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Plant economy in the westernmost territory of the Roman state through waste: the wet site of O Areal (Vigo, Spain)

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Abstract: The Roman economy of the Iberian Peninsula has habitually been characterised in terms of prestige goods and economic activities such as trade, mining and metallurgy. The analysis of plant-based foods –less prestigious but more essential in everyday life– has commonly been marginalised in state-of-the-art reviews. The O Areal saltworks is exceptional in terms of the large number of organic materials it preserves, and the excellent state of that preservation. After its abandonment (end of the 3rd/4th century AD), the saltworks was briefly used as a dumping ground for the surrounding area. The site's archaeobotanical remains, preserved under anoxic, waterlogged conditions, consist of the building materials used at the saltworks, tools and other artefacts, organic objects employed in activities such as fishing, and refuse. The assemblage suggests a wide diversity of species to have been introduced into northwestern Iberia during the Roman Period, including the mulberry, peach, fig, plum, grapevine, and melon. The notable presence of other edible fruit species that normally grew wild during this period, such as chestnut, walnut, stone pine, and cherry trees, might be related to the start of their cultivation.

Keywords: waterlogged preservation; millet; arboriculture; crop expansion; urban area; Iberian Peninsula.

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1 Introduction

The representativeness of plants in the archaeobotanical record is conditioned by many factors, including their selection and transformation by humans, the environmental and edaphic conditions where the remains were deposited, their alteration by biotic factors, the stability of the deposition conditions, and how such materials were recovered and stored during archaeological excavations. Plant materials for which fire is involved at some point in their gathering, processing, storage, consumption or discarding, are commonly much better represented than those that are consumed fresh, require much processing, or that rapidly perish. Although the Iberian Peninsula has a diversity of climatic conditions, the seeds and fruits represented in the Roman archaeological record are usually found in the form of charred remains (Peña-Chocarro et al. 2019). Waterlogged sites have received relatively little attention (Figure 1) but could help complement our archaeobotanical knowledge. Such sites include the saltworks of O Areal (Vigo, Spain) (Teira Brión 2010), the healing spa of Aquae Flaviae (Chaves, Portugal) (Vaz et al. 2016), the well of Idanha-a-Velha (Portugal) (Almeida and Ferreira 1967) and the structures of the port of Irun (Euskadi, Spain) (Carrión 2012; Peña-Chocarro and Zapata 1997; Peña-Chocarro and Zapata 2005; Urteaga Artigas 2003; Urteaga Artigas and Gereñu Urzelai 2003).

Constantly submerged, waterlogged sediments facilitate the preservation of organic matter, including that used to make objects. The oxygen turnover is slow, generating conditions unsuitable for microbial growth, consequently reducing the rate of degradation (Bleicher and Schubert 2015). This allows for the better preservation of leaves, pericarps, endocarps, woody materials and fibres commonly broken down at dry sites, although it does not favour the preservation of cereal caryopses (their recovery from wet sites is unusual). The organic remains found at wet sites can, of course, have been affected by transport or re-deposition (Antolín et al. 2017a), or changes in the physicochemical conditions and relative humidity of the surrounding water and sediment (Martín Seijo et al. 2010).

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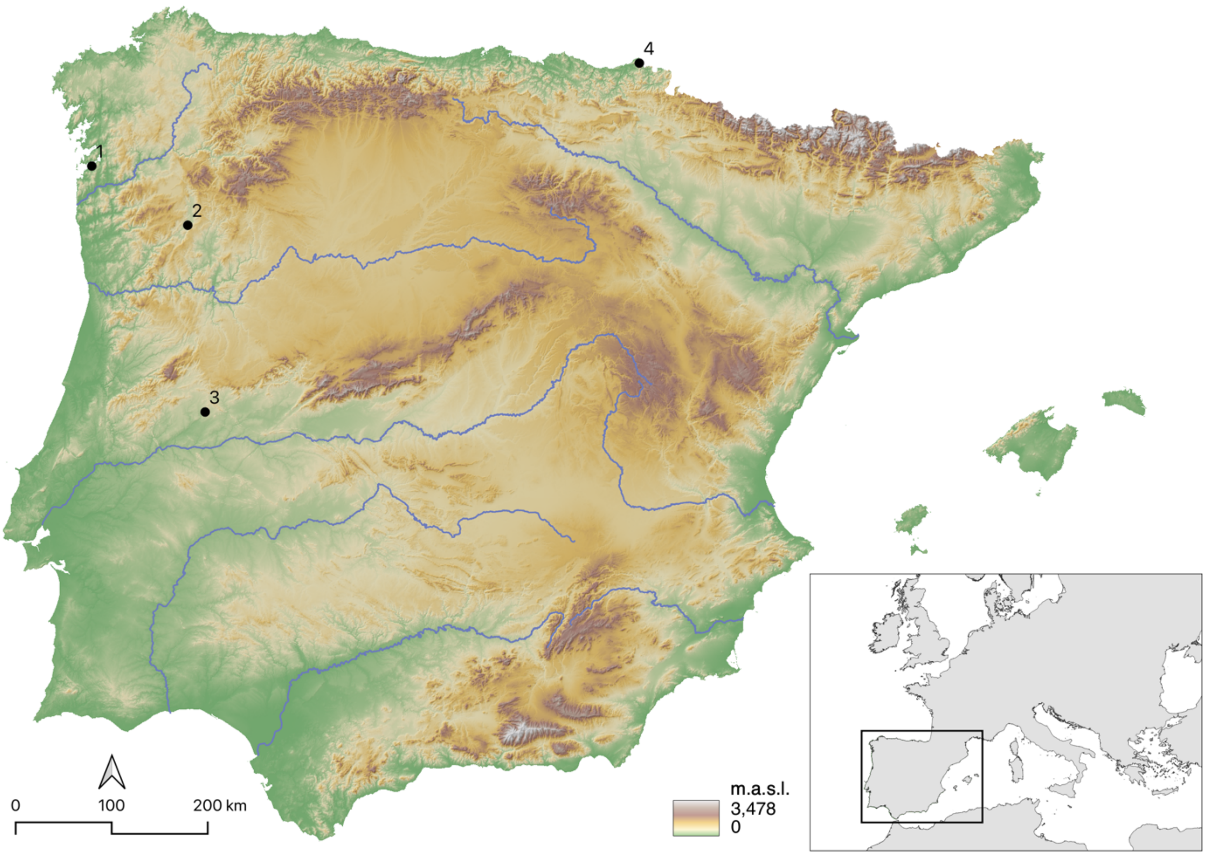

Figure 1 Location of waterlogged Roman sites in the Iberian Peninsula: 1) O Areal, 2) Aquae Flaviae, 3) Idanha-a-Velha, and 4) Irun.

1.1 Archaeological background

The conquest of the Iberian Peninsula by the Roman State (218-19 B.C.) brought about a social and economic rupture. In agriculture, its impact can be observed at several scales: a) the introduction of new crops (Peña-Chocarro et al. 2019); b) new forms of land organisation and exploitation (Brun 2004; Lewit 2020); c) changes in the social structure of labour (Alfaro Giner 2010; Rodríguez Neila et al. 1999), and d) the integration of agricultural production within more global trade systems (Carreras and Morais 2012; Martín i Oliveras et al. 2017; Rubio-Campillo et al. 2018). The arrival of new fruit-tree species from the Mediterranean began during the 1st millennium B.C., thanks to the establishment of Phoenician and Greek colonies on the Mediterranean and southern Atlantic coasts (Buxó 2008; Pérez-Jordà et al. 2021). It was during this time that pomegranate (*Punica granatum*), almond (*Prunus dulcis*), and fig (*Ficus carica*) trees arrived, along with the grapevine (*Vitis vinifera* subsp. *vinifera*) and melon (*Cucumis m*elo) (Pérez-Jordá et al. 2017). Although these civilisations established commercial exchanges and intense cultural contacts, arboriculture did not fully spread throughout Iberia during the Iron Age (cf. Pérez-Jordà et al. 2021). Certainly, it was not until the Roman conquest that new food crops (possibly including rye) and ornamental species (*Cupressus sempervirens*) were introduced and the interior and north of the Peninsula became home to plants cultivated in the Mediterranean area (vines, figs, olives, peaches, melons) (Alonso Martínez 2005; Peña-Chocarro et al. 2019; Teira Brión and Rey Castiñeira 2021; Tereso et al. 2020; Vaz et al. 2016).

It is not easy to trace the biographies of many of these new crops in the archaeobotanical literature. The arrival of Mediterranean peoples could have driven the development of innovative agricultural practices and led to the domestication of certain local species, new domestic varieties, and perhaps even allowed for genetic exchange with wild varieties, as suggested for grapevine (Cunha et al. 2020; Freitas et al. 2021; Riaz et al. 2018). The same may have been true for other species at this time, such as chestnut (*Castanea sativa*), apples/pears (*Pyrus/Malus*), olive (*Olea europaea*) or sweet cherry (*Prunus avium*); species that frequently appear in archaeobotanical assemblages (cf. Peña-Chocarro et al. 2019) but whose remains offer little information regarding a wild or domestic origin. The context in which they are found, and their frequency, need to be taken into account in any interpretation of their presence.

Some crops, e.g., citrus fruits (*Citrus medica* and *Citrus limon* - the citron and lemon respectively) known from texts, pictorial representations and preserved seeds and fruits (Zech-Matterne and Fiorentino 2017) to have been present in other parts of the Roman State, e.g., the Italian Peninsula, did not arrive in the Iberian Peninsula in Roman Period according to current data (Peña-Chocarro et al. 2019). The same is true for black pepper (*Piper nigrum*), bottle gourd (*Lagenaria siceraria*), sesame (*Sesamun indicum*), and rice (*Oryza sativa*) (Bakels and Jacomet 2003; Bosi et al. 2020; Jacomet and Vandorpe 2011; Livarda 2011; Wiethold 2003). Their absence (and that of other species) may be due, however, to a) the need for further archaeobotanical study, b) these species being associated –in very specific contexts– with poorer social classes or high-status individuals, or c) differences in the adoption of the same species within the different territories that made up the state. Knowing the reasons why crops were accepted or not in each territory allows for the economic transformations that took place, and the preferences and habits in food and drink, to be observed, bringing us closer to understanding how society changed, and to comprehending the intercultural context that laid the foundations of Roman culture in Iberia.

1.2 Objectives

The O Areal saltworks provides an opportunity to gain new knowledge about the use of plant species by human communities during the Roman Period in the Iberian Peninsula, complementing that made available by other archaeobotanical research lines (Peña-Chocarro et al. 2019). The site is home to an interesting assemblage of archaeobotanical remains preserved below sea level, some of which have been the subject of previous publications (Martín-Seijo 2019; Teira Brión 2010). The majority are construction structures, wooden artefacts, the seeds, and fruits etc. of cultivated and wild species, foodstuff residues, and objects made of organic (e.g., leather) and inorganic materials.

The aim of the present work is to identify the plants represented in the organic matter-containing level that was deposited over the saltworks after it was abandoned. The results throw light on the establishment of a Roman agricultural economy in northwestern Iberia, on how urban areas may have acted centres for the expansion of new agricultural practices, on the introduction of new crops, the consumption of species present in the natural environment, the possible combined use of domestic and wild plants, and on how human activity affected the natural environment, complementing the information obtained in previous archaeobotanical research –see (Peña-Chocarro et al. 2019).

2 The saltworks of O Areal

Salting was a known food processing technique in the northwest of the Iberian Peninsula from at least the mid 2nd century B.C. (González Gómez de Agüero 2013; Rodríguez Martínez et al. 2011), although it was not until the Roman Period that it became an important economic activity. Pelagic species such as the sardine (*Sardina pilchardus*) were commonly caught (González Gómez de Agüero 2013) to make salting and sauces (García Vargas and Bernal Casasola 2009). Salting fish, however, required a reliable supply of salt. A series of coastal saltworks (cf. Currás Refojos 2007) was thus established to extract it from sea water. The O Areal saltworks, with a surface area of around 10 Ha (García Vargas and Martínez Maganto 2017), is one of the largest ever identified in the Roman State (Currás 2017). The structures of the saltworks extend for more than a kilometre parallel to the coastline of the present-day city of Vigo (cf Castro Carrera 2006; Castro Carrera 2007; Castro Carrera et al. 2019; César Vila 2010; Iglesias Darriba 2009; Iglesias Darriba 2010; Iglesias Darriba et al. 2017).

The construction of the saltworks was associated with the transformation and anthropization of a fluvial-marine complex with a lagoon environment that formed around 1500-1000 B.C.

(Tallón-Armada et al. 2018). Its development may have been favoured by the beginning of the Roman Warm Period (100 B.C.-400 A.D.), characterised by a drier and warmer conditions than the previous climatic phase (Tallón-Armada et al. 2018). This, together with the stabilisation in sea level or its slight rise, may have justified the location of this type of exploitation on the Atlantic coast (Tallón-Armada et al. 2018). The archaeological levels prior to the saltworks have been radiocarbon dated to 149 cal B.C.-116 cal A.D. (2020±40 BP) (Tallón-Armada et al. 2015), and the ceramic materials they contain indicate that the first construction facies of the ponds would have taken place after 50-70 A.D. (Iglesias Darriba et al. 2017).

O Areal was a solar evaporation saltworks divided into three main areas connected by a system of channels and sluices (Castro Carrera 2007): 1) settling ponds, where brackish water was stored and decanted to remove materials in suspension; 2) evaporation ponds where the salt concentration was increased through exposure to the sun, and 3) crystallisation ponds, where the transformation into salt crystals took place. The settling ponds documented in the eastern sector are rectangular in shape and between 14.6-16.2 m long and 7.5 to 8.3 m wide (Iglesias Darriba et al. 2017). The walls, made of slabs of schist and granite, were 0.7-0.8 m high, indicating that the water would have been around 0.6 m deep (Iglesias Darriba et al. 2017). This water entered under the control of a sluice (Iglesias Darriba et al. 2017). The same sector contains several crystallisation ponds and a building that could have been used for storage (Iglesias Darriba et al. 2017). The crystallisation ponds were built on stone slabs with a clay pavement, and had small walls bordering them. A peculiarity is that these ponds were located higher than the evaporation ponds, requiring brine of variable density –depending on the degree of Baumé reached– be transported to them manually or mechanically (García Vargas and Martínez Maganto 2017; Iglesias Darriba et al. 2017).

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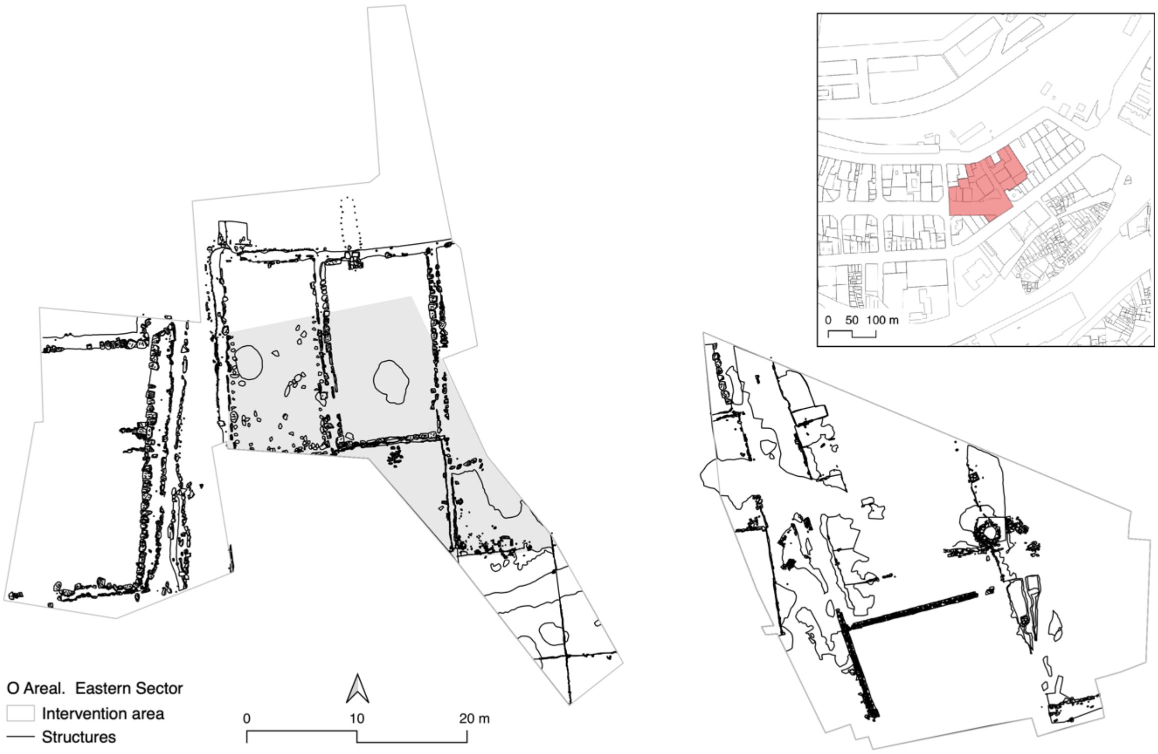

Figure 2 Evaporation and crystallisation ponds in the eastern sector of the O Areal site (*Unidade de Actuación II-06*). Sediment around samples B2548 and B2616 was gathered from SU1049 (grey area). Re-drawn from the survey plan of M. J. Iglesias Darriba and M. Á. Sartal Lorenzo.

The increase in rainfall at the end of the 3rd century A.D. may have shortened the useful brine evaporation period (Tallón-Armada et al. 2015), perhaps leading to the end of the saltworks' activity in the 4th century A.D. However, the lack of a general context for saltworking in northwestern Iberia renders it impossible to know whether salt production was abandoned because of changes in the activity of the fish-salting factories it served. The zenith of the latter activity was reached during the Early Roman Empire; in the 3rd-4th A.D. centuries it declined and many salting installations disappeared, a crisis that affected the entire Iberian Peninsula (cf. Corrales Aguilar 2011-2012; Expósito Álvarez 2011).

The abandonment of the saltworks is marked in the archaeological record by levels of stones resulting from the collapse of the surrounding structures, on which a level with a high content of silt and clay formed (Tallón-Armada et al. 2018), plus an intercalated sandy deposit representative of a coastal-marine environment that accumulated a large amount of organic matter (Tallón-Armada et al. 2015). The plant remains within it have been interpreted as the result of a higher tides (Iglesias Darriba et al. 2017). However, materials of marine origin, e.g., mollusc shells and different highly eroded materials, are very rare. The organic matter deposited where the saltworks once stood may therefore have arrived: 1) in the form of human waste, or 2) via a stagnant water ecosystem under the influence of marine-littoral conditions, with contributions of vegetation from the river system that flowed into the surrounding salt marsh (Teira Brión 2010). However, the accumulation of waste from anthropogenic activities, such as debris, crafted objects, wooden tools (Martín-Seijo 2019), and the seeds and fruits of domestic and wild plant species, is evidence of strong human pressure from the nearby settlement; in effect, the abandoned saltworks was used as a dumping ground (Teira Brión 2010). This deposit has been dated to 259-280 and 335-416 cal A.D. (Figure 3), an estimate reached by combining the two radiocarbon dates available: Beta-267583:1720±40 B.P. (Tallón-Armada et al. 2018; Tallón-Armada et al. 2015) and Beta-302977:1680±30 B.P. (Teira Brión 2013).

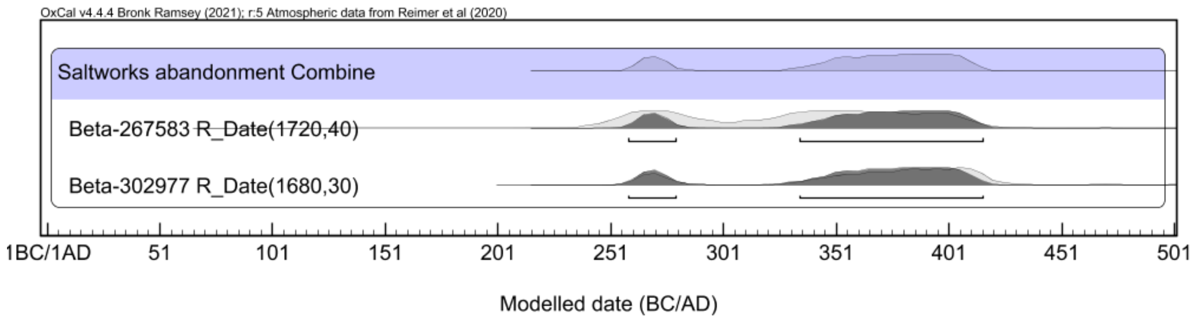

Figure 3 Chronology of the organic matter in the abandonment deposit, estimated using the Combine function in OxCal v.4.4.4. software (Bronk Ramsey 2009) and employing the IntCal20 curve (Reimer et al. 2020).

The above levels are overlain by a dune level. Indeed, the entire abandonment facies is marked by the appearance of sandy levels with aeolian morphological characteristics and edaphogenetic features suggesting a buried soil horizon and thus the stability of the above dune (Tallón-Armada et al. 2015). In the vicinity, and over part of the buried site, a burial and cremation necropolis began to appear in 350-400 A.D., lasting until the Early Middle Ages (César Vila 2010; Iglesias Darriba 2010; Valle Abad et al. 2020).

3 Materials and methods

The archaeobotanical samples examined in this work come from the *Unidade de Actuación I-06* in Rosalía de Castro Street, Vigo (Spain), an archaeological area that was excavated over five archaeological campaigns between 2006 and 2008. Their geographical location refers to the outline of the stratigraphic units of origin; xyz coordinates were not provided. The sediment comes from the deposit of organic matter that appeared after the abandonment of the saltworks, and from successive levels of fill that formed over the saltworks' ponds. Of the total 127 samples collected, 115 were analysed. Most were manually collected and included worked wooden objects and the remains of seeds and fruits; 29 samples were either wet or dry sediment that required processing to extract their contents (see below).

The majority of the examined remains were collected during the CD 102A 2006/368 campaign in sediment from stratigraphic unit SU1049, a wet and sandy-loamy deposit formed inside the evaporation ponds. This was covered by a sand dune up to 1 m in height with several levels of organic matter interspersed in its lower part. It preserved huge quantities of organic matter such as plant macrofossils –wood, fruits, seeds, leaves–, leather, fish scales and other ichthyological remains. Each sediment sample from SU1049 was sub-sampled (volume 3 L) and the contents analysed; the subsampling of small volumes of sediment has been shown sufficient for constructing representative records of wet sites for the study of their associated economy (Antolín et al. 2017b).

The dry sediment samples collected were processed using a flotation machine to recover the remains. The wet sediment samples, in contrast, were sieved to the wash-over technique in a bucket –no pressurised water was used– (Steiner et al. 2015). The floating material recovered using both techniques was poured onto sieves of 2, 1 and 0.5-mm mesh size for separation. Some of the organic material was subjected to desalination and the elimination of oil by means of a solution of water and neutral soap. This oil comes from spillages from a 20th century canning factory built over part of the archaeological area. The remains were stored immersed in still water inside rigid packaging and kept in a cold chamber to prevent the proliferation of microorganisms. Table 1 provides information on the sampling and processing performed.

Table 1 Archaeobotanical sampling performed during the archaeological excavations at the O Areal saltworks.

Intervention	Sampling					Remains	
	Total samples	Handpicked samples	Flotation samples	Wash-over samples	Processed volume (litres)	Waterlogged	Charred
CD 102A 2006/368	6	4	0	2	6	2675	5
CD 102A 2007/302	24	24	0	0	0	4	
CD 102A 2008/154	63	37	26	0	81.25	10	
CD 102A 2008/303	2	2	0	0	0	7	
CD 102A 2008/648	32	20	12	0	0	15	
Total	**127**	**87**	**38**	**2**	**87.25**	**2711**	**5**

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The remains were then sorted according to their state of preservation using a trinocular microscope at 1-7x magnification. For material from the sediment, this was performed dry; for the waterlogged material it was sorted in a sheet of water to avoid moisture loss which would accelerate the rate of physical alteration or chemical degradation. The anatomical characteristics of seeds and fruits were compared against the reference collection of the Archaeobotanical Laboratory of the *Universidade de Santiago* and the specialised literature, mainly carpological atlases (Anderberg 1994; Bojnanský and Fargašová 2007; Cappers et al. 2012; Neef et al. 2012; Sabato and Peña-Chocarro 2021; Schöch et al. 1988).

Figure 4. Evaporation ponds. The archaeobotanical remains were deposited on a stone slab/clay pavement and became covered by a dune. Photograph M. Á. Sartal Lorenzo.

4 Results

The total of 2716 carpological remains (individual seeds, seed fragments, and other plant parts) were recovered. Most were waterlogged; only five charred cereals remains were found. The concentration of carpological remains in the sediment samples from inside the evaporation ponds (SU1049) and processed by the wash-over technique was 1320/L, much greater than that obtained by flotation from samples taken outside of SU1049 (0.09/L). A total of 38 species and 13 genera within 28 families were identified; some could not be identified. These are high counts given the relatively small number of samples processed, and include plants cultivated and/or managed by humans, plus species that grew naturally but whose presence was influenced by the artificial environment produced by the saltworks. Table 2 summarises the species found and their abundance.

Table 2. Carpological results for each sample.

	Intervention	**CD 102A 2006/368**		**CD 102A 2007/302**	**CD 102A 2008/154**			**CD 102A 2008/303**	**CD 102A 2008/648**	
	Processing	**Sediment (wash-over)**		**Hand-picked**	**Sediment (flotation)**		**Handpicked**			
	Stratigraphic Unit	**1049**	**1049**	**2188**	**346**	**289**	**289**	**4040**	**2842**	**2233**
Group / Taxa	**Sample**	**B2616**	**B2548**	**18**	**3**	**37**	**B44**	**1**	**6**	**7**
Cereals	*Hordeum vulgare* (rachis)	1								
	Panicum miliaceum (lemma/palea)	1508	9							
	Triticum aestivum/durum (seed)		4							
Orchard/Garden	*Apium graveolens* (mericarp)	2	3							
	Cucumis melo (seed)	3								
	Cucumis melo/sativus (seed fragment)		1							
	Physalis alkekengi (seed)	5	2							
Arboriculture	*Castanea sativa* (pericarp)		3				1	1	1	
	Castanea sativa (pericarp fragment)	339	277	1					1	
	Ficus carica (infructescence)	17	11							
	Juglans regia (pericarp fragment)	21	32					1		
	Morus nigra (seed)		1							
	Olea europaea (seed)		1							
	Pinus pinea (bract)		3	1				1	1	
	Pinus pinea (bract fragment)	1								
	Prunus avium (endocarp)	8	1							
	Prunus avium (endocarp fragment)						2	2		
	Prunus avium/cerasus (endocarp)		8							
	Prunus avium/cerasus (endocarp fragment)	8								
	Prunus domestica subsp. *insititia* (seed)		1							
	Prunus persica (endocarp)			1					2	
	Prunus persica (endocarp fragment)		2	1						
	Prunus sp (seed)		1							
	Vitis vinifera (seed)	4	5			1				
	Vitis vinifera (seed fragment)	1	4							
Ruderals/Weeds	*Atriplex prostrata (seed)*	2	1							
	cf *Atriplex prostrata (seed)*		1							
	Atriplex/Chenopodium (seed)	1	5							
	Chenopodium album (seed)	5	7							
	Chenopodium glaucum (seed)		1							
	Glebionis segetum (seed)	1	2							
	Hyoscyamus niger (seed)	2								

	Medicago polymorpha (fruit)		1							
	Portulaca oleracea (seed)		4							
	Polygonum sp (seed)	3	1							
	Polygonum aviculare (seed)	4	1							
	Polygonum lapathifolium (seed)	4	2							
	Polygonum persicaria (seed)	4	3							
	Rumex sp (seed)	4	1							
	Silene sp (seed)		5							
	Silene dioica (seed)		1							
	Silene vulgaris (seed)	3	1							
	Stellaria sp. (seed)	1								
	Urtica dioica (seed)	1	19							
	Verbena officinialis (seed)		2							
Wild species	*Arundo/Phragmites* (stem fragment)									
	Carex sp (nutlet)	1								
	Cirsium sp (seed)		1							
	Corylus avellana seed (pericarp fragment)		3							
	Corylus avellana (seed)							1		
	Frangula alnus (berry)				1					
	Frangula alnus (seed)				2					
	Frangula alnus ((seed fragment)				3					
	Juncus conglomeratus/effussus (seed)		1							
	Juncus sp (seed)	1	3							
	Juncus sp (leaf fragment)							1	9	
	Nasturtium officinale (seed)		1							
	Oxalis sp (seed)		3							
	Prunella sp (seed)	2								
	Quercus sp (fruit)	1								
	Ranunculus sp (seed)	1	2							
	Reseda media/phyteuma (seed)	1								
	Rubus fruticosus (seed)	75	52							
	Rubus fruticosus (spines)	64	3							
	Rubus sp (seed)		1							
	Sambucus nigra (seed)	23	23							
	Amaranthaceae (seed)	1								
	Apiaceae (mericarp)	2	9							1
	Brassicaceae (seed)		1							
	Caryophilaceae (seed)		2							
	Cyperaceae (seed)	1								
	Polygonaceae (seed)		2							
	Solanaceae (seed)	1								
Undetermined	Undetermined (seed)	3	6							
	Undetermined (capsule fragment)		4							
	Undeterminable (seed)		5							
	Undeterminable (seed fragment)		2							

Total	**2129**	**551**	**4**	**6**	**1**	**3**	**7**	**14**	**1**

4.1 *Cereals*

Cereals were the best represented of all plant types in terms of abundance. Most remains corresponded to paleas and lemmas of broomcorn millet (*Panicum miliaceum*); indeed, this species accounted for 55.85% of the remains of the entire assemblage. Four caryopses of wheat (*Triticum aestivum/durum*) and one rachis of barley (*Hordeum vulgare*) were also documented. These species of the tribe Triticeae accounted for all five charred remains recovered.

4.2 *Horticultural and garden species*

Melon seeds (*Cucumis melo*) were recovered in small numbers. Remains of celery (*Apium graveolens*) and bladder cherry (*Physalis alkekengi*) were also found in small numbers. Notwithstanding the fact that celery and bladder cherry can be understood as wild plants, here it is proposed both species were cultivated (see Discussion).

4.3 *Fruit trees*

Fruit-tree and fruit-shrub species were well represented in the samples. Fragments of chestnut pericarps (*Castanea sativa*) made up more than 50% of the total for this group, few complete pericarps were detected. Other species recovered included walnut (*Juglans regia*), fig infructesences (*Ficus carica*), grapevine (*Vitis vinifera*), mulberry (*Morus nigra*), Prunaceae species such as sweet cherry (*Prunus avium*), peach (*Prunus persica*) and plum (*Prunus domestica* subsp. *insititia*) –all represented by endocarps–, olive (*Olea europaea*), and fragments of stone pine bracts (*Pinus pinea*).

4.4 *Weeds and ruderal species*

Many species of weed were identified, the growth of which may have been favoured by the niches created by agricultural exploitation (some are frequently present in communities associated with cereal fields). These included *Chenopodium album*, *Glebionis segetum*, *Medicago polymorpha*, *Portulaca oleracea*, *Polygonum aviculare, Polygonum lapathifolium, Polygonum persicaria*. Other species common in anthropised environments, such as *Atriplex prostrata*, *Silene dioica*, *Silene vulgaris* and *Urtica dicoica*, were also found.

4.5 *Wild plants*

Some of the documented remains belonged to fruit-bearing species, though no evidence of consumption was detected. These included an immature acorn of *Quercus* sp. and complete individuals (hazelnuts) of *Corylus avellana*, some with rodent bites, making it feasible that their presence is the result of transport or that they were simply natural inclusions. Elder (*Sambucus nigra*) and alder buckthorn (*Frangula alnus*) seeds and other remnants were also found. These plants grow naturally in humid environments in the northwestern Iberian Peninsula and produce fruits that may have provided human food. The presence of blackberry (*Rubus fruticosus*) seeds and spines indicates the existence of this plant in the surrounding area. Reeds (*Arundo/Phragmites*), compact rush (*Juncus conglomeratus/effusus*) and watercress (*Nasturtium officinale*) also found suitable places to grow; they may have formed part of the natural background or may have proliferated at the site.

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Figure 5 Carpological remains: a) *Castanea sativa*, b) *Juglans regia*, c) *Prunus persica*, d) *Olea europaea*, e) *Pinus pinea*, f) *Prunus domestica* subsp. *insititia*, g) *Prunus avium*, h) *Frangula alnus*, i) *Vitis vinifera*, j) *Ficus carica*, k) *Morus nigra*, l) *Cucumis melo*, m) *Panicum miliaceum*, n) *Triticum aestivum/durum*, o) *Hordeum vulgare*, p) *Apium graveolens*, q) *Physalis alkekenji*, r) *Hyoscyamus niger*, s) *Verbena officinalis*, t) *Rubus fruticosus*, u) *Sambucus nigra*, v) *Corylus avellana*, w) *Medicago polymorpha*, x) *Atriplex prostrata*, y) *Chenopodium album*, z) *Portulaca oleracea*, aa) *Stellaria* sp., ab) *Polygonum lapathifolium*, ac) *Polygonum persicaria*, ad) *Carex* sp., ae) *Glebionis segetum*, af) *Juncus* sp., ag) *Prunella* sp., ah) *Nasturtium officinale*, ai) *Oxalis* sp., aj) *Ranunculus* sp., ak) *Reseda media/phyteuma*. al) *Urtica dioica*.

5 Discussion

The O Areal site contains a unique array of species that helps us understand the changes in the agricultural economy that occurred in the Iberian Peninsula during Roman times. However, care should be exercised when drawing conclusions. The primary context of the plants used for food is unknown, as are the areas where they were cultivated and the background against which they were processed. The examined remains were all found in a waste dump with anthropogenic and natural inputs, and although they are exceptionally well preserved, sampling was undertaken during excavation campaigns, making the results impossible compare with those obtained by systematic archaeobotanical sampling at other wet sites (cf. Antolín et al. 2017b; Maier and Harwath 2011, among others).

5.1 Plants in the surroundings of O Areal

The results indicate that different components of cereal processing were undertaken in the area around the saltworks. Although cereal caryopses are poorly preserved in damp environments, the woody parts of broomcorn millet were well preserved, providing the largest quantity of remains analysed for this species. These remains are likely a by-product of winnowing or the digested remains of animal feed. Two ways of dehusking the grain from the covers have been recorded for millet, namely pounding and grinding, which leaves the paleas and lemmas reduced to very small fragments (Moreno-Larrazabal et al. 2015; Teira Brión 2022). The intactness of many paleas and lemmas among the present remains thus rules out their processing for human consumption. The other cereals found, i.e., *Triticum aestivum/durum* and *Hordeum vulgare*, together with *Panicum miliaceum*, are the most common species found at sites with charred materials from this period (cf. Peña-Chocarro et al. 2019; Teira Brión 2019; Tereso et al. 2020; Tereso et al. 2013).

The finding of the remains of melons, which were widely consumed in antiquity, is indicative of the existence of probably areas given over to horticulture. *Cucumis melo* has been identified at Roman sites all over the Iberian Peninsula (Peña-Chocarro et al. 2019); it was originally introduced in the 9-8th century B.C. when the Phoenicians began to establish commercial settlements in southern Iberia (Pérez-Jordá et al. 2017). Plant such as celery was cultivated for food in many different regions of the Roman state (e.g. Bakels and Jacomet 2003; Van der Veen 2016). As well as in O Areal, celery it is documented in the Roman port of Irun (Peña-Chocarro and Zapata 2005), although it is interpreted as a wild species in this site.

It is difficult to establish whether other common and ruderal plants detected at O Areal were present in the natural environment or linked to gardens and horticultural land, as some of them were used in Roman times but this cannot be deduced from the samples analysed at the site. For example, bladder cherry is not naturally occurring in the northwestern Iberia (vid. Romero Buján 2008), but it was present in the wild in other areas of the Iberian Peninsula during prehistoric times (Antolín 2016). Its fruit has a diuretic effect and cures jaundice according to Dioscorides; therefore, bladder cherry may have been introduced into the settlement for medicinal or even ornamental purposes. Henbane is a good proxy for soil fertility due to their prevalence in rich soils (Grime et al. 1988) but it has also psychotropic properties highly appreciated by the Greek physician Dioscorides (*De materia medica* 4.68.1) in the 1st century A.D. (Scarborough 2018). Their seeds were used as a local anaesthetic and were prepared in an ointment with wool fat for treating soldiers' pain (Belfiglio 2017). Henbane has also been recorded at other sites in northwestern Iberia (Tereso et al. 2020; Vaz et al. 2017), although it has not been associated with any medicinal use and here is considered as a weed.

Perhaps the most important aspect of this archaeobotanical assemblage is the variety of consumable fruits identified. *Ficus carica*, *Olea europaea*, *Prunus persica* and *Vitis vinifera* were all domestic species widely distributed across Roman settlements (Peña-Chocarro et al. 2019). The introduction of domestic varieties of fruit trees occurred during the 1st millennium B.C. in the Mediterranean area (Pérez-Jordá et al. 2017), but in the archaeological sites of the northern Atlantic area of the Iberian Peninsula they are documented for the first time during the Roman Period. This points to chronological differences in the expansion of arboricultural practices and their associated species. The introduction of other fruit trees, such as mulberry (*Morus nigra*) and plum (*Prunus domestica* subsp. *insititia*) is linked to Roman conquest. The mulberry at O Areal is the oldest remain of this taxon found in the current state of the archaeobotanical literature in the Iberian Peninsula. The seed is within the usual measurements for the *Morus nigra* species, although some studies indicate that size alone is insufficient to properly distinguish *Morus nigra* from *Morus alba* (Durand et al. 2016).

Chestnut, walnut, cherry and stone pine have been grown in tree formations since ancient times (Carrión 2012), but they also grow wild, so it is hard to say whether wild or cultivated varieties provided the material at O Areal. The Iberian Peninsula was a glacial refuge for the chestnut (Roces-Díaz et al. 2018), and wild fig was present in natural environments during Prehistory (Carrión 2012). Olive has been documented at archaeological sites from the 1st millennium

B.C. (Martín-Seijo et al. 2020; Silva 2008). All these species were potentially used for food, but no evidence is available of their use or transport to sites in northwestern Iberia or the Cantabrian area (northern Iberia) during the Iron Age. However, given the biography of these fruit trees and the frequency with which they began to appear in Roman settlements, the expansion of their cultivation and consumption probably began in Roman times.

The remains of fruits of *Castanea sativa* and *Juglans regia* were recovered in a highly fragmented state, perhaps indicating intentional fragmentation for consumption. It is also possible that part of the fruits was deposited as a natural inclusion due to the existence of specimens close to the saltworks; these may have then suffered degradation for different reasons (see Antolín et al. 2017a). However, the type of fragmentation seen for the bracts of *Pinus pinea* clearly indicates human action. Pine nuts and whole pine cones were found during the archaeological excavation (Benavides García 2010; Iglesias Darriba 2009) although they were not available for the present study.

The remains of adventitious and ruderal species were present. These taxa are compatible with a profoundly transformed environment, and are frequently found in hedges, along roads, and in fields, etc. *Corylus avellana*, *Rubus fruticosus* and *Sambucus nigra* were also detected – among other species– but no evidence of their use or consumption was found.

5.2 Roman towns as centres for the introduction of crops

The O Areal site presents an assemblage of species with numerous parallels across Europe (Bakels and Jacomet 2003; Bosi et al. 2020; Jacomet and Vandorpe 2011; Livarda 2011; Lodwick 2017; Vandorpe 2010). Within the Iberian Peninsula, similarities can be seen in particular with the Roman port of Irun (Peña-Chocarro and Zapata 1997; Peña-Chocarro and Zapata 2005). The expansion of species during Roman times was linked to the appearance of urban areas, military camps and specialised production areas (Bakels and Jacomet 2003; Livarda 2011; Livarda and Orengo 2015; Lodwick 2017), contexts involving strong social interactions exposed to change. Urban areas represented dynamic settings that served as the entry points for new practices, customs and ideas being adopted throughout the Roman State. Certainly, O Areal was on the maritime routes running between the Atlantic and the Eastern Mediterranean, and the area could have been receptive to novel ideas. Not only the low cost of sea traffic would have been key, but also the terrestrial routes would have favoured the expansion of crops and agricultural practices. The land road networks would have internally connected the different productive regions, of which the northwest Iberian region was one of the most significant in economic terms (de Soto 2013; de Soto 2019).

The productive and administrative centres of the Roman Period would have favoured the expansion of arboriculture and acted as hubs for the consumption and redistribution of foodstuffs (Teira Brión and Rey Castiñeira 2021). They would have facilitated the arrival of new species but could also have served as sites for secondary domestication events thanks to the implementation of new agricultural practices in the management of local wild varieties. A previous morphometric study performed on vine seeds from O Areal made it possible to distinguish between those of *Vitis vinifera* subsp. *vinifera* and *Vitis vinifera* subsp. *sylvestris*, and detected specimens very similar to seeds of the current grape variety 'Albariño' (Boso et al. 2020). This might indicate a process of local domestication of wild subspecies (Boso et al. 2020), or the introgression of wild *V. sylvestris* in the study region. Genetic analyses of ancient grapevines from the neighbouring wine-growing region of Vinho Verde (in Portugal) pointed out the existence of introgression from wild plants into currently cultivated varieties (Cunha et al. 2020). Thus, in the surroundings of the saltworks, the agricultural practices followed could have favoured genetic exchange within the Iberian Northwest. If this domestication/introgression process is confirmed by future analyses, it may be necessary to think more along the lines of hybrid crop communities than any dichotomy between domestic and wild types. Introduced, domesticated and non-domesticated vines may all have been present and have been subject to the same agricultural management. The same may also have been the case for *Castanea sativa*, *Juglans regia* and *Prunus avium*.

The Roman Period witnessed a transformation in the productive landscape in terms of tree species. The cultivation of fruit trees required changes in spatial organisation, and a workforce dedicated to orchard maintenance and the distribution of the fruit to markets. Urban centres even generated new habitats mediated by humans, including the formation of gardens, and leisure spaces, and in these plants may have been cultivated for their beauty or medicinal properties. A conception of plants beyond their use as food or as part of a productive activity is provided by species grown for ornamental reasons, e.g., the cypress trees (*Cupressus sempervirens*) at the thermal baths of Aquae Flaviae (Vaz et al. 2016). *Juglans regia* and *Pinus pinea/pinaster* were also planted for funerary rites; the quality of their wood for crematory fires and their significance in Roman culture (Martín-Seijo and César Vila 2019) would have made them good choices.

6 Conclusions

The state of preservation of the waterlogged materials at O Areal allowed the identification of species not commonly found at sites in the Iberian Peninsula, where the macroremains of fruits and seeds are usually preserved either in carbonised or mineralised form. They also allow the biography and consumption of plants to be traced during the Roman Period in the northwest of the Iberian Peninsula and reflect the transformations in agricultural practices that were underway such as arboriculture. The tree and shrub species detected, i.e., *Castanea sativa*, *Juglans regia*, *Morus* sp, *Pinus pinea*, *Prunus avium*, *Prunus domestica* subsp. *insititia*, *Prunus persica* and *Vitis vinifera* reached different corners of the Iberian Peninsula during this period. Other species, such as the cereals *Panicum miliaceum*, *Triticum aestivum/durum*, *Hordeum vulgare*, and horticultural species such as *Cucumis melo* and, probably, *Apium graveolens* and *Physalis alkekengi*, were also detected, as were several species belonging to weed communities linked to cropland. The results also provide data on the surrounding plant communities. Although the influence of a productive and strongly altered area for making salt influenced the composition of the archaeobotanical assemblage, some of the taxa identified would have grown naturally, occupying different niches. Thus, although the O Areal saltworks was abandoned and became a dumping ground, the components of its archaeobotanical assemblage have different origins, including coastal environments, damp areas, open woodland, cultivated areas, and crop-processing areas.

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