ENTRE MARES

Emplazamiento, infraestructuras y organización de los puertos romanos

Mertxe Urteaga
Antonio Pizzo
(Eds.)

Volumen II

«L'ERMA» di BRETSCHNEIDER
Roma - Bristol

ENTRE MARES

Emplazamiento, infraestructuras y organización de los puertos romanos

VOLUMEN II

Edición del volumen:
Mertxe Urteaga y Antonio Pizzo

Coordinación editorial:
Mertxe Urteaga y Antonio Pizzo

Diseño y maquetación:
Artes Gráficas Rejas, S. L. Mérida (Spain)

Ilustración de la cubierta: Reelaboración de un segmento de la Tabula Peutingeriana (K. Miller, 1898)

ENTRE MARES
Emplazamiento, infraestructuras y organización de los puertos romanos
(Hispania Antigua, Serie Arqueológica, 15)

ENTRE MARES. Emplazamiento, infraestructuras y organización de los puertos romanos

1012 p.; 21x29,7 cm. (Hispania Antigua. Serie Arqueológica, 15)
ISBN brossura: 978-88-913-3270-7
ISBN PDF: 978-88-913-3271-4
DOI: 10.48255/9788891332714
CDD 930 Archeologia
ISSN: 2612-0003

Índice

VOLUMEN I

MEDITERRÁNEO OCCIDENTAL

ÁFRICA DEL NORTE

MAR ROJO

MEDITERRÁNEO ORIENTAL I

VOLUMEN II

MAR NEGRO

MEDITERRÁNEO ORIENTAL II

OCÉANO ATLÁNTICO

PUERTOS FLUVIALES Y LACUSTRES

DOI: 10.48255/9788891332714.63

The harbour installations of the coastal settlements of Boca do Rio and Cerro da Vila (Algarve, Portugal)

Las instalaciones portuarias de los asentamientos costeros de Boca do Rio y Cerro da Vila (Algarve, Portugal)*

Florian Hermann[**], **João Pedro Bernardes**[***], **Felix Teichner**[****]

Abstract

The maritime industry of the Roman Iberian provinces was located in both urban and highly specialised coastal settlements. Boca do Rio and Cerro da Vila in Portugal (Algarve) are two typical examples of these production sites, where favourable natural conditions were used in a far-seeing manner. In both settlements, harbour installations were added to the production facilities specifically for the pursued economic purposes. They did not serve trade purposes in the wider sense, save a specific and vital role regarding the operation of the production plants to ensure a connection to the immediate production network. In both cases siltation caused major problems in the long-term operation of the ports.

Keywords: Fish sauce, *garum*, maritime economy, aglomeraciones secundarias, geoarchaeology.

Resumen

La industria marítima de las provincias ibéricas romanas se localizaba en asentamientos costeros tanto urbanos como altamente especializados. Boca do Rio y Cerro da Vila, en Portugal (Algarve), son dos ejemplos típicos de estos lugares de producción, en los que las favorables condiciones naturales se aprovechaban con visión de futuro. En ambos asentamientos, las instalaciones portuarias se añadieron a las instalaciones de producción específicamente para los fines económicos perseguidos. No servían a fines comerciales en sentido amplio, salvo un papel específico y vital en relación con el funcionamiento de las plantas de producción para garantizar una conexión con la red de producción inmediata. En ambos casos, la sedimentación causó problemas importantes en el funcionamiento a largo plazo de los puertos.

Palabras clave: Salsa de pescado, *garum*, economía marítima, aglomeraciones secundarias, geoarqueología.

* La traducción del título al castellano, el resumen y palabras clave se deben a los editores.

** Vorgeschichtliches Seminar an der Philipps-Universität Marburg orcid.org/0000-0001-9499-7419 florian.hermann0@gmail.com
*** Universidade do Algarve - CEAACP orcid.org/0000-0002-1086-2128 jbernar@ualg.pt
**** Vorgeschichtliches Seminar an der Philipps-Universität Marburg orcid.org/0000-0003-4276-0983 felix.teichner@staff.uni-marburg.de

Introduction

For the Hispanic and north African provinces of the Roman Empire, preserved maritime products, which can generally be summarised as *salsamentum* and *garum* respectively, represented an important aspect of the local economy whose products were widely sold throughout the Roman world. The sites of Boca do Rio (Budens, Vila do Bispo) and Cerro da Vila (Vilamoura, Quarteira) are typical representatives of the more than 300 locations known so far regarding this maritime industry, which itself was embedded into a complex network of different agents, namely salting plants or workshops, amphora potteries, salt works/gardens, fisheries and coastal traders (Fig. 1).

As is to be expected, most sites in this economic sector are concentrated along the coast, especially at river mouths, bays and estuaries. Aside from numerous sites of urban contexts, the main settlement context of workshop sites were the specialised *villae maritimae* and village-like to semi-urban settlements (*vici*, aglomeraciones secundarias). Regarding the examples of Boca do Rio and Cerro da Vila the demand of this maritime business on the logistical infrastructure can be observed.

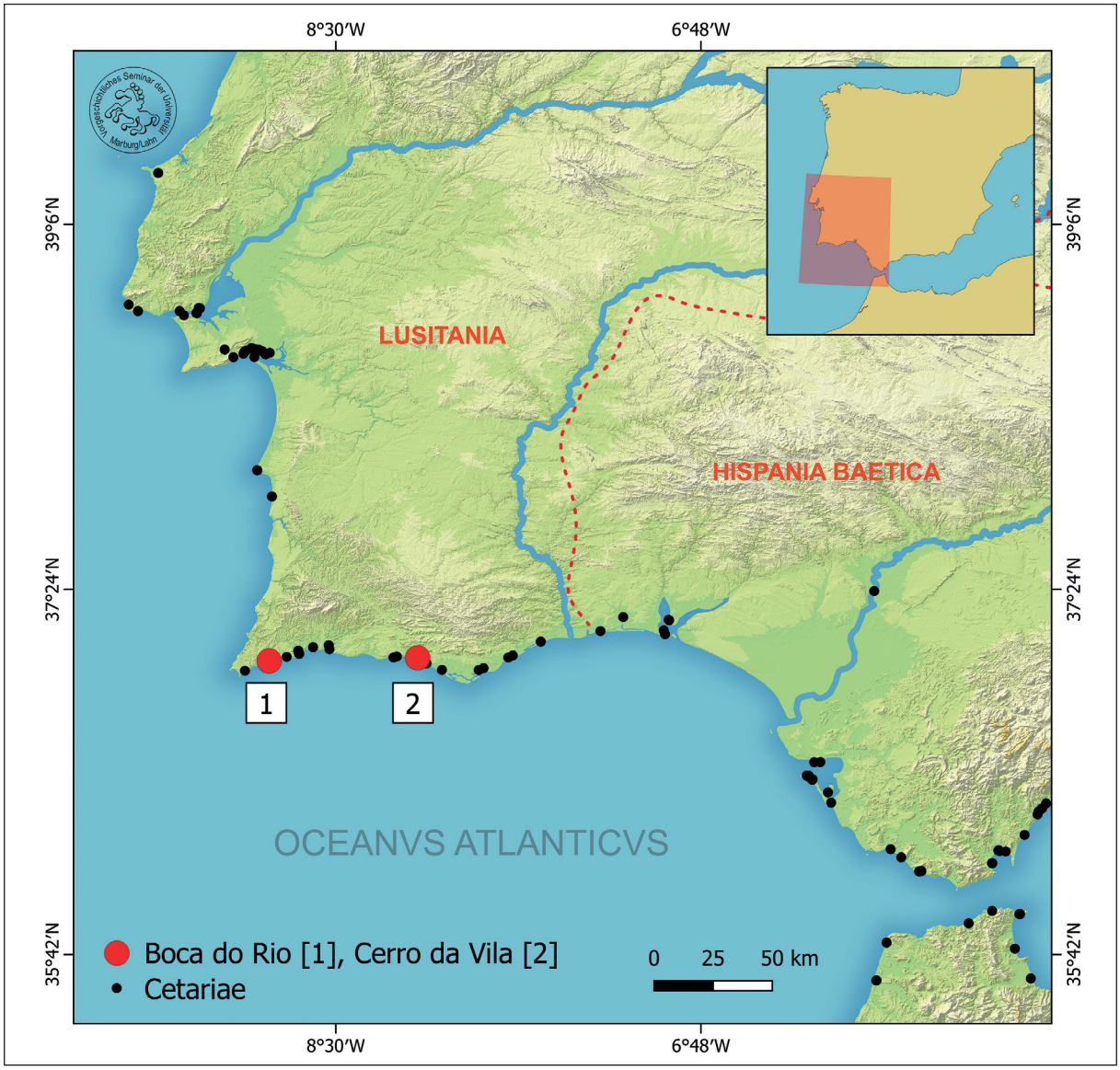

Fig. 1: Distribution of *cetariae* (fish-salting workshops) along the southern Atlantic coastline of the Iberian Peninsula with the Lusitanian settlements of Boca do Rio (1) and Cerro da Vila (2) highlighted (*cetariae* distribution: RAMPPA).

The site of Boca do Rio

Location and topography

Boca do Rio is located on the southwestern Algarve coast, Portugal (37°04'00'' N and 08°48'37'' W), approximately 18 km east of Cape St Vincent (Sagres) and 15 km west of the town of Lagos (Fig. 1). It is a formerly V-shaped, flat-floored, sediment-filled river valley, dissecting a coast with prominent Jurassic and Cretaceous cliffs to the west and east, and bordered by the Atlantic to the south (Hindson *et al.,* 1999). This floodplain valley, consisting of mostly fine-grained Holocene sediments (silt, clay), extends up to 1 km inland, where it is divided into three sub-valleys. The dynamic and seasonally blocked gravelly and sandy river mouth highly influences the surrounding floodplain and beach. A dune complex, bordered by steep terrain with an eroding cliff and a beach break with coarse gravel and boulders from the cliff, is situated to the west of the floodplain and covers the Roman ruins (Feist *et al.,* 2019; Hermann *et al.,* 2022a).

At the beginning of the Roman occupation of the site in the second half of the first century AD, it is assumed that the estuary was still largely open to the sea, although protected by a sand barrier. However, paleochannels identified in the aforementioned floodplain indicate that most parts of the estuary were only partially navigable (Feist *et al.,* 2019). The retreating qcoastline offered ideal conditions for the production of salt in evaporation ponds due to an extensive tidal marsh on its edges and high evaporation rates during the summer months.

Description and typology

The geophysically detected harbour installations of Boca do Rio extend over 100m along the banks of the estuary (Bernardes *et al.,* 2022; Hermann *et al.,* 2022 b). In addition, facilities most likely also existed along the sand barrier, for example in the form of a fortified shore edge. So far, the archaeological investigations have been focused on workshop I, a rectangular, NW-SE orientated building with a length of 45.0m and a width of 9.5m (Hermann *et al.,* 2022b). In front of the central segment of this structure, a stone quay had been built. It was connected to an elevated rectangular platform measuring 1.20 × 1.50 × 1.30m, with a walking surface at 3.12m a.s.l.[1], which allowed access to the workshop. To the northwest, the platform drops vertically down to a mat foundation (Fig. 3, UE 212) built of coarse stone. To the southeast, however, a 0.15m step connects the platform with a ramp (UE 175), which has a gradient of around 9.1° and a minimum height of 2.1m a.s.l. A two-stage staircase (UE 298) built of lateres and a monolithic limestone ashlar is attached. Approximately 1.0m above the level of the ramp (UE 175), a vertically perforated mooring stone (UE 295) protrudes 0.26m from the façade of the wall (UE 252) towards the former estuary. Along the inner side edges of its 0.10m wide bore hole it shows clear signs of local abrasion.

Just below the bottom step of the staircase an approximately 0.05m thick layer of poorly sorted pebbles with medium-sized shattered and partially worn ceramic material, broken shell fragments and traces of lime plaster was found. This ancient surface can be interpreted as an intentional, anthropogenically reinforced beach section between 1.37 and 1.26m a.s.l. To the north it connects to an approximately 2.4m wide rampart of boulders (UE 392), which was placed in front of the walls (UE 177=252) and their foundations (UE 212) to support and protect the structures from waves and tides.

[1] All information given on altitude relative to sea level refers to today's level.

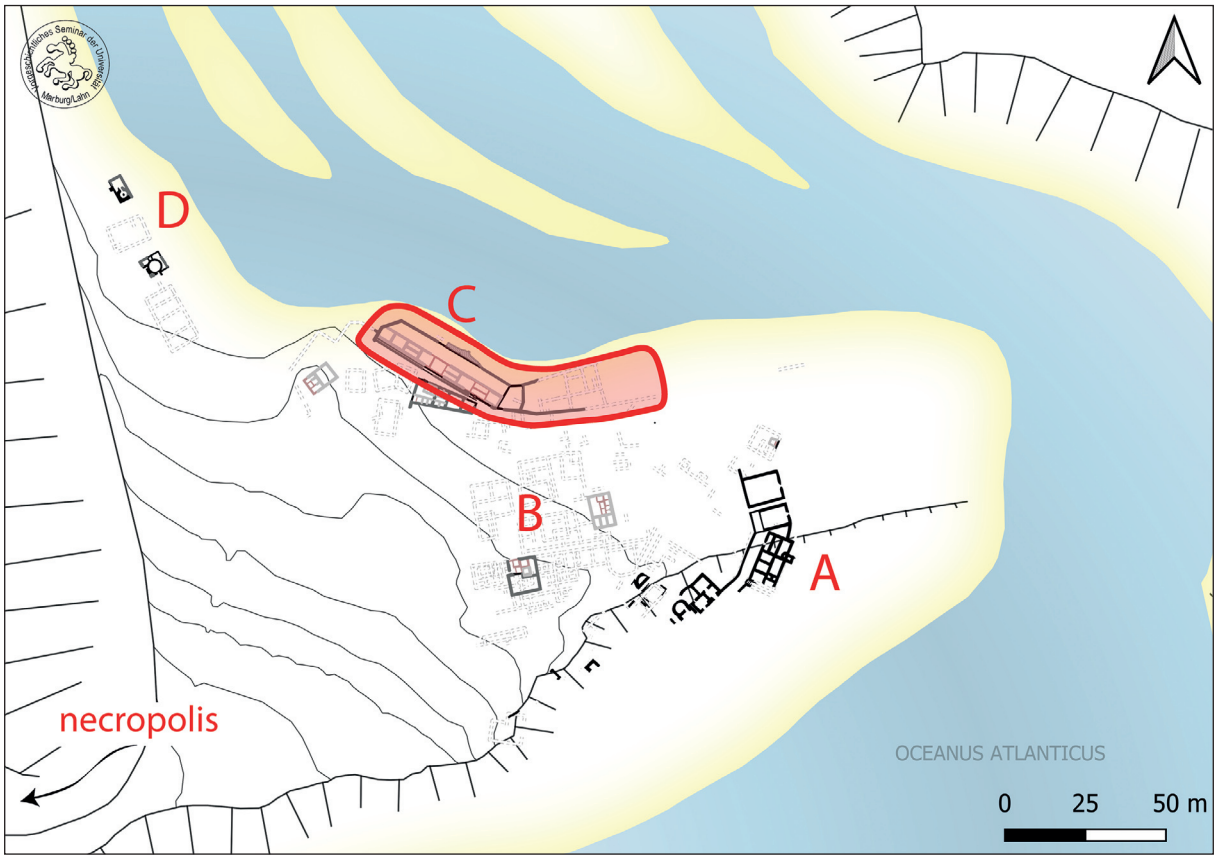

Fig. 2. Boca do Rio. General plan of the settlement's residential (A) and production (B; D) areas as well as the combined harbour and production buildings (C) highlighted in red. Given positions of streams in the paleo-estuary are hypothetical.

Building phases and chronology

In a second phase of use, roughly constructed quarry stone walls (UE 248 + 172) were erected on both sides of the rectangular platform (UE 175), orthogonally adjacent to the outer wall (UE 177=252). These – UE 248 to the southeast and UE 172 to the southwest – are between 0.90 and 0.95m wide and extend over the width of the ramp (UE 175) and the foundations (UE 212) below. Due to their coarse type of construction, the two walls are quite distinctive in comparison to the original structure. Remarkably, both walls were erected at a distance of 0.25m from the original platform (UE 175), thus leaving 0.25 wide and 1.40m long rectangular gaps, with a depth ranging from 0.15 to 0.20m, between them. The two walls were both built on top of a complex sequence of sediments and levelling layers (UE 245, 249, 391, 390, 388).

We interpret this modification to be the sign of the replacement of the previous stone quay by a wooden structure, serving then as a pier or footbridge (Fig. 3, B). This conclusion is further supported by the accumulation of long bronze and iron nails in the harbour area. By elevating the level of the port installations, the continued access to a receding waterfront could be achieved (Hermann *et al.,* 2022a).

The dating of this modification is mainly based on ceramic material from the aforementioned levelling layers, with two fragments originating directly from the wall (UE 248) itself. In contrast to this material, which mainly consists of African cookware and Hispanic terra sigillata, material from the sediments dating after the modification work (UE 248) already contains African red slip ware (ARS-D). This absence indicates a deposition of the material before the middle of the third century AD. A

fragment of charcoal (BDR-18-853) from one of the levelling layers (UE 249) was radiocarbon-dated to cal. AD 135-332 (2σ), with a clear peak at the end of both the second and the third centuries AD. In connection with the aforementioned chronological range of the ceramic finds, the overall picture points to the late second or the first half of the third century AD as being the most probable date for the modification work. This also gives a *terminus ante quem* for the initial harbour structures and the workshop I, which can thus be dated to the second century AD in analogy to structures in the residential area of the site even to the first half of the second century AD (Bernardes *et al.,* 2022). The harbour as a whole and the associated workshop were in operation until the fourth century, most likely the second half.

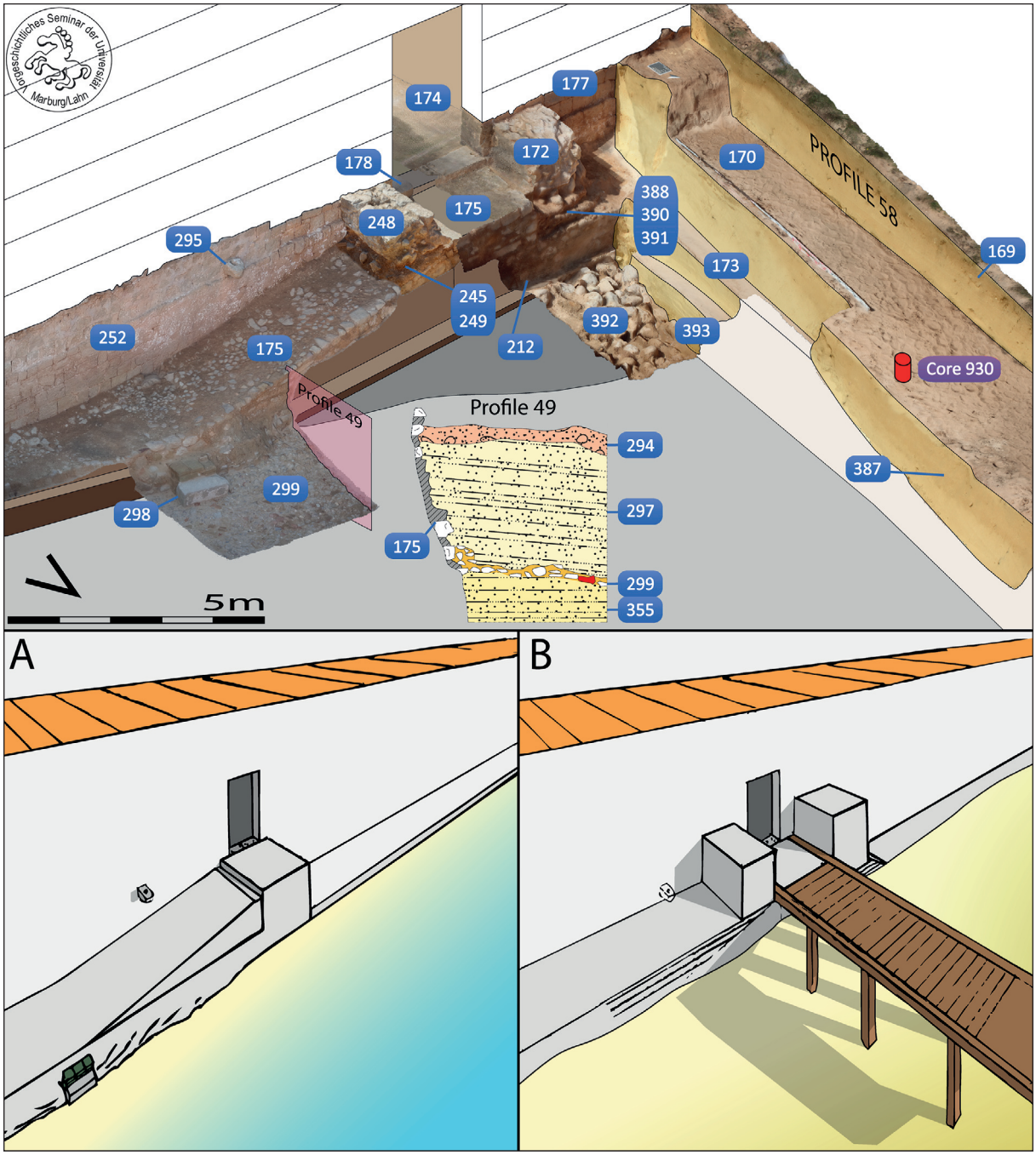

Fig. 3. Boca do Rio. Isometric view of the quay and entrance to workshop I (above) and evolution of the structures with the reconstruction of the main building phases (below, A+B). Numbers indicate stratigraphic units (UE).

Associated facilities

According to the geophysical measurements, the Roman settlement extended in a NW-SE direction approximately 180m along the palaeo-estuary (Fig. 2; Hermann *et al.,* 2022b). Most of the remaining structures are fish salting workshops with fermentation vats, as demonstrated by recent excavations (Fig. 2.B; Bernardes *et al.,* 2022; Hermann *et al.,* 2022; Hermann *et al.,* 2022b). Their estimated accumulated vat volume distinguishes Boca do Rio as a supra-regional centre of this non-agricultural economy. The northern part of the settlement is occupied by a small pottery workshop with two kilns (Fig. 2.D). Along the southern part, now mainly eroded by the sea, stretched an area with residential buildings and a *balneum* (Fig. 2.A; Bernardes y Medeiros, 2016; Bernardes *et al.,* 2022).

The harbour facilities themselves follow the palaeo-shoreline of the estuary (Fig. 2.C). They are strongly interconnected with the fish-salting workshops, as can be seen in workshop I, where the façade wall of the harbour serves also as the outside wall of the workshop. This unit contained 12 vats of long rectangular or close to square shape. With sizes of about 3.90 × 3.40 × 2.14m and 4.60 × 1.30-1.50 × 2.27m respectively, the net volume of the workshop not only exceeds all other workshops known in Boca do Rio but also the entire Algarve region. Adjacent to the workshop a small storage facility was situated. The results of the geophysical prospection suggest further storehouses following the shoreline towards the southeast (Hermann *et al.,* 2022b).

Spatial and functional planning, other aspects: interpretation

By land the quay was only reachable through the aforementioned workshop I. Although the (past) existence of additional quays cannot be ruled out (nor should their existence surprise!), due to the high uniformity observed within this building phase of the settlement, it does not seem advisable to assume a considerably changed layout. We thus expect other possible quays or landing stages within these harbour installations to have been of a similarly exclusive nature. From these observations and thoughts can be fairly securely deduced that the installations discovered were erected to fulfil very specific tasks, namely to guarantee the in- and outflow of specific goods needed for the production (i.e. raw fish, salt, fresh water) and shipment (i.e. transport vessels such as amphorae) themselves. Amphorae finds from the harbour basin confirm that this area was used for loading and discharging cargo.

The site of Cerro da Vila

Location and topography

The Cerro da Vila is located on the southwestern Algarve coast, Portugal (3°04’49’’ N and 8°07’22’’ W), approximately 50 km east of Lagos and 18 km west of the town of Faro (Fig. 1). The geomorphological situation on the Vilamoura coast reveals a former lagoon which extended almost parallel to the coastline about 5 km inland. This former estuary is orientated in a NW-SE direction and corresponds in its extent to the present floodplain of the Quarteira River, which is up to 2 km wide. The present floodplain is separated from the coast by a cliff of Miocene and Quaternary sandstones and gravels. The cliff consists of Pleistocene fluvial sands and gravels that have been attacked by fluvial erosion of the Quarteira River from the north and coastal erosion from the south (Hilbich *et al.,* 2005; Schneider *et al.,* 2010; Teichner *et al.,* 2014).

At the beginning of the construction of the Roman harbour settlement on the lagoon, during the provincialisation, the lagoon was already largely silted up. Its appearance corresponded more to a coastal marsh or marshland in which only some flow channels of the Quarteira River or the tidal current still existed. Corresponding contemporary palaeo-channels in the area of Cerro da Vila, to which navigability was restricted, have already been identified (Teichner, 2016; Teichner, 2017).

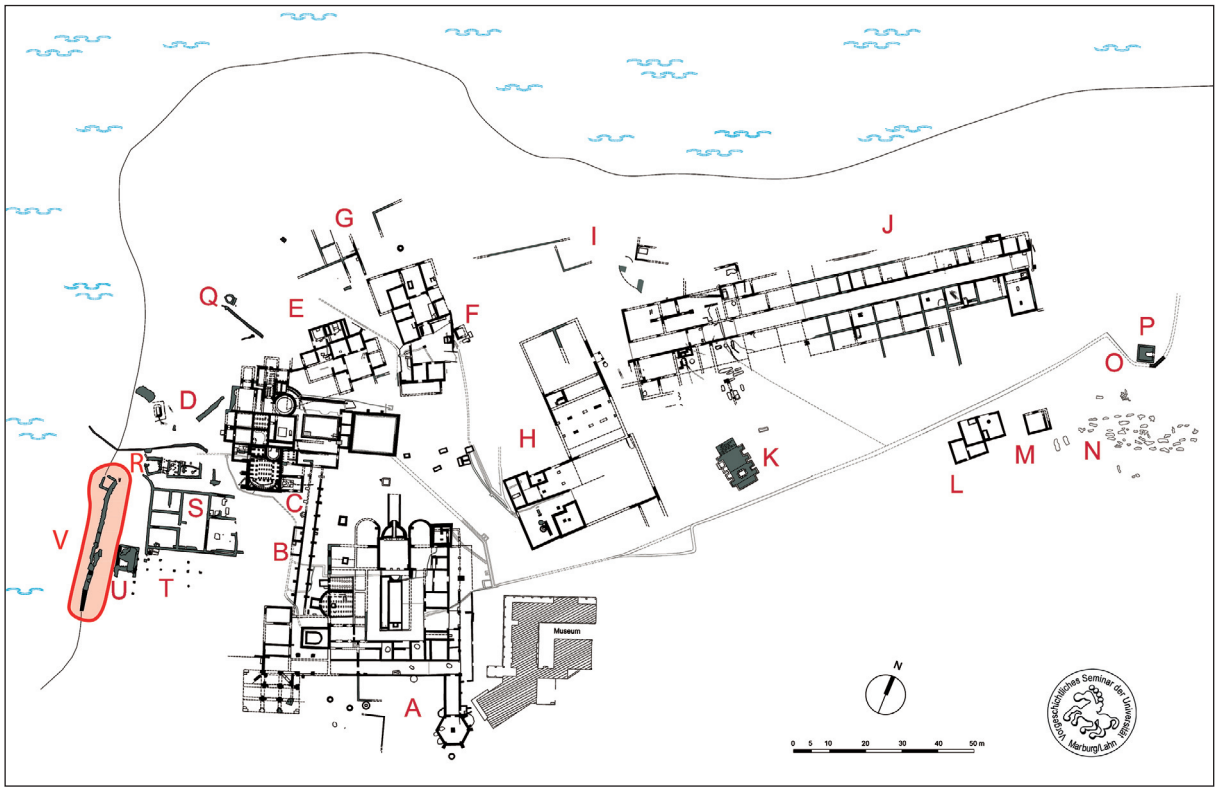

Fig. 4. Cerro da Vila. General plan of the settlement with the harbour area (V) highlighted in red.

Description and typology

The settlement of Cerro da Vila (Vilamoura) is bordered to the west by a wall (Fig. 4, V) made of natural stone, which can be classified as a bank reinforcement, maybe with the additional mooring characteristics of a quay. The structure (Fig. 5, UE 26) runs relatively straight from north to south and measures 1.0 to 1.10m wide. The excavated length is 32.30m, but the total length is unknown, because the structure extended southward beyond the boundaries of the excavation. At its northern end, a rectangular annex of the same construction phase is situated.

The bank reinforcement is preserved to a height of only 0.6m and is partly made of heavily eroded natural stones, which are a maximum of 0.35 – 0.40m in size. The stones are laid rather densely, without being fixed with mortar. Occasionally, there are fragments of yellow- and red-fired bricks on the upper edge of the wall and shell remains between the stones. It seems that the stones were piled up directly on the embankment, which may have been cut somewhat vertically beforehand for this purpose. The entire wall sits at a height of 1.85m a.s.l. (modern!) on a grey-toned layer.

In the southern part of the wall (UE 26), evidence can be found for later extension or reconstruction work in the form of a superstructure (UE 27). This addition, for which spolia were used, was accessible through a ramp made of *opus caementitium* (UE 30). This reconstruction is separated from the underlying original structure by a thin layer of sediment of marine origin.

The rectangular annex (UE 49) at the northern end measures about 3.75 × 2.50m and consists of at least three layers of stone. Its 0.50 – 0.55m wide walls were built of 0.15 – 0.40m large rubble stones without the use of mortar. Its preservation in the eastern part, where it connects to UE 26, is better than in the west (facing the estuary), where it is only badly preserved.

To the northeast of the wall, north of the annex (UE 49), between 1.58m and 1.75m a.s.l., four log trunks (UE 53) were uncovered lying closely next to each other. The layer overlying the logs contains mortar fragments. It is intersected with the foundation of the bank reinforcement, which confirms that the wooden structure is older than the wall. Since these finds were only recorded within a small stratigraphic section, no further statements can be made about their overall extent. However, the section may be interpreted as the walking surface of a pier that reached into the contemporaneous channels.

Building phases and chronology

The stone layers of the annex (UE 49) and the wall (UE 26) are interlocked without a visible seam, therefore they can be assigned to the same construction phase. The ceramic evidence from the related construction layers suggests that these structures were not built before the Flavian era, which is supported by the radiocarbon dates (Fig. 5, a-b).

A second phase of remodelling, consisting of a superstructure of unknown characteristics and a ramp constructed of *opus caementitium* can be identified. Re-used architectural materials (*spolia*), for example decorative elements (e. g. mouldings) made of grey marble, were incorporated into the construction. A radiocarbon date from the marine sediment layer which separates the two phases gives a date in the second half of the third or the beginning of the fourth century AD (Fig. 5, c).

This separation of these harbour installations into two construction periods is of special importance. After some kind of destruction, the bank reinforcement wall (UE 26) was re-built on a higher level (UE 27). A comparable chronology has already been attributed by archaeological means to the hiatus in the nearby fabrica J (Teichner, 2008; Teichner, 2017). From this broader perspective, it is no longer a question of local development limited to one building. Rather, it seems that large, if not all, parts of the buildings near the shore were affected by an assumed high-energy event (Teichner, 2017).

Regarding the wooden pier (UE 53) found at the northern end of the bank reinforcement wall and based on the materials found, only little can be said about its absolute chronology. Stratigraphically speaking, the pier is older than the stone structure which replaced it. Taking into account the low walking level, this surface could be among the oldest actual harbour structures of the Cerro da Vila, very likely connected to the first settlement phase in the late Republican to pre-Flavian period. This is why it has to be considered the first phase of the Roman harbour of the Cerro da Vila (Teichner, 2017).

Associated facilities

The Cerro da Vila belongs to the group of *agglomération secondaire* characterised by a wide spectrum of production and residential buildings (with mosaic floors), including private and public baths, and a necropolis. The site's economical basis was firmly grounded in the maritime economy. While the residential buildings A-C, E and F were situated on the highest area of the site, they were surrounded by production and commercial buildings, located closer to the ancient bank of the estuary (Fig. 4).

The largest of the production facilities, building J, at 114m long, was located at the northern edge of the settlement, parallel to the contemporaneous shoreline. It consisted of two large production halls and rooms arranged parallel to a central street enclosed by the complex. Within the rooms vats of 1.90 to 2.45m length and 0.75 to 1.75m width, with a minimum depth of at least 0.60m. An associated pier for unloading cargo has been assumed to exist but has yet to be found (Teichner, 2008; Teichner, 2017).

In the western part of the settlement, where the actual harbour has been identified, a dense development can be observed. The orientation and level of numerous sewage canals (*cloacae*) which

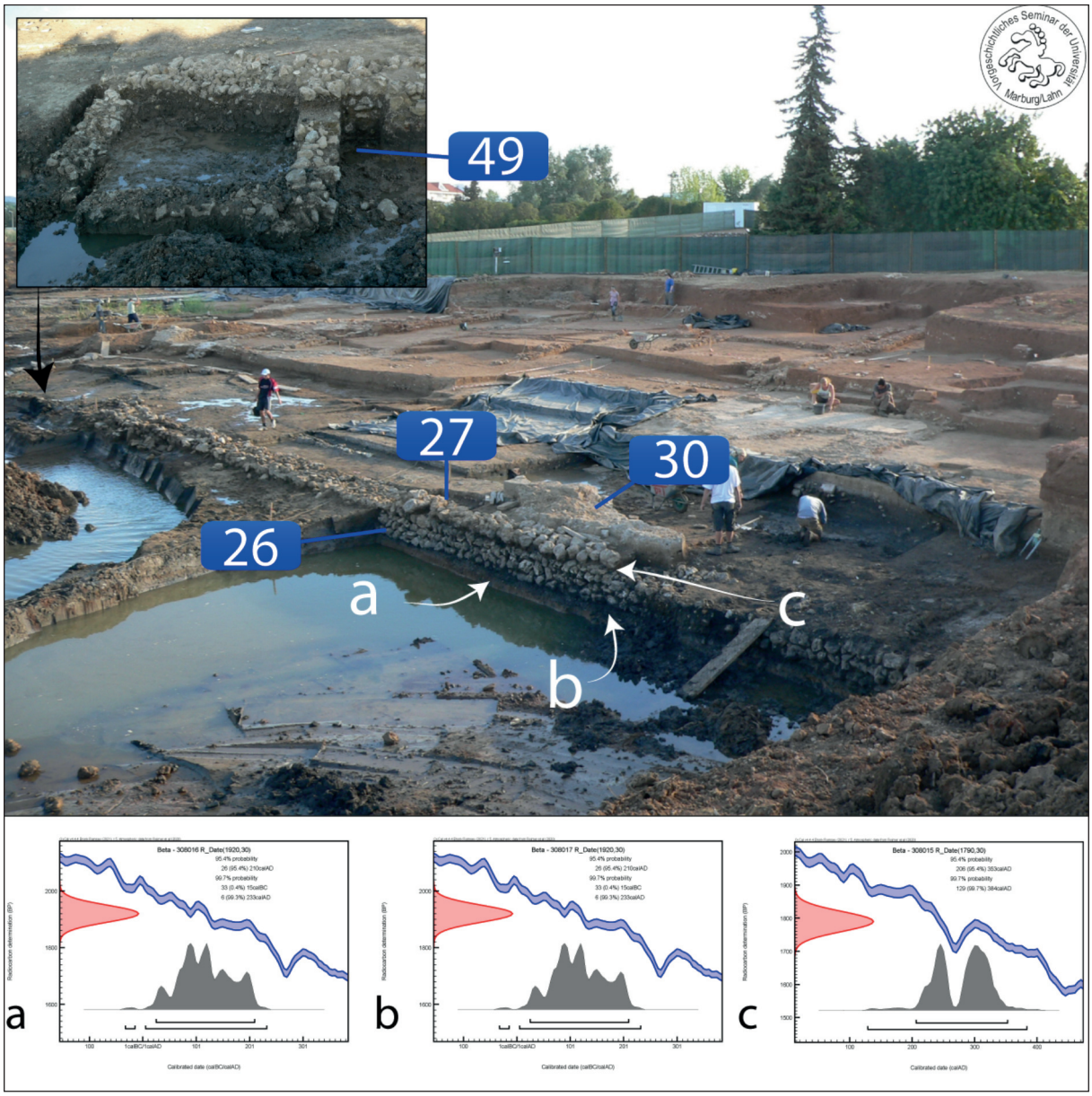

Fig. 5. Cerro da Vila. Photographs of the ongoing excavation of the bank reinforcement (UE 26) and annex/tower? (UE 49, inlet), also the C14 dates dating the first (a+b) and second (c) phases.

flowed into the ancient waterbody, suggest a steep natural westward sloping of the terrain with a height difference of more than 3m. The above-ground structures can be divided into production buildings (S) and an extensive maritime-themed "garden" or "fresh water cult" architecture (D, Q, U), which encircled the other buildings.

Building S had a rectangular ground plan, an area of nearly 480m^2 and an east-west oriented long axis. Sunken amphorae, a well, a bailing system and a small basin indicate its use for production (fish sauces) and storage purposes. The "garden" architecture, which accompanied the westward harbour installations consists, for one, of the public baths (C; Teichner, 2020), but also of the excessive display of fresh water in the context of two *nymphaea* (Q, U) and an open garden *triclinium* with a small water basin and a maritime-themed mosaic (D).

Spatial and functional planning, other aspects: interpretation

Similar to what has been observed in Boca do Rio, the workshops at Cerro da Vila are also very close to the shoreline, which was fortified in the western part, where contemporaneous palaeo-channels have also been found (Teichner, 2017). This elaborate bank reinforcement is strongly reminiscent of a similarly functional, although more complex, feature in the provincial capital *Tarraco* (Tarragona). There, commercial buildings (*horrea*) were closely arranged along a quay wall on the shoreline, just like building unit S on the Cerro da Vila (Adserias *et al.,* 2000; Pociña y Remolà, 2001).

The reinforcement could have also served another purpose. Its annex was likely the base for a large platform measuring approximately 6m². Such a rectangular structure built onto the quay wall could have been the basis of a certain type of observation deck or tower as described for fishing stations, which were used for watching schools of fish (θυννοσχοπεϊον: Strabon V 2, 6. 8; XVII 3,16), or as a basis for a navigational light.

Conclusion

The harbour installations of both Boca do Rio and the Cerro da Vila faced towards the palaeo-estuary. In this way, they were shielded from the strong waves and tidal forces of the Atlantic Ocean. With this natural protection, breakwaters or similar structures seem to have been unnecessary, as in both cases, no such evidence has been found so far. However, their positioning in the estuary has two major implications: Firstly, the access to the harbour basin, or the estuary itself, would be very limited given the fact that at the time only rather narrow palaeo-channels were actually navigable. This results in only ships with little draught, like small scale boats (such as of *caudicarius* type), being able to access the installations.

Secondly, siltation was a major problem on a medium scale. As shown in the estuary of Cerro da Vila (Teichner, 2008; Schneider *et al.,* 2010) and in the case of Boca do Rio (summary above; en détail: Hermann *et al.,* 2022a), this ongoing process results in changing courses of navigable channels, thus further limiting, or even hindering, access to the port-structures.

Therefore, it may be concluded that the harbours of Boca do Rio and the Cerro da Vila did not serve trade purposes in the wider sense, but played a specific and vital role regarding the operation of the production plants by ensuring a connection to the immediate production network (amphorae, salt, raw fish, etc.). In Boca do Rio, the harbour's ongoing importance can be seen in the effort taken to overcome the increasing siltation problems of the palaeo-estuary by the erection of a wooden pier or footbridge in order to ensure its functionality. The discovery of the *in-situ* mooring stone also points us to the distinguished position that the structures occupy in comparison with numerous other Roman harbour settlements on the Iberian Peninsula (Bernal Casasola, 2017, 330-332).

Finally, it is again worth noting the excellent natural location of the two sites, which not only offered a sheltered anchorage, but also provided a good supply of resources for the maritime economy. Highly specialised fish-salting plants were set up in these «sweet spots». These, Boca do Rio and Cerro da Vila, are just two examples of the Lusitanian and Baetian small maritime settlements with their own harbour buildings, which served not only for fishing but also as a hub for the production network of the Roman maritime economy.

Bibliography

Adserias Sans, M., Pociña López, C. A. y Remolà Vallverdú, J. A. (2000). "L'hàbitat suburbà portuari de l'antiga Tàrraco. Excavacions al sector afectat pel PERI 2 (Jaume I – Tabacalera)". In: Ruiz de Arbulo, J. (coord.). *Tàrraco 99. Arqueologia d'una capital provincial romana. Actes de les jornades d'arqueologia sobre intervencions a la ciutat antiga i al seu territori (1993–1999)*. Doc. Arqu. Cláss. 3, Tarragona: Universitat Rovira I Virgili, 137–154.

Bernal-Casasola, D., Expósito, J. A., Díaz, J. J., Carayon, N., Strutt, K., Salomon, F., Keay, S. (2017). "Baelo Claudia, Puerto pesquero, comercial y de viajeros. Nuevas perspectivas". In: Campos Carrasco, J. M. (coord.). *Los puertos romanos Atlánticos, Béticos y Lusitanos y su relación comercial con el Mediterráneo*. Hispania Antigua ser. Arqueológica, 7, Rom: L'Erma, 309-344.

Bernardes, J. P. y Medeiros, I. E. (2016). "Boca do Rio (Budens, Vila do Bispo). Novos dados de uma villa piscícola romana". *Revista Portuguesa de Arqueologia,* 19, 265–286.

Bernardes, J. P., Teichner, F., Hermann, F. y Soares, R. (2022). "Novos dados do sítio pesqueiro romano da Boca do Rio". In: *Actas do X Encuentro de Arqueología del Suroeste Peninsular*.

Feist, L., Frank, S., Bellanova, P., Laermanns, H., Cämmerer, C., Mathes-Schmidt, M., Biermanns, P., Brill, D., Costa, P. J.M., Teichner, F., Brückner, H., Schwarzbauer, J. y Reicherter, K. (2019). "The sedimentological and environmental footprint of extreme wave events in Boca do Rio, Algarve coast, Portugal". *Sedimentary Geology*, 389, 147–160.

Hermann F., Feist, L., Teichner, F., Bernardes, J. P., Reicherter, K., Brückner, H. (2022a). "At the mercy of the sea –Vulnerability of Roman coastal settlements in the Algarve (Portugal). Boca do Rio as an emblematic example of a key marine industry". In: Marti Aguilar, M. A. (coord.). *Historical Earthquakes and Tsunamis in the Iberian Peninsula*, Springer Earth System Sciences.

Hermann, F., Paul, K., Teichner, F., Reicherter, K. y Brückner, H. (2022 b). "GeoarchäologischeForschungen zur römischen Fischsaucenproduktion in Lusitanien: Boca do Rio und Tróia". In: Engel, M., Stock, F. y Brückner, H. (Coords.). *Coastal Geoarchaeology in the Mediterranean – on the Interdependence of Landscape Dynamics, Harbour Installations and Economic Prosperity in the Littoral Realm, Panel 2.3*, Archaeology and Economy in the Ancient World 5, 5–25. https://doi.org/10.11588/propylaeum.897.c11658

Hermann, F., Bernardes, J. P., Teichner, F. y Soares, S. (2022 c). "A Centre of Export Oriented 'garum' Production on the Shore of Roman Lusitania". In: Bentz, M. y Heinzelmann, M. (coord.). *Sessions 2 – 3, Single Contributions*. Archaeology and Economy in the Ancient World 53, Heidelberg: Propylaeum, 573–576.

Hilbich, C., Mügler, I., Daut, G., Frenzel, P., Teichner, F. y Mäusbacher, R. (2005). "Geophysikalische, sedimentologische und mikrofaunistische Methoden zur Rekonstruktion der Paläogeographie einer römischen Hafensiedlung: Die Landschaftsgenese der Lagune von Vilamoura (Portugal) während der letzten 6000 Jahre". In: Beck, N. (coord). *Neue Ergebnisse der Meeres- und Küstenforschung: Beiträge der 23. Jahrestagung des Arbeitskreises Geographie der Meere und Küsten vom 28. - 30. April 2005, Universität Koblenz-Landau, Campus Koblenz*, Koblenz: MPI, 51-71.

Hindson, R.A., Andrade, C. y Paris, R. (1999). "A microfaunal and sedimentary record of environmental change within the late Holocene sediments of Boca do Rio (Algarve, Portugal)". *Geol. Mijnb.*, 77, 311-321.

Pociña López, C. A. y Remolà Vallverdú, J. A. (2001). "Nuevas aportaciones al conocimiento del puerto de Tarraco (Hispania Tarraconensis)", *Saguntum*, 33, 85-95.

Schneider, H., Höfer, D., Trog, C., Busch, S., Schneider, M., Baade, J., Daut, G. y Mäusbacher, R. (2010). "Holocene estuary development in the Algarve Region (Southern Portugal) – A reconstruction of sedimentological and ecological evolution", *Quaternary International*, 221, 141–158.

TEICHNER, F. (2008). *Zwischen Land und Meer – Entre tierra y mar. Studien zur Architektur und Wirtschaftsweise ländlicher Siedlungen im Süden der römischen Provinz Lusitanien*, Stvdia Lvsitana, 3, Merida: Museo Nacional de Arte Romano.

TEICHNER, F. (2016). "A Multi-Disciplinary Approach to the Maritime Economy and Palaeo-Environment of Southern Roman Lusitania". In: Vaz Pinto, I., de Almeida, R. R. y Archer, M. (coords.). *Lusitanian Amphorae: Production and Distribution*, Roman and Late Antique Mediterranean Pottery, 10, Oxford: Archaeopress Archaeology, 243-257.

TEICHNER, F. (2017). "Cerro da Vila: A rural commercial harbour beyond the Pillars of Hercules". In: Campos Carrasco, J. M. (coord.). *Los puertos romanos Atlánticos, Béticos y Lusitanos y su relación comercial con el Mediterráneo*. Hispania Antigua ser. Arqueológica, 7, Rom: L'Erma, 403-435.

TEICHNER, F. (2020). "Las termas públicas de Mirobriga y Cerro da Vila: reflejos arquitectónicos del desarrollo de dos asentamientos lusitanos". In: Noguera Celdrán, J. M., García-Entero, V. y Pavía Page, M. (coord.). *Termas públicas de Hispania*. SPAL Monografías Arqueología, 33, Sevilla: Editorial Universidad de Sevilla, 825-831.

TEICHNER, F., SCHNEIDER, H., HÖFER, D., MÄUSCHBACHER, R. Y DAUT, G. (2014). "Investigações geo-arqueológicas sobra a configuração do litoral algarvio durante o Holoceno – Resultados preliminares", *Revista Portuguesa de Arqueologia*, 17, 141–158.

TEICHNER, F. Y WINKEMEIER, A. (2023). "Cerro da Vila (Portugal). An Example of a Harbour Infrastructura Typical of the Rural Maritime Economy of Roman Lusitania", In: Pasquinucci, M. y Facella, A. (coord.) *Porti antichi e retroterra produttivi,* Pisa University Press.

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES
CSIC Consejo Superior de Investigaciones Científicas
EEHAR Escuela Española de Historia y Arqueología en Roma - CSIC
Gipuzkoako Foru Aldundia
Kultura, Lankidetza, Gazteria eta Kirol Departamentua
Diputación Foral de Gipuzkoa
Departamento de Cultura, Cooperación, Juventud y Deportes
FUNDACIÓN ARKEOLAN
Irun OIASSO MUSEOA
ISBN 978-88-913-3270-7