, using X-ray diffraction, and determination of the chemical composition of the samples (majority and minority components). Further, a textural analysis by optical microscopy – completed with thin sections and macrophotographs, was developed in the Autonomous University of Madrid. The results have made possible to propose that all these amphorae were manufactured in workshops located in the Guadalquivir valley (Bernal-Casasola 2000: 85-100, Appendix V).

Of these, only five examples have been selected for residue analysis to be included in this paper, as it presents only some preliminary results on the contents of some series of western ovoid amphorae.

### 3. The residue analyses

#### 3.1. Methodology

##### 3.1.1. Sampling

Five amphorae were sampled for residue analysis. All the specimens analysed come from museum collections, and consequently the act of the sampling was complicated (only a few milligrams from the interior surface were taken, avoiding any visible damage of the vessels). Two of the ovoid amphorae come from the San Fernando Museum and the rest of the amphorae come from the Ceuta Museum. One

can be identified as type Ovoid 1 (sample 179) and is from the Ceuta Museum (Figure 4, no. 12); three more have been classified as Ovoid 5 amphorae (Figure 4, no. 11) (sample 133 from the Ceuta Museum and two samples from the San Fernando Museum) (Figure 2). They were chosen because of the almost absolute lack of reliable data about the contents of both types. Another individual, a Haltern 70 vessel (Figure 3, no. 6), was studied as reference sample to compare its results (very likely it is a wine amphora) with those obtained with the ovoid amphorae samples.

| Sample | Amphora Typology | Current Storage       | Sample weight (gr) | Figure   |
|--------|------------------|-----------------------|--------------------|----------|
| 1      | Ovoid 5          | Museo de San Fernando | 0.13               | 2, infra |
| 2      | Ovoid 5          | Museo de San Fernando | 0.5                | 2, supra |
| 3      | Ovoid 5          | Museo de Ceuta nº 133 | 0.2                | 4, 11    |
| 4      | Ovoid 1          | Museo de Ceuta nº 179 | 0.18               | 4, 12    |
| 5      | Haltern 70       | Museo de Ceuta nº 126 | 0.102              | 3, 6     |

FIGURE 5. TABLE OF THE AMPHORA SAMPLES ANALYSED.

All the samples have been taken from the walls of the amphorae. In most cases, and most specifically in samples 1 and 2, some black material was attached to the inner side of the sherds. This appearance suggested the presence of a visible pitch lining of the amphorae. This black material was analysed together with the ceramic powder from the wall of the amphora. It is important to underline that in all cases the quantity of sample recovered was very small and that it is not possible to sample them again.

##### 3.1.2. Methodology

Each sample was pulverised and subjected to up to three extractions, as detailed below:

- a) We carried out on all the samples the total lipid extraction and its hydrolysis following Chartres *et al.* 1993 (slightly modifying the hydrolysis protocol).
- b) Samples 2 and 5 were extracted following the method published by Pecci *et al.* (2013) to identify wine biomarkers (both grape and fermentation biomarkers).
- c) Due to the fact that there was not enough sample to perform both extractions (a) and (b) on the powdered samples, samples 1, 3 and 4, were firstly extracted following Chartres *et al.* (1993) (extraction a) and then following Pecci *et al.* 2013 (extraction b).

All the extracts were derivatised by adding 25 µL of N,O-bis(trimethylsilyl)trifluoroacetamide (BSTFA, Sigma Aldrich) and heated to 70°C for one hour. After cooling, 75 µL of hexane were added. Samples 1 and 2 had to be further diluted. 1 µL of the obtained extract was injected for analysis by GC-MS. The samples were analysed using



a Thermo Scientific Trace GC Ultra chromatograph equipped with a column TRB-5MS Teknokroma 5% phenyl 95% methyl polysiloxane, 30 m long, 0.25 mm internal diameter, 0.25  $\mu\text{m}$  film thick and coupled with a Thermo Scientific ITQ900 mass spectrometer operated in the electron ionization mode (70 eV). A liner LNR TQ CE 3 mm ID Single tap (105 mm long) splitless type was used.

### 3.2. Results of the analyses

The results indicate that all of the amphorae were coated with *Pinaceae* products. Samples 1 and 2 are very rich in pitch. In the extract (a) there are dehydroabiatic acid and 7oxo-dehydroabiatic acid, both markers of *Pinaceae* products. In all the samples there is retene, a marker of the heating of these products. In samples 1, 2, 3 and 4, there is also methyl-dehydroabietate, which is identified when pitch is obtained burning the wood of *Pinaceae* trees. In sample 5 (the Haltern 70 amphora), there are dehydroabiatic acid and 7oxo-dehydroabiatic acid, markers of *Pinaceae* products, but there are no markers of the production process of the *Pinaceae* products. In this sample there is also cholesterol, a marker of animal products, which could possibly indicate that animal products were mixed to the pitch to soften it or that the amphora contained animal products. To underline that recently cholesterol has also been identified as the result of post-depositional contamination.

Therefore, the results of the analyses confirm that all the amphorae were coated with *Pinaceae* by-products, which in most cases can be classified as pitch extracted directly from the wood. The function of the coating was to waterproof the vessels and probably to add flavour and eventually facilitate the preservation of the contents (especially when it is wine).

As for the contents of the amphorae, the limited quantity of the sample did not allow to repeat extractions in order

to identify residues besides the *Pinaceae* products. Either way, in three cases it is possible to suggest the presence of wine or its derivatives in the *amphorae*. In particular, this is the case of the Haltern 70 amphora, a type that has traditionally been considered to be a wine amphora series. The analyses indicate that in the sample there are tartaric and succinic acids. Although tartaric acid is also present in other fruits (such as tamarind; cf. Barnard *et al.* 2011), it is likely that in this area of the Roman world the tartaric acid is related to the presence of grape juice (Guash-Jané *et al.* 2004; McGovern 2004; Pecci *et al.* 2013; Garnier and Valamoti 2016). Therefore, it is possible to suggest that the Haltern 70 amphora contained wine or its derivatives.

Also, in the extract (c) of sample 4 (Ovoid 1 amphora from Ceuta) there are tartaric, fumaric, malic and succinic acids, which suggest that wine (or its derivatives) was contained in the amphora. In sample 4 also palmitic, stearic and oleic acids are present, suggesting the possibility that the amphora was re-used the Ovoid 5 amphora from the San Fernando museum (sample 2), the application of extraction (c) allows identifying of traces of tartaric acid and other acids that are also present in wine (malic, succinic and fumaric acids), thereupon again suggesting that it contained wine or its derivatives.

In the case of sample 1 (Ovoid 5 from San Fernando), the pitch is so abundant that it was not possible to identify any other residue. As a result, it is not possible to determine: whether the content of the amphora could not be identified because of the abundance of pitch, or if the content was the pitch itself, or if the amphora contained some kind of substance that cannot be identified with the analyses performed. Also, in sample 3 (Ovoid 5, Museum of Ceuta #133), besides the markers of pitch, no other compound related to the content of the amphora was identified. Only the cholesterol is higher than in the extracts of the other amphorae. However, it is likely that it derives from contamination.

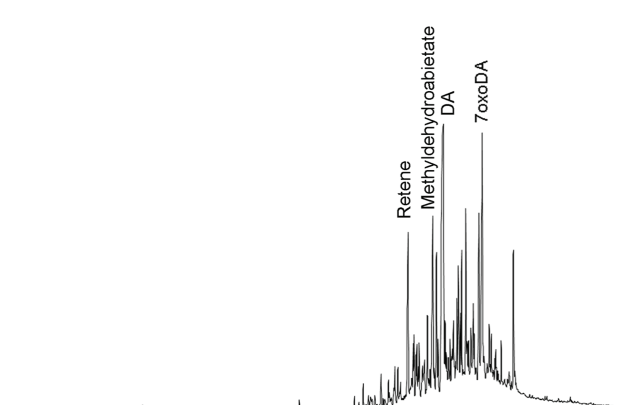


FIGURE 6. CHROMATOGRAM OF EXTRACT (A) OF SAMPLE 2. IT IS POSSIBLE TO OBSERVE THE ABUNDANCE OF PITCH MARKERS IN THE SAMPLE

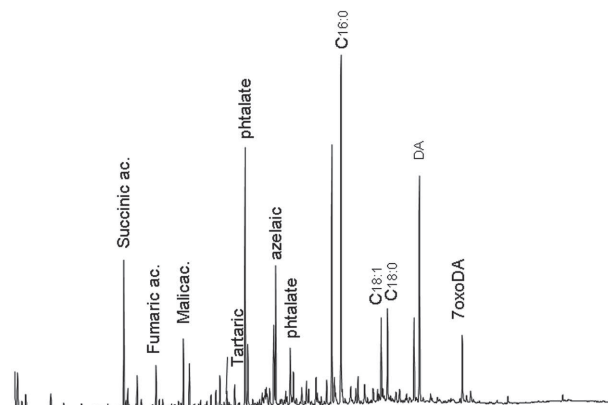


FIGURE 7. PARTIAL CHROMATOGRAM OF EXTRACT (C) OF SAMPLE OV 4. IT IS POSSIBLE TO OBSERVE, THE PRESENCE OF TARTARIC, SUCCINIC AND MALIC ACIDS, PRESENT IN WINE OR ITS DERIVATIVES.

#### 4. Final remarks and perspectives

The organic residue analysis confirmed that all the amphorae were coated in pitch, and that for most of them (the ovoid amphorae) the pitch was obtained by burning the wood of *Pinaceae* trees. The analysis of the organic residues made it possible to identify residues that can be related to a wine (or its derivatives) content in three out of the five analysed amphorae. Namely, the Ovoid 5 from ancient *Gades* coast, present-day San Fernando (sample 1), an amphora of the type Ovoid 1 from Benzú near Ceuta (sample 3), in addition to the Haltern 70 recovered in the same north-African site.

These results suggest that possibly at least some amphorae of the types Ovoid 1 and Ovoid 5 of the Guadalquivir valley were, as was the Haltern 70, linked to the maritime trading of wine or its derivatives products, and that the analysed amphorae included ones holding wine or grape by-products. Thus, although the number of analysis is very small and does not allow to make any generalisation, for the first time it is possible to make a progress on the characterisation of these transport series and their relationship with specific products. In fact, previously the debate on their contents had been able to be presented only in a generic way and without putting forward any objective arguments (an updated synthesis can be found in Almeida 2008: 195).

These results suggest that at least part of the analysed vessels did not contain fish by-products.

In this particular case an indication for this option may be seen in the existence of the groove below the rim or on the upper part of the neck, a feature that can be considered one of the most defining typological characteristics of the LC67 or Ovoid 1 and 5 types.

The study of the function of this typological detail has not been addressed in the previous research on these types (Almeida 2008; González Cesteros, Almeida and García Vargas 2016; García Vargas, Almeida and González Cesteros 2016c). We consider that this attribute was designed to avoid dripping when the contents were transferred, so minimizing the loss of liquid. In any case, it is a structural detail that also many forms of ceramic tableware concerned with the handling of liquid contents display, as for instance the case of many regional variants of plain or slipped medium-sized jars. Finally, the total absence of faunal (bones, scales, spines, etc.) or botanic (seeds, etc.) remains inside the complete amphorae of these types that have been documented in shipwrecks, of which are at least several dozen (García Vargas 1998; Liou 2001; Almeida 2008), allows one to disclaim any regular connection with salted fish and fish sauces (at least those sorts that generate fish remains, namely the solid or semi-solid preserves).

For this reason, and taking into consideration the results of the analyses of organic residues absorbed by the coating of the amphorae, it seems reasonable to consider that at least some individuals of the two types of ovoid transport vessels from the Guadalquivir valley (Ovoid 1 and Ovoid 5) could have contained wine or its derivatives. It is also probable that other types associated with the generic group of the Lomba do Canho 67, including the Ovoid 1 from Cadiz area produced in the aforementioned Verinsur workshop, were likewise connected with wine products. In the case of the Ovoid 4, due to its typological similarity with the Haltern 70, it is again also highly probable that they transported wine or grape derivatives. Either way, it is necessary in the near future to make more frequent use of chemical residue analyses such as those carried out in this preliminary work, with many more samples taken from reliable archaeological contexts (including wrecks and well-preserved deposits). Only then may one verify or clarify the attribution proposals outlined above and define more firmly the content of the Ovoid 1 and Ovoid 4 series.

#### Acknowledgements

This study is the result of the projects 'La Ruta de las Estrímnides' (HAR2015-68310-P), 'Ánforas romanas y análisis de contenidos' (HAR2017-84242-P), RACAMed (HAR2017-84242-P), ARQUEOSTRA (201800104415) of the Operative Program Feder Andalucía 2014-2020 and 'GARVM II' (HAR2016-78691-P) funded by MINECO, and also of the Collaboration Agreement signed between the Autonomous City of Ceuta and the University of Cadiz. It is also part of the activities of the ERAAUB, Consolidated Group (2014 SGR 845) funded by the Comissionat per a Universitats i Recerca del DIUE of the Generalitat de Catalunya and the Ramon y Cajal contract of Alessandra Pecci (RYC 2013-13369) funded by the Ministerio de Economía y Competividad.

#### Bibliography

- Almeida, R.R. de 2008. *Las ánforas del Guadalquivir en Scallabis (Santarém, Portugal). Aportación al conocimiento de los tipos minoritarios* (Col.leció Instrumenta 28). Barcelona: Publicacions Universitat de Barcelona.
- Barnard, H., Dooley, A.N., Areshian, G., Gasparyan, B. and Faull, K.F. 2011. Chemical evidence for wine production around 4000 BCE in the Late Chalcolithic near eastern highlands. *Journal of Archaeological Science* 38: 977-984.
- Bernal-Casasola, D. 2000. *Análisis arqueológico de los restos del cargamento de un pecio romano de vino en Ceuta. Contribución al conocimiento de las relaciones comerciales entre la Baetica y la Mauretania Tingitana*. Unpublished Research Final Report (Memoria inédita de Ayuda a la Investigación), Ceuta, Instituto de Estudios Ceutíes.
- Bernal-Casasola, D. 2013. Septem Fratres, ciudad portuaria y comercial entre Juba II y Justiniano. Del palimpsesto de su arqueología preislámica, in *XV Jornadas de Historia de Ceuta. Arqueología en las Columnas de Hércules. Novedades y nuevas perspectivas*

- de la investigación arqueológica en el Estrecho de Gibraltar (Ceuta, 2012): 9-50. Ceuta: Instituto de Estudios Ceutíes.
- Bernal-Casasola, D. 2015. What contents do we characterise in Roman amphorae? Methodological and archaeological thoughts on a trending topic, in C. Oliveira, R. Morais and A. Morillo (eds) *Archaeoanalytics. Chromatography and DNA analysis in archaeology (Esposende, 2014)*: 61-83. Esposende: Município de Esposende.
- Bravo, J. and Muñoz, R. 1965. *Arqueología submarina en Ceuta*. Madrid: Consejo Superior de Investigaciones Científicas.
- Bravo, J. and Muñoz, R. 1968. Hallazgos arqueológicos submarinos en Ceuta. *Noticiario Arqueológico Hispánico* 10/12: 159-171.
- Bravo, J. and Muñoz, R. 1972a. Vestigios del pasado de Ceuta, in *Inmersión y Ciencia*: 5-39. Barcelona: Federación Española de Actividades Subacuáticas.
- Bravo, J. and Muñoz, R. 1972b. Vestigios del pasado de Ceuta. *Transfretana* 4, año IV: 49-82.
- Cau Ontiveros, M.Á., Martínez Ferreras, V., Pecci, A., Mas Florit, C. and Fantuzzi, L. 2018. Archaeometric analysis for provenance and content of Roman amphorae from the site of Sa Mesquida (Mallorca, Spain). *Mediterranean Archaeology and Archaeometry* Vol. 18, No. 2: 87-105.
- Charters, S., Evershed, R.P., Goad, L.J., Leyden, A., Blinkhorn, P.W. and Denham, V. 1993. Quantification and distribution of lipid in archaeological ceramics: implications for sampling potsherds for organic residue analysis and the classification of vessel use. *Archaeometry* 35: 211-223.
- Chic García, G. 1978. Acerca de un ánfora con pepitas de uva encontrada en la Punta del Nao (Cádiz). *Boletín del Museo de Cádiz*: 37-42.
- Condamin, J., Formenti, F., Metais, M.O., Michel, M. and Blond, P. 1976. The application of Gas Chromatography to the tracing of oil in ancient amphorae. *Archaeometry* 18 (2): 195-201.
- Díaz Rodríguez, J.J., Sáez Romero, A.M. and Sáez Espligares, A. 2012. Evidencias de un taller alfarero inédito en el territorium insular de Gades. El alfar de playa de Camposoto. *Boletín Ex Officina Hispana* 3: 26-29.
- Fabião, C. 1989. *Sobre as ânforas do acampamento romano da Lomba do Canho (Arganil)* (Cadernos da UNIARQ 1). Lisboa: Junta Nacional de Investigação Científica.
- García Vargas, E. 1998. *La producción de ánforas en la bahía de Cádiz en época romana (siglos II a.C. - IV d.C.)*. Écija: Gráficas Sol.
- García Vargas, E., Almeida, R.R. de and González Cesteros, H. 2011. Los tipos anfóricos del Guadalquivir en el marco de los envases hispanos del siglo I a. C. Un universo heterogéneo entre la imitación y la estandarización. *Spal* 20: 185-283.
- García Vargas, E., Almeida, R.R. de and González Cesteros, H. 2016a. Ovoide 6 (Valle del Guadalquivir), in *Amphorae ex Hispania. Paisajes de producción y de consumo*, <<http://amphorae.icac.cat/amphora/ovoid-6-guadalquivir-valley>>, 20 julio, 2016.
- García Vargas, E., Almeida, R.R. de and González Cesteros, H. 2016b. Ovoide 4 (Valle del Guadalquivir), in *Amphorae ex Hispania. Paisajes de producción y de consumo*, <<http://amphorae.icac.cat/amphora/ovoid-4-guadalquivir-valley>>, 20 julio, 2016.
- García Vargas, E., Almeida, R.R. de and González Cesteros, H. 2016c. Ovoide 5 (Valle del Guadalquivir), in *Amphorae ex Hispania. Paisajes de producción y de consumo*, <<http://amphorae.icac.cat/amphora/ovoid-5-guadalquivir-valley>>, 20 julio, 2016.
- Garnier, N. 2003. *Structural analysis of organic amorphous materials preserved in archaeological ceramics. Contribution of chromatography and mass spectrometry*. Unpublished PhD dissertation, Université Pierre et Marie Curie Paris VI / École Normale Supérieure de Paris Ulm.
- Garnier, N. 2007a. Analyse de résidus organiques conservés dans des amphores: un état de la question, in M. Bonifay and J.C. Trégliá (eds) *LRCW 2. Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and Archaeometry* (British Archaeological Reports, International Series 1622): 39-49. Oxford: Archaeopress.
- Garnier, N. 2007b. Annexe: analyse du contenu des amphores africaines, in E. Papi (ed.) *Supplying Rome and the Empire, Proceedings of an International Seminar (Siena / Certosa di Pontagnano, may 2-4, 2004)* (Journal of Roman Archaeology Supp. 69): 25-31. Portsmouth, R.I.: Journal of Roman Archaeology.
- Garnier, N. and Pecci, A. forthcoming. Amphorae and residue analysis: content of amphorae and organic coatings, in D. Bernal-Casasola, M. Bonifay and A. Pecci (eds) *Proceedings of the Roman Amphora Contents International Interactive Conference (RLAMP Series)*. Oxford: Archaeopress.
- Garnier, N., Silvino, T. and Bernal-Casasola, D. 2011. L'identification du contenu des amphores: huile, conserves de poissons et poissonnage. *SFECAG. Actes du congrès d'Arles* (Arles, 2-5 juin 2011): 397-416. Marseille: SFECAG.
- Garnier, N. and Valamoti, S.M. 2016. Prehistoric wine-making at Dikili Tash (Northern Greece): Integrating residue analysis and archaeobotany. *Journal of Archaeological Science* 74: 195-206.
- González Cesteros, H., Almeida, R.R. de and García Vargas, E. 2016. Ovoide 1 (Valle del Guadalquivir), in *Amphorae ex Hispania. Paisajes de producción y de consumo*, <<http://amphorae.icac.cat/amphora/ovoid-1-guadalquivir-valley>>, 08 julio, 2016.
- Guash-Jané, M.R., Ibero Gómez, M., Andrés-Lacueva, C., Jáuregui, O. and Lamuela-Raventós, R.M. 2004. Liquid chromatography with mass spectrometry in tandem mode applied for the identification of wine markers in residues from ancient Egyptian vessels. *Analytical Chemistry* 76: 1672-1677.
- Liou, B. 2001. Las ánforas béticas en el mar, in D. Bernal-Casasola and E. García Vargas (eds) *Actas del Congreso Internacional Ex Baetica Amphorae. Conservas, aceite y vino de la Bética en el Imperio Romano (Écija y Sevilla, 17-*



- 20 diciembre, 1998): 1061-1110. Écija: Gráficas Sol.
- Manacorda, D. and Pallecchi, S. (eds) 2012. *Le fornaci romane di Giancola (Brindisi)*. Bari: Edipuglia.
- McGovern, P.E. 2004. *Ancient Wine: The Search for the Origins of Viniculture*. Princeton: Princeton University Press.
- Mirò i Canals, J. 1988. *La producció de ánforas romanas en Catalunya. Un estudio sobre el comercio del vino de la Tarraconense (siglos I a.C.-I d.C.)* (British Archaeological Reports, International Series 473). Oxford: British Archaeological Reports.
- Molina Vidal, J. 1997. *La dinámica comercial romana entre Italia e Hispania Citerior*. Alicante: Universidad de Alicante / Instituto de Cultura Juan Gil-Albert.
- Pecci, A. 2009. Analisi funzionali della ceramica e alimentazione medievale. *Archeologia Medievale* 36: 21-42.
- Pecci, A. and Cau Ontiveros, M.Á. 2010. Análisis de residuos orgánicos en ánforas. El problema de la resina y del aceite, in J.M. Blázquez Martínez and J. Remesal Rodríguez (eds) *Estudios sobre el Monte Testaccio (Roma)* V (Col. Lecció Instrumenta 35): 593-600. Barcelona: Publicacions Universitat de Barcelona.
- Pecci, A. and Cau Ontiveros, M.Á. 2014. Análisis de residuos orgánicos en algunas ánforas del Monte Testaccio (Roma), in J. M. Blázquez Martínez and J. Remesal Rodríguez (eds) *Estudios sobre el Monte Testaccio (Roma)* VI (Col. Lecció Instrumenta 47): 601-613. Barcelona: Publicacions Universitat de Barcelona.
- Pecci, A., Clarke, J., Thomas, M., Muslin, J., Van der Graaff, I., Toniolo, L., Miriello, D., Crisci, G.M., Buonincontri, M. and Di Pasquale, G. 2017. Use and reuse of amphorae. Wine residues in Dressel 2-4 amphorae from Oplontis Villa B (Torre Annunziata, Italy). *Journal of Archaeological Science, Reports* 12: 515-521.
- Pecci, A., Domínguez-Bella, S., Buonincontri, M., Miriello, D., De Luca, R., Di Pasquale, G., Cottica, D. and Bernal-Casasola, D. 2018. Combining residue analysis of floors and ceramics for the study of activity areas at the Garum Shop at Pompeii. *Archaeological and Anthropological Sciences* 10: 485-502.
- Pecci, A., Giorgi, G., Salvini, L. and Cau Ontiveros, M.Á. 2013. Identifying wine markers in ceramics and plasters with gas chromatography-mass spectrometry. Experimental, ethnoarchaeological and archaeological materials. *Journal of Archaeological Science* 40: 109-115.
- Pecci, A., Salvini, L. and Cantini, F. 2010. Residue analysis of some Late Roman amphora coming from the excavations of the historical centre of Florence, in S. Menchelli, S. Santoro, M. Pasquinucci and G. Guiducci (eds) *LRCW3. Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and Archaeometry* (British Archaeological Reports, International Series 2185): 363-367. Oxford: Archaeopress.
- Pecci, A., Salvini, L., Cirelli, E. and Augenti, A. 2010a. Castor oil at Classe (Ravenna, Italy): residue analysis of some Late Roman amphorae coming from the port, in S. Menchelli, S. Santoro, M. Pasquinucci and G. Guiducci (eds) *LRCW3. Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and Archaeometry* (British Archaeological Reports, International Series 2185): 617-622. Oxford: Archaeopress.
- Pecci, A., Vaccaro, E., Cau Ontiveros, M.Á. and Bowes, K. 2015. Wine consumption in a rural settlement in Southern Tuscany during Roman and Late Roman times, in E. Cirelli, F. Diosono and H. Patterson (eds) *Le forme della crisi. Produzioni ceramiche e commerci nell'Italia centrale tra Romani e Longobardi (III-VIII sec. d.C.)*, *Atti del Convegno (Spoleto-Campello sul Clitunno, 5-7 Ottobre 2012)* (Collana 'Ricerche' - Series Maior 5): 229-238. Bologna: Ed. Ante Quem.
- Romanus, K., Baeten, J., Poblome, J., Accardo, S., Degryse, P., Jacobs, P., De Vos, D. and Waelkens, M. 2009. Wine and olive oil permeation in pitched and non-pitched ceramics: relation with results from archaeological amphorae from Sagalassos, Turkey. *Journal of Archaeological Science* 36: 900-909.
- Sáez Romero, A.M. 2014. Fish Processing and Salted-Fish Trade in the Punic West: New Archaeological Data and Historical Evolution, in E. Botte and V. Leitch (eds) *Fish & Ships: Production et commerce des salsamenta durant l'Antiquité (Actes de l'atelier doctoral, Rome 18-22 juin 2012)* (Bibliothèque d'Archéologie Méditerranéenne et Africaine 17): 159-174. Aix-en-Provence: Publications du Centre Camille Jullian.
- Sáez Romero, A.M. and Díaz Rodríguez, J.J. 2012. Entre tierra y mar, entre lo púnico y lo romano. Adaptaciones económicas y territoriales en un medio cambiante: algunas notas sobre paleogeografía y sistemas de explotación del hinterland insular de Gadir/Gades, in B. Mora Serrano and G. Cruz (coords) *La etapa neopúnica en Hispania y el Mediterráneo centro occidental: identidades compartidas* (Serie Historia y Geografía 246): 259-300. Sevilla: Publicaciones de la Universidad de Sevilla.
- Sáez Romero, A.M., Montero Fernández, A.I. and Díaz Rodríguez, J.J. 2005. Nuevos vestigios del santuario gadirita de Melqart en Sancti Petri (San Fernando, Cádiz), in *Congreso Internacional El Periodo Orientalizante. III Simposio de Arqueología de Mérida (Mérida, mayo de 2003)* (Anejos de AEspA XXXIII): 873-878. Madrid: Consejo Superior de Investigaciones Científicas / Instituto de Arqueología de Mérida.
- Woodworth, M., Bernal-Casasola, D., Bonifay, M., De Vos, D., Garnier, N., Keay, S., Pecci, A., Poblome, J., Pollard, M., Richez, F. and Wilson, A. 2015. The content of African Keay 25/Africana 3 amphorae: initial results, in C. Oliveira, R. Morais and A. Morillo (eds) *Archaeoanalytics. Chromatography and DNA analysis in archaeology (Esposende, 2014)*: 35-50. Esposende: Município de Esposende.
- Zamora López, J.A. and Sáez Romero, A.M. 2014. The Oceanfront of Phoenician Cadiz: A new epigraphic find and its palaeogeographical context, in M. Botto (ed.) *Los Fenicios en la Bahía de Cádiz. Nuevas Investigaciones* (Collezione di Studi Fenici 46): 251-263. Pisa-Roma: Fabrizio Serra Editore.