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Crops on the edge of a cliff: Storage at Castro S. João das Arribas (Northwest Iberia) in the Late Antiquity

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ABSTRACT

The site of Castro S. João das Arribas is placed on the edge of a cliff over the Douro river (Miranda do Douro, Northeast of Portugal). Archaeological interventions in its highest area uncovered a main occupation from Late Antiquity. On its western part a functional space was recorded, which included two small above-ground structures and abundant charred carpological remains. These were found inside ceramic vessels and spread throughout the area, suggesting its destruction occurred after a fire event. A radiocarbon date places such episode in some moment between the late 6th and the first half of the 7th century CE.

Carpological results revealed an assemblage dominated by cereal grains, mostly rye (*Secale cereale*). Naked wheat (*Triticum aestivum/durum*), barley (*Hordeum vulgare*), common millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*) were also found but in smaller amounts. The large amount of carpological remains in the above-mentioned contexts, suggests the space was used for storage, at least between the 6th and 7th centuries CE. Although some uncertainties remain regarding how crops were stored, evidence points that they were kept in ceramic vessels, outside and inside the small storage facilities, but also in other types of containers, eventually made of perishable materials.

At Castro S. João das Arribas, past communities chose a diversity of crops, however, most of them show undemanding features in terms of soil and climatic conditions. The agricultural choices could have been motivated by several factors, but cereals like rye were certainly well-suited to the environmental conditions around the settlement.

1. Introduction

Peasant communities were fundamental during the Late Antiquity and the early Middle Ages. This period of time in Northwest Iberia witnessed several conflicts related to the rise and collapse of new political entities (e.g. Quirós-Castillo, 2020). In the early 5th century CE there was an influx of Germanic groups onto western European regions, which led to economic, political and cultural changes in several areas of the Iberian Peninsula, including the northwest, where they settled in 411 through an agreement with the Romans. The period that follows is one of persistent conflicts and turmoil. After a short period of Suebian domination, the Visigoths ended up establishing their rule over the remaining groups throughout the 6th century, becoming the dominant authority in Iberia until the arrival of the Muslims, in the early 8th century (Leguay, 1993; Mattoso, 1997).

This period of instability has been described as one of some ruralisation both socially and economically, although abundant small rural settlements could already be found in previous periods (e.g. Carvalho,

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2009; Tente, 2010; Marques, 2011; Pereira et al., 2014; Sá Coixão, 2017; Tereso et al., 2020).

In this scenario, it is crucial to characterise peasant communities and address their productive strategies. In Northern Iberia, considering the lack of written sources, peasant economy needs to be tackled from the information retrieved by applying environmental and bioarchaeological analyses. In the specific case of grain storage, a number of archaeological features, mostly pits, have been identified in medieval contexts (e.g. Vigil-Escalera et al., 2013), but archaeobotanical analyses are still not common in the region (Peña-Chocarro et al., 2019b) making it difficult to identify the main crops from this period and characterize agricultural strategies.

Although there is a reasonable number of sites with fruits/seeds dating back to Roman times (e.g. Teira-Brión, 2010; Peña-Chocarro et al., 2019b; Tereso et al., 2020), earlier evidences from Late Antique and early medieval sites are considerably lower. Those are even narrower if we just consider the archaeological contexts from the 5th to the 8th centuries CE, when NW Iberia was under Suebian and Visigothic rule. A Mourela (As Pontes), Agro de Deus (Pontevedra), and Quinta de Crestelos (Mogadouro) provided small assemblages of charred plant remains, with few crops (Antolín and Alonso, 2009; Tereso et al., 2018b; Peña-Chocarro et al., 2019b). On the western edge of Asturias, at Tabacalera (Gijón), a waterlogged context revealed a substantial and diverse assemblage of wild remains, although crops were also reduced (Carrión Marco et al., 2015; Peña-Chocarro et al., 2019a). Those were collected in a well and more precisely in three filling deposits, whose chronology has been a matter of debate, with some authors suggesting a Late Antique chronology (e.g. Fernández Ochoa et al., 2015) and others proposing a later date (Vigil-Escalera, 2018).

The development of a new study at Castro S. João das Arribas (Fig. 1), in north-eastern Portugal is, thus, of exceptional importance. Here, a fire of unknown scale may have allowed the preservation of a large carpological assemblage, above all cereal grains, some of which inside a ceramic vessel. This work aims to present such assemblage, discuss how it was originated, its relationship with the respective archaeological contexts and its significance to understand agriculture and storage on local and regional scales.

2. The Castro S. João das Arribas site

The site of Castro S. João das Arribas, also known as Castro de Aldeia Nova (hereinafter - CSJAMD) is located on a small spur next to the Douro river, in the village of Aldeia Nova (Miranda do Douro, Northeast Portugal). It is embedded in a high and wide plateau area, greatly

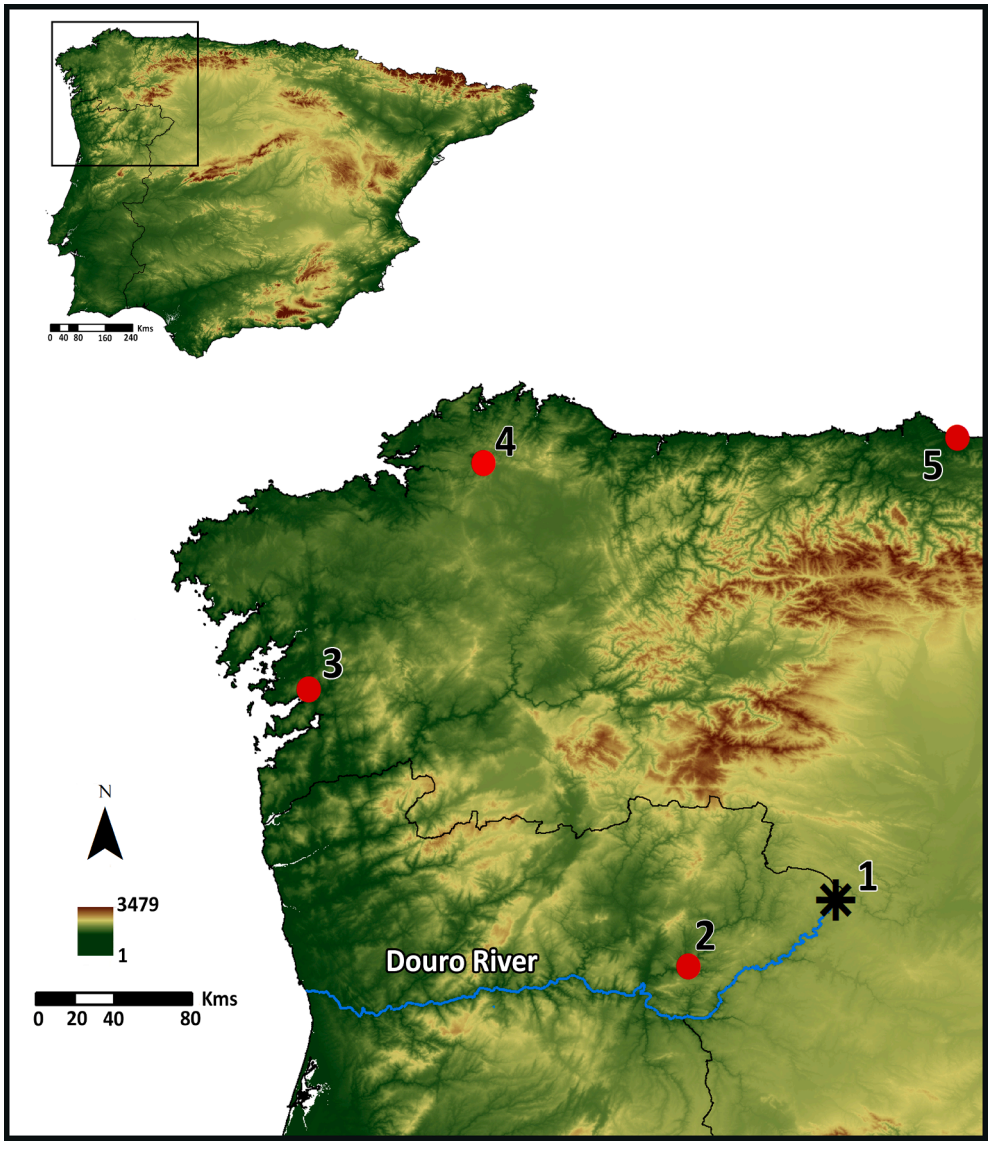

Fig. 1. Location of the sites mentioned in the text (NW Iberia): 1- Castro S. João das Arribas; 2- Quinta de Crestelos; 3- Agro de Deus; 4 – A Mourela; 5 – Tabacalera.

defined by granitic boulders. From a biogeographic point of view, it is incorporated in the Mediterranean region, in a contact area between the Salmanticensean and Lusitanian-Duriensean Sectors. CSJAMD and its surrounding territories are mainly characterized by supramediterranean and dry to subhumid bioclimatic conditions, and are also part of a climatic area usually designed as Cold Land. Forests of evergreen oaks are prevailing, namely *Quercus suber* and above all *Quercus rotundifolia*. The latter reveals a distinctive association with *Genista hystrix,* an Iberian endemism (Costa et al., 1998; Aguiar and Vila-Viçosa, 2017; Aguiar, 2021).

Although it suffered considerable disturbances due to agricultural activities and the construction of a church, the site still displays important defensive features. It was naturally protected in the southeast side by a large cliff over the river and the remaining area was defended by two wall alignments as well as a circular turret (Lemos, 1993; Salgado and Pereira, 2018; Salgado and Pereira, 2018–19). The site has been quoted by several authors since the 18th century, providing general descriptions and mentioning isolated findings, such as funerary inscriptions or ceramic material (e.g. Cardoso, 1747; Lemos, 1993; Alves, 2000; Redentor, 2012–13). CSJAMD is usually considered an Iron Age hillfort, with a Roman occupation (Lemos, 1993). In this context, emmer grains identified by Maria Hopf are generically attributed to the Iron Age (Hopf quoted by Silva, 1988), even though there is no information regarding the archaeological context where they were recovered.

In 2015, archaeological surface surveys were conducted in nearby terrains providing evidence of agricultural activities at least, since Late Roman times. Radiocarbon dates pointed to a time span between the late 3rd century and the 6th century CE (Sánchez-Palencia et al., 2015). Excavations were conducted in the site between 2016 and 2019 (Salgado and Pereira, 2018; Salgado and Pereira, 2018–19; Salgado and Pereira, 2019). During this time, 13 test pits and excavation areas implanted all over the site led to the identification of an occupation between the Late Antiquity and the Early Middle Ages. Evidence of previous occupations consists mostly of sporadic ceramic material, without a clear correlation with archaeological contexts (Salgado and Pereira, 2018; Salgado and Pereira, 2018–19; Salgado and Pereira, 2019). High concentrations of charred plant remains were observed in Area 2, and several samples were recovered for archaeobotanical analysis, being these as well as the respective archaeological contexts addressed here in more detail.

2.1. Area 2 and excavated features

Excavation Area 2 (Fig. 2) was implanted on the highest area of the spur, at an elevation of 658 m.a.s.L. Here, the archeological interventions were carried out over three excavation campaigns (2016–2018). Fieldwork has revealed thin deposits and evidence of perturbations caused by recent agricultural activities that made difficult a full understanding of some archaeological contexts. Still, and as observed in other areas of CSJAMD, the occupation of Area 2 started during Late Roman Times and lasted, at least, until the later moments of the Late Antiquity.

A granite wall [207] from the Late Roman phase might have been reused on a later phase, as a supporting structure of walls [226] and [236]. Together, they delimit three sides of a functional space, on the western part of Area 2, whose layout, size, and structural characteristics are impossible to determine due to its bad preservation (Fig. 2). Inside, two small structures (s.u. [229] and [247]), were found next to each other (Fig. 3):

- Structure [229] had a usable area of around 1 m^2. It was attached to wall [207], and delimited by wall [226], on the north side. Its subquadrangular form is attested by the preservation of a solid mortar base level, which was also identified in the structure floor, alongside schist slabs.

- Structure [247] was badly preserved but shows similar characteristics to structure [229]. It was attached to the latter, and delimited by wall [226]. On the other hand, granitic stones were used to define its south side. Despite they were not well aligned, most likely due to preservation issues, those seem to provide a quadrangular shape to [247]. It is not certain if the schist slabs found, served as the west side edge, still, structure 247 would also have a usable area close to 1 m^2. It seems that as observed in [229], the floor was prepared with mortar and schist slabs.

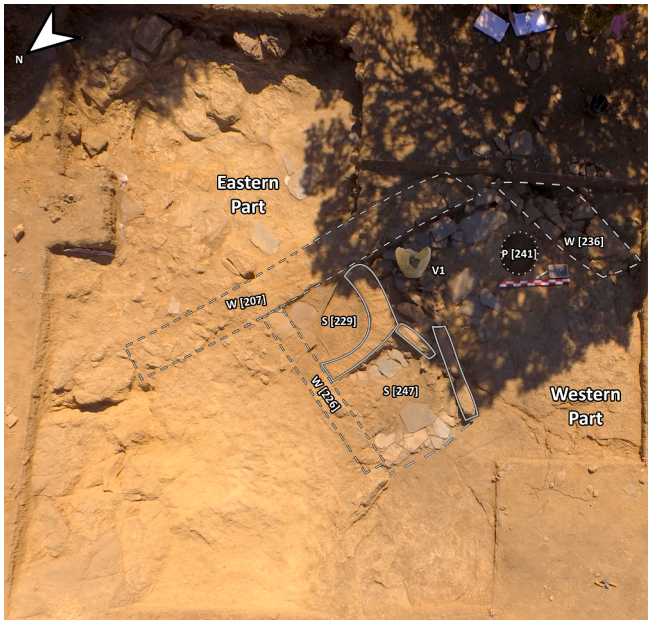

Fig. 2. Aerial view of Area 2. Legend: W – Wall; S- Structure; V- Vessel; P – Pit.

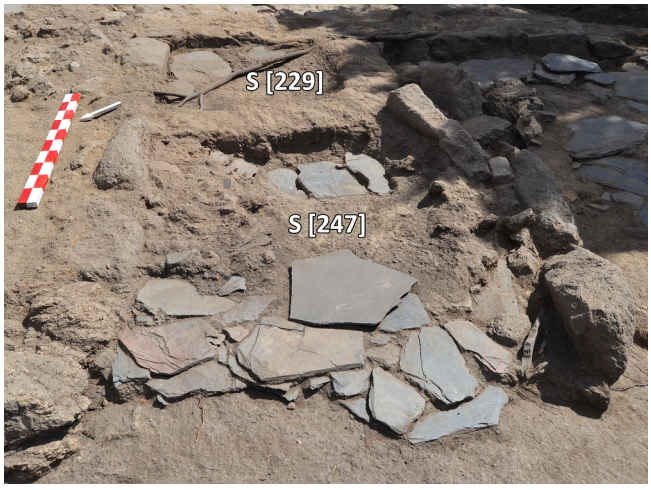

Fig. 3. Detailed view of Structures [229] (above) and [247] (below).

Some meters away, and near wall [236], a pit was found. Its [241] excavation did not provide enough information to clarify its original function. In between pit [241] and structures [229] and [247], archaeobotanical remains were found in three successive layers (deposits [225], [234] and [238]). Among those, layer [225] was noteworthy, due to the presence of abundant archaeobotanical remains. In this layer, a small pottery vessel (Vessel 1) with charred cereals still inside was also recovered (Fig. 2, Fig. 5). Besides cereals, its content was composed of a few charcoals, fragmented ceramic remains of the vessel itself, and a fine sediment, some of it still stuck to the vessel's inner surface. It was found next to wall [207], and at approximately 50 cm straight from structure [229]. Although fragmented, it shows the following measures: c. 8 cm high; bottom of c. 5 cm diameter; and a max-diameter of c. 10 cm. It appears to be part of a narrow and short, flared

jar, though it is not possible to determine a clear typology.

Inside one of the storage facilities, namely in structure [247], cereals were found in other vessel. Sadly, it was only possible to recover and study one vessel, since most of the remaining vessels seem to have been smashed, either during the fire either through recent agricultural plantations. The vessel from [247] was found during the excavation but disappeared from the field in the context of illicit actions by an unknown perpetrator. The abundancy of charred cereals recorded in this area suggests they were burned during a fire that destroyed the storage structures and eventually also the building where they were located.

Considering the relevance of Vessel 1, cereal grains from its content were selected for radiocarbon dating (Table 1). The result suggests that an event involving fire should have occurred in Area 2 between the end of the 6th century and the first half of the 7th century of our era.

On the eastern part of Area 2, structural and other evidences of occupation were less clear (Fig. 2). Immediately next to wall 207, two deposits, namely [203] and above all [205] (destruction level) revealed some charred plant remains.

3. Materials and methods

3.1. Sampling and associated contexts

During field work at CSJAMD judgment sampling was carried out, focusing mostly on contexts with visible plant macroremains. Considering wall [207] may have had a delimitation function, we use it as a benchmark, establishing a division between the western and eastern parts of Area 2 (Table 2, Fig. 2).

In the western side, the sampling strategy was focused on deposits from structures [229] and [247], as well as in a destruction layer (deposit [225]) identified next to the storage facilities. It was also collected a sediment sample in pit [241]. On the eastern side, the sediment recovered was scarce. In fact, only a small soil sample was collected in [205]. From [203], only handpicked archaebotanical remains were retrieved.

Overall, between 2016 and 2017, 23 samples from 10 stratigraphic units were recovered for archaeobotanical analysis (Table 2), 16 corresponding to sediment samples and 7 to handpicked plant remains. The volume of the samples is usually low and amounts to just 12 L, which corresponds to a biased set, and disregards standard field sampling and recovery methods. This limitation will be taken into consideration in the interpretation of the assemblage.

From those sediment samples, 14 were processed through bucket flotation and 2 were gently dry sieved. These corresponded to particularly rich samples, one of them recovered in Vessel 1, in which dry sieving was carefully carried out in the laboratory in order to extract thin elements and avoid further fragmentation of plant remains. Either through flotation or sieving, a 0.5 mm mesh was used.

3.2. Laboratory analysis

Light fractions and handpicked samples were sorted under a stereoscopic microscope and specialized bibliography was used for the taxonomic diagnosis (e.g. Beijerinck, 1976; Castroviejo, 1986–2012; Hillman et al., 1996; Buxó, 1997; Jacomet, 2006; Nesbitt, 2006; Neef et al., 2012; Zohary et al., 2012). Whenever necessary, the carpological remains were compared with modern material from the reference collections of the University Porto Herbarium (PO) at the Natural History and Science Museum of the University of Porto (MHNC-UP) and from CIBIO.

To optimize laboratory work, fifteen samples that provided larger volumes of plant remains were subsampled according to the following procedures: each light fraction was separated into different size classes, through a column of sieves with 2 mm, 1 mm and 0.5 mm meshes; the contents of the 2 mm meshes were often fully analysed; the contents of all 0.5 mm meshes and most 1 mm meshes were sub-sampled with the help of a riffle box (Table 3).There are short differences in the volume of the sub-samples, leading to stronger variations in the percentages studied from each samples. The decision to determine sub-samples by their volume rather than by percentages was meant to optimize the sorting, considering time limitations as well as the fact that 1 mm and 0.5 mm fractions consisted mostly of small fragments of grains.

Whenever sub-sampling was carried, results reflect extrapolations based on the original and sorted weights of each mesh. Still, extrapolations were only calculated to units, not fragments, and when a minimum number of 10 units per taxon and mesh was found.

Whole carpological remains as well as fragments with scutella or hila were counted as units. In the case of longitudinal fragments –cereals- and whole cotyledons –legumes-, they were counted as a single unit when two fragments were identified in the same mesh/sample. Each of the aggregated remains was counted as one, when unit elements were observed. Therefore, in Table 4 only units of each stratigraphic unit (s. u.) are represented, whereas in Table 1 in supplementary material the detailed results (units and fragments) of each sample are presented.

Taxonomic designations follow the checklist for Portuguese flora (Sequeira et al., 2012) and, for cultivated plants, Zohary et al. (2012). The designation *Triticum aestivum/durum* was used to name naked wheat grains following Buxó (1997). This includes *Triticum aestivum* subsp. *vulgare*, *Triticum turgidum* subsp. *durum* and *Triticum turgidum* subsp. *turgidum* grains.

4. Results

4.1. Characterization of the assemblage

Carpological results showed an assemblage dominated by cereal grains (98%). Rye (*Secale cereale*) is clearly the main crop, with almost 50,000 grains. Naked wheat (*Triticum aestivum/durum*), hulled barley (*Hordeum vulgare*), common millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*) grains are much fewer, together representing less than 1% and 1,000 units of the complete assemblage (Fig. 4, Table 4 and Table 1 in supplementary material). Two grains of oat (*Avena* sp.) have also been found, but no floret bases were recovered.

However, in number, grains merely identified at the tribe level, as Triticeae, are predominant (63%), which results from the high degree of fragmentation observed. Since those Triticeae concentrations are coincident with the largest rye assemblages, they most likely correspond to the mentioned crop.

Besides cereals, other crops are scarce. One hundred and forty-one flax seeds (*Linum usitatissimum*) were found, representing just 0.1% of the total. Clear evidence of cultivated pulses was not recorded. It was only found one seed from an undetermined pulse and identified as *Vicia/Lathyrus/Pisum*. No remains from domestic fruit trees have been recovered at CSJAMD so far.

The remaining plant macrofossils, correspond to grasses, namely *Bromus* sp. and caryopsis identified at the family level (Poaceae), as well as few other wild plants. Despite some diversity was recorded, these remains were recovered in small amounts. Corncockle (*Agrostemma githago*) was the exception, being identified in significant amounts (1.7%). This weed was mostly represented through the seeds, but also by

Table 1
Radiocarbon date from Vessel 1 at Castro S. João das Arribas. Calibration Oxcal 4.4 software (Bronk Ramsey, 2009), Intcal20 calibration curve (Reimer et al., 2020).

Sample N°	Context	Sampled context	Taxon dated	Lab. Reference	14C age (yr B.P.)	Calibrated age (1 σ)	Calibrated age (2 σ)
121	Western area - Vessel 1	225	*Secale cereale* (grains)	D-AMS 042654	1435 ± 24	605–645 CE	590–654 CE

Table 2
Inventory from Area 2, at CSJAMD.

S.U.	Sample	Sampled context - description	Context	Campaign	Processing	Volume (L)
202	6	Abandonment/Destruction layer	Western area - Structure 229	2016	Floated	0.5
	8			2016	Floated	0.2
228	4			2017	Floated	3
	15			2017	Floated	1
	21			2017	Handpicked	N/A
	22			2017	Floated	0.9
230	16	Destruction layer	Western area -Structure 247	2017	Floated	0.5
237	18			2017	Handpicked	N/A
225	121	Deposit inside vessel	Western area - Vessel 1	2017	Dry Sieved	0.1
	13	Destruction layer	Western area	2017	Floated	1.5
	14			2017	Floated	1.5
	23			2017	Floated	0.1
	24			2016	Floated	0.5
	25			2016	Floated	0.5
	26			2016	Floated	0.5
	29			2017	Floated	0.1
234	20	Destruction layer	Western area	2017	Handpicked	N/A
238	28	Abandonment/Destruction layer	Western area	2017	Handpicked	N/A
242	5	Filling layer	Western area - Pit 241	2017	Floated	1
203	12	Abandonment/Destruction layer	Eastern area	2016	Handpicked	N/A
205	7	Destruction layer	Eastern area	2016	Handpicked	N/A
	10			2016	Handpicked	N/A
	17			2016	Dry sieved	0.1

Table 3
Subsampling applied over light fractions, at CSJAMD.

Mesh	S.U.	2 mm			1 mm			0.5 mm		
Sample		Original weight (g)	Sorted (g)	%	Original weight (g)	Sorted (g)	%	Original weight (g)	Sorted (g)	%
4	228	4.16	4.16	100%	23.75	2.49	10.5%	40.55	0.58	1.4%
6	202	25.92	25.92	100%	19.26	2.75	14.3%	14.81	0.48	3.2%
8	202	4.81	4.81	100%	3.51	3.51	100%	2.51	0.69	27.5%
13	225	3.90	3.90	100%	7.13	1.73	24.3%	8.12	0.45	5.5%
14	225	1.73	1.73	100%	3.49	3.49	100%	6.63	0.78	11.8%
15	228	147.56	35.6	24.1%	96.89	2.9	3.0%	72.5	0.41	0.6%
16	230	77.78	37.12	47.7%	100.5	3.52	3.5%	65.93	0.32	0.5%
17	205	26.38	26.38	100%	10.77	2.89	26.8%	7.02	0.41	5.8%
22	228	33.24	33.24	100%	83.73	2.72	3.2%	94.58	0.42	0.4%
23	225	14.97	14.97	100%	8.7	2.28	26.2%	5.73	0.33	5.8%
24	225	0.64	0.64	100%	1.31	1.31	100%	2.22	0.52	23.4%
25	225	13.45	13.45	100%	35.14	1.28	3.6%	56.69	0.4	0.7%
26	225	3.52	3.52	100%	3.27	1.47	45.0%	8.56	0.32	3.7%
29	225	28.03	28.03	100%	58.61	3.73	6.4%	14.38	0.47	3.3%
121	225	67.73	67.73	100%	24.24	24.24	100%	17.73	2.05	11.6%

capsule and pedicel fragments (Fig. 4).

4.2. Spatial distribution

Most of the remains were found in the western part of the area (Fig. 2, Fig. 3, Table 4), namely in two structures ([229] and [247]), and one destruction layer [225]. Pit [241] displayed just two rye grains; [234] and [238] also showed few remains but it is necessary to take into consideration that no sediment samples have been recovered in these two contexts and all plant remains have been handpicked. In the destruction levels sampled in the eastern area, carpological remains were only abundant in a small sediment sample from [205]. As expected, scarce remains were identified in a handpicked sample from [203].

Structures [229] and [247] are particularly relevant since both revealed 75.5% of the total remains. The majority (51.1%), came from just one stratigraphic unit, namely [228] in the sub-quadrangular structure [229]. Close to those structures, in [225], a considerable assemblage comprising 23.1% of all remains was collected, being of particular notice the ceramic vessel found with remains still inside (Fig. 5). In this vessel around 1,500 grains of a single cereal crop (rye) have been found. Some wild remains, mostly corncockle seeds, were also retrieved from the vessel but these are likely weeds from rye fields.

The enormous amount of remains per litre strengthens the idea of a large carpological assemblage (Tables 2 and 4). The highest concentrations are still in structures [229] and [247]. However, since a small volume of sediment was recovered in the whole site (12 L), and variations between contexts were significant (0.1 – 4.9 L), comparisons can be somehow misleading. Taking into consideration that sampling was directed at contexts that had visible and abundant plant remains, the large concentrations here recorded cannot be extrapolated to the rest of the site, not even to the whole extension of the s.u. that were sampled.

Independently of the archaeological context, rye was always the dominant crop. Regarding the other cereals, considerations should be careful since these were often collected in small amounts (Table 4, Fig. 6). Furthermore, due to their size, millets are likely to be underrepresented when handpicking is carried out.

While rye predominates in the site and overshadows other taxa, results show differences in the distribution of the other crops throughout the excavated area. Most of the naked wheat was found in the eastern area, namely in [205] (388 out of 513). Barley grains were more abundant on the west, in structure [247] (108 out of 182). Almost all common millet grains were recovered in structure [229] (135 out of 143). Due to the low number of remains (Table 4), foxtail millet and oat were not included in Fig. 6, however all foxtail millet grains, although scarce, have been recovered in the Eastern part of Area 2.

Table 4
Carpological results at CSJAMD.

Volume (litres)	0.7	4.9	0.5	0.1	4.7	N/A	N/A	1	0.1	N/A	Total	% Total
S.U.	202	228	230	225	225	234	238	242	205	203		
Context	Western area Structure 229	Western area Structure 229	Western area Structure 247	Western area Vessel 1	Western area	Western area	Western area	Western area Pit 241	Eastern area	Eastern area		
Cereals (grain)												
*Avena*sp.		1	1								2	0.00%
Hordeum vulgare		4	108		52				18		182	0.13%
Panicum miliaceum		135	6		2						143	0.10%
Setaria italica									10		10	0.01%
Panicum/Setaria										1	1	0.00%
Panicoideae		843	4		3						850	0.59%
Secale cereale	3,658	19,855	11,870	1,569	11,338	2	7	2	884	1	49,186	33.90%
Triticum aestivum/durum		15	47		61		2		388		513	0.35%
*Triticum*sp.		2			2				9		13	0.01%
Triticeae (with scutellum)	2,340	51,798	16,822	682	19,357	2	1		495		91,497	63.07%
Other Poaceae (grain)												
*Bromus*sp.	1			6							7	0.00%
Poaceae	1	5	1	1	2				1		11	0.01%
Fabaceae (seed)												
Vicia/Lathyrus/Pisum		1									1	0.00%
Fabaceae				3							3	0.00%
Fibre/Oil plant												
Linum usitatissimum (seed)					141						141	0.10%
Other remains												
Agrostemma githago (seed)	126	1,506	316	49	227				252	1	2,477	1.71%
Apiaceae (achene)				2							2	0.00%
Caryophyllaceae (seed)		1			2				3		6	0.00%
*Galium*sp. (mericarp)		1			5						6	0.00%
*Malva*sp. (seed)		1									1	0.00%
Polygonaceae (achene)					1						1	0.00%
*Polygonum*sp. (achene)				1							1	0.00%
*Rumex*sp. (achene)	1										1	0.00%
Veronica sp.	1										1	0.00%
Undetermined (seed/fruit)		6	1		8				1		16	0.01%
Total	6,128	74,174	29,176	2,313	31,201	4	10	2	2,061	3	Total remains	
%	4.22%	51.13%	20.11%	1.59%	21.51%	0.00%	0.01%	0.00%	1.42%	0.00%	145,072	
Remains per litre	8,754	15,138	58,352	23,130	6,639	N/A	N/A	2	20,610	N/A		

5. Discussion

5.1. Crops

Cereal grains are dominant in Area 2 at CSJAMD. Rye is the main crop by a large margin, having been identified almost 50,000 grains. The other crops, namely naked wheat, hulled barley, common millet, foxtail millet and flax are incomparably lesser than rye. Only two grains of oat were found, without floret bases. In this case, chaff remains are fundamental for a distinction between wild/cultivated oat (Van Zeist, 1968; Ruas and Pradat, 2001; Jacomet, 2006). Oat is often found in other sites leading several authors to suggest its cultivation in NW Iberia began in the Iron Age (Dopazo Martínez, 1996; Tereso et al., 2013a; Teira-Brión, 2019). However, it is also a frequent weed and ruderal plant in the region. As such, whether the few grains from CSJAMD belong to cultivated individuals is a hypothesis impossible to confirm due to the absence of chaff.

Spring rye has been cultivated in the region until recently (Taborda, 1932) but the recurrence of corncockle seeds alongside rye at CSJAMD, indicates rye should have been a winter crop. With the exception of the millets, which are known as spring crops, the other crops could have been sown in both seasons.

The large amount of rye suggests that this crop would have had a relevant role in this site's agricultural strategies as in other places in inland Portugal during the Late Antiquity. Older rye grains were collected at Crastoeiro (Mondim de Basto), dating to the 1st century BCE (Seabra et al., 2018). However, rye is more frequent in sites from Late Roman times onwards, either in NW Iberia (Tereso et al., 2013b; Tereso et al., 2018b; Seabra et al., 2020a) or other regions of the Iberian Peninsula (Alonso, 2005; Tente et al., 2018; Peña-Chocarro et al., 2019b). Besides CSJMAD, in Northeast Portugal rye was only found in the Sabor valley (Douro River tributary), namely at Quinta de Crestelos (Mogadouro) (Tereso et al., 2018b). Here, few rye grains were collected from levels dated from the 5th-6th century CE to the 10th-12th century

Fig. 4. Some of the fruits/seeds remains identified at CSJAMD. Grains of *Hordeum vulgare* (1), *Triticum aestivum/durum* (2), *Secale cereale* (3), *Panicum miliaceum* (4), *Setaria italica* (5). Seed (6), capsule (7), pedicel (8) of *Agrostemma githago*. Grain of *Bromus* sp. (9).

CE, being absent in the Iron Age and Roman levels. More to the west, rye has been found in Late Antique levels of Monte Mozinho (Penafiel) (Tereso et al., 2013b; Vaz et al., 2017) and Freixo/Tongobriga (Marco de Canaveses) (López-Dóriga, 2020). Guifões, in the coast, also provided rye grains and chaff of this chronology (Seabra et al., 2020a). In central Portugal, grains of rye have been found in the early medieval levels of Senhora do Barrocal (Tente et al., 2018; Seabra et al., 2022) and S. Gens (Oliveira et al., 2017).

Naked wheat, hulled barley and millets (common/foxtail millet) are frequently found in NW Iberia, and in distinct chronological periods, including Late Antiquity (e.g. Buxó et al., 1997; Tereso et al., 2018a; Peña-Chocarro et al., 2019a; Peña-Chocarro et al., 2019b; Seabra et al., 2020b). Since a reduced number of remains from those crops was collected, it is hard to evaluate their importance at CSJAMD. Despite the small magnitude, their record demonstrates that past communities relied on a diversity of crops, with different characteristics.

Besides cereals, it was recorded one non-cereal crop: flax. It is represented since the Chalcolithic in NW Iberia (Bettencourt et al., 2007; Ramil-Rego and Aira Rodríguez, 1993; Sanches, 1997; Tereso et al., 2016). However, its record during historical times is not consistent, being rarely found in the region (Teira-Brión et al., 2012; Peña-Chocarro et al., 2019b). The small archaeobotanical assemblage found, as well as the absence of archaeological material (e.g. spindle whorls), does not allow a solid interpretation about the use of flax to obtain oil and/or

Fig. 5. Ceramic vessel with carpological remains inside.

fibre plant.

The scarcity of non-cereal crops may be biased. Others, such as pulses or fruits, were probably known and cultivated by the CSJAMD inhabitants, during the Late Antiquity. In fact, the assemblage studied is the result of a single destruction event, representing a single moment in the occupation of Area 2. Therefore, the information obtained is limited and unrepresentative of the whole site's occupation. Other sites with a similar chronology in NW Iberia, such as Agro de Deus and Quinta de Crestelos, also did not provide any evidence of other crops rather than cereals. However, those sites may not represent a good parallel, since they displayed small carpological assemblages (Tereso et al., 2018b; Peña-Chocarro et al., 2019b). Among the two, Quinta de Crestelos is the only one located in the same region, in Northeast Portugal, 63 km southwest from CSJAMD. It was a small rural site during the Late Antiquity and the Early Middle Ages. Contrary to CSJAMD, it benefited from a wide and probably fertile valley where, during the Iron Age and the Roman Period, naked wheat, barley and millets were widely cultivated (Tereso et al., 2018a; Tereso et al., 2020). While wheat predominates in the earlier phases, the medieval carpological assemblage is much smaller, making it difficult to evaluate the weight of each crop in the agricultural strategies. Rye is the only addition regarding previous periods (Tereso et al., 2018b).

For CSJAMD we only have data from the 6th-7th century CE. Apart from naked wheat, the crops found grow well in undemanding environmental conditions, both in terms of soil fertility and sun exposure. CSJAMD was placed on the edge of a steep cliff, next to the Douro River. The area around is characterized by rugged terrains with abundant granitic rocks but close-by there is a vast plateau which during the early 20th century was dominated by large rye fields and restricted, more fertile areas, with wheat (Santos Júnior, 1981). The poor and acidic soils, as well as the cold winters and frequent frost, made rye the perfect crop, probably the only truly yielding in the region. Such combination of factors could have been determinant in agricultural strategies already in the Late Antiquity, although other factors, such as cultural, economic, or political, could also have had a relevant impact on the choices of past agriculture communities. The arrival of Germanic groups, and their control over Northwest Iberia, may have involved the establishment of different agricultural strategies, including crop choices. Such decisions could have been conditioned by the current economic situation in the region, or due to cultural/political reasons defined by the new rulers, since rye was already an important crop in other areas of Europe (e.g.

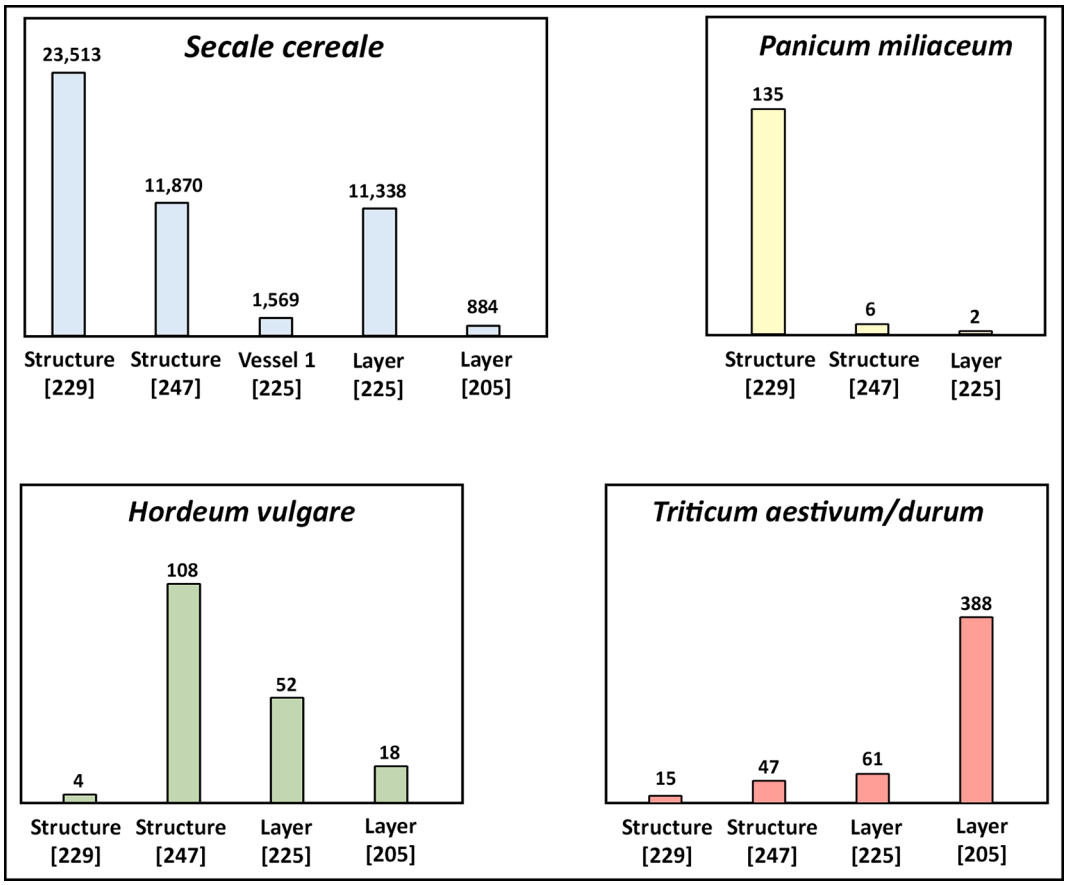

Fig. 6. Individual results of the main cereal crops at CSJAMD.

Behre 1992).

5.2. Storage

The large concentration of cereals in the above-ground structures [229]/[247], and in their surrounding contexts, as well as their association with some vessels suggest the area was used for the storage of grains, mostly rye. A more heterogeneous scenario would be expected in other circumstances, such as accidents involving fire (e.g. grain drying or cooking).

Although this seems to have been the case when the remains were exposed to fire, some moment within the late 6th century or the first half of the 7th CE, it is not possible to extrapolate this interpretation for the whole period the settlement was inhabited. Other crops could have been stored and the whole place could have been used for other purposes. In fact, structures similar to those recorded at CSJAMD have been found in other sites in the region and interpreted differently (e.g. as tanks related with wine or olive presses) (e.g. Pereira et al., 2014; Tereso et al., 2020). So, the facilities recorded in Area 2, could have been reused and readjusted over time, considering the needs of past communities, before their final usage for storage (Pereira, 2018; Salgado and Pereira, 2018; Salgado and Pereira, 2018–19; Salgado and Pereira, 2019).

It is unclear how the entire assemblage was stored. Inside structure [247] one ceramic vessel with cereals has been registered, but not studied. The only vessel retrieved (Vessel 1) was found in [225]. It was found outside the storage facilities but near one of them (Structure [229]) (Fig. 2). This demonstrates that cereals were stored in containers, outside and inside the sub-quadrangular storage facilities. The final number of vessels is unknown due to recent perturbations (agricultural activities).

However, it is unlikely that all cereals were stored in ceramic vessels. First, there was no evidence of any container in structure [229]. Second, since the single container that was possible to evaluate so far - Vessel 1 - is small and contained c. 1,500 grains of rye (out of the 142,397 that have been found). So, either a great number of small vessels were used, or fewer but larger vessels would have been required. Future studies are necessary to address this subject, but it is possible that other types of containers were also used, eventually made of perishable material. Thus, the plant remains were possibly stored in different ways, in the storage space, at CSJAMD.

On the other hand, the use of containers with such small dimensions can be the result of a daily transitional phase, between the collection of grains from the storage structures and their transformation into food (Tripković, 2011; Filipović et al., 2017). Nevertheless, and despite some uncertainties regarding what and how storage facilities were used, it is clear that several cereals were kept in ceramic vessels, and they would have been placed next to the facilities and/or inside the above-ground structures.

The use of ceramic containers for storage is well-known in the Iberian Peninsula as in other areas of Europe, and in different chronological contexts (e.g. Bouby et al., 2005; Tripković, 2011; Pérez Jordà, 2013; Filipović et al., 2017; Seabra et al., 2020b; Tarongi et al., 2020). Nonetheless, the identification of a pottery vessel with a significant amount of cereal grains inside, in a good preservation state, is rare, thus noteworthy.

It is difficult to ascertain, in a secure way, if distinct crops were kept in different containers or spaces, either inside or outside the structures. Some differences in crops' distribution were noted which might suggest some sort of space organization (Fig. 6). However, apart from rye, other cereals were found in small quantities, which can produce a biased interpretation.

In Area 2, no chaff remains and rare weeds were collected. This means grains were stored fully processed. The cereals found have different characteristics and are usually associated with particular processing procedures (e.g. Hillman, 1981; Moreno-Larrazabal et al., 2015; Alonso, 2019), but essentially they are free-threshing cereals, and particularly in the case of rye the chaff's absence is unsurprising. Common millet, foxtail millet and barley have to be dehusked after threshing, still, these cereals were generally scarce, being thus of difficult evaluation. Since remains at CSJAMD show no evidence of hulls, either they did not survive the charring or dehusking was fully carried out before storage. If dehusking of grain was conducted at a daily basis, it would tally the hypothesis according to which some of the grain was in a transitional phase between storage and use (e.g. Alonso, 2019).

The small number of weeds also suggests that all post-harvesting activities would have been conducted prior to storage. The presence of several corncockle seeds may be justified by their large size. Corncockle is a non-native plant in the Iberian Peninsula, and often associated with winter cereals. It has been frequent in the archaeobotanical record, mainly in contexts from Late Antiquity onwards (Alonso, 2005; Tente et al., 2018; Colominas et al., 2019; Quirós-Castillo et al., 2020). With large dimensions, this seed is resistant to the several post-harvest processing stages (e.g. Thompson, 1973; Borojević, 2005; Fuller et al., 2014). Besides seeds, capsules and pedicels fragments (Fig. 4) were also found, suggesting that some seeds were still inside the capsules, when they were harvested (on an unintentionally way). Such prevalence is common in corncockle plants (Thompson, 1973).

Until now, there is no evidence of other storage contexts with archaeobotanical remains for the period of time here addressed (6th-7th centuries CE), in Northwest Iberia. Nonetheless, some similarities concerning the storage facilities and the associated carpological remains were observed in other sites in the region, and in Central Portugal as well (Tereso et al., 2013b; Vaz et al., 2017, Tente et al., 2018; Seabra et al., 2022). In Northern Portugal, namely at Monte Mozinho, two above-ground structures with similar morphologies and dimensions were identified within two compartments dated to the Late Antiquity. Cereals were dominant and particularly significant inside the structure from Compartment 1. Here, broomcorn millet and foxtail millet were predominant, being also collected several rye grains. The same cereals, plus hulled barley and naked wheat were observed in Compartment 2, but mostly outside the storage structure. Inside, fruits and seeds were rare (Tereso et al., 2013b; Vaz et al., 2017). Further southeast, at the Early Medieval site of Senhora do Barrocal, storage structures were not found. However, a massive assemblage of archaeobotanical remains was collected, mainly in a fire level corresponding to the destruction of a building, which would have been built in perishable materials and used for storage. In comparison with CSJAMD, some differences were noted in the carpological assemblage, but the cereal crops were essentially the same. Rye was relevant, being a dominant crop alongside oat. Hulled barley, common millet, naked wheat, and foxtail millet were also recovered, and in larger proportions than in CSJAMD (Tente et al., 2018; Seabra et al., 2022).

6. Final remarks

This study provided relevant data about crop diversity and storage strategies during the Late Antiquity, in Northwest Iberia, particularly, for the time when Germanic groups settled in the region. This is a period for which there is limited carpological information, due to the small number of sites analyzed and the small amount of fruits/seeds they provided. Thus, the results and considerations here presented are of utmost pertinence.

Archaeological interventions at CSJAMD, revealed contexts which are difficult to understand due to their bad preservation, in great part as a result of recent agricultural activities on the site. Nevertheless, fieldwork displayed evidence of a major occupation from the Late Antiquity, with a fire of unknown scale probably occurring somewhere between the late 6th century and the mid-7th century CE, according with the radiocarbon date obtained. The western part of Area 2 is the most relevant, mainly due to the large amount of carpological remains found in association with two sub-quadrangular structures, ceramic vessels, and a destruction layer. These contexts were part of what seems to have

been a domestic storage area where, at the moment of its destruction, rye was by far the dominant crop. Other crops, namely naked wheat, hulled barley, common millet, foxtail millet and flax have been found in much smaller amounts. All these seem to have been kept already fully threshed and dehusked both in ceramic vessels and other containers made with perishable materials.

Despite carpological results are conditioned by specific archaeological contexts, and a small volume of sediment, the great amount of rye at CSJAMD suggest that would have been an important crop at CSJAMD. Although the lack of parallels makes it difficult to have a good long-term perspective on crop choices, evidence for the relevance of rye cultivation in the Late Antique inland areas of the northwest is increasing as more analyses are conducted in sites of these chronologies (see above). Whether the growing role of rye since Late Roman times is related with environmental trends or with the political and social changes of these times is a matter of debate (Tereso, 2012; McCormick, 2013) but in the case of CSJAMD, rye would fit perfectly in the harsh environmental conditions and low fertility of the surrounding area.

CRediT authorship contribution statement

L. Seabra: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **P. Pereira:** Investigation, Resources, Writing – original draft, Writing – review & editing. **M. Salgado:** Investigation, Resources, Writing – original draft, Writing – review & editing. **M. Martín-Seijo:** Writing – original draft, Writing – review & editing, Supervision. **R. Almeida-da-Silva:** Writing – original draft, Writing – review & editing, Supervision. **J.P. Tereso:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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