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Crops behind closed walls: Fortified storage at Castelinho in the Late Iron Age of NW Iberia

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ABSTRACT

The site of Castelinho (Torre de Moncorvo, northeast of Portugal) is a fortification strategically placed on a small elevation, near the river Sabor, built in the Late Iron Age and occupied until the Early Roman period. It is characterized by impressive defensive features, including large walls with turrets, ditches and complex entrances, inside of which no clear evidences of domestic areas were found. On the contrary, this monumental defensive apparatus seems to have served mostly to protect several storage facilities, mainly elevated granaries, in which abundant archaeobotanical remains were recovered.

The excavation of Castelinho comprised the systematic sampling of sediment in a wide diversity of contexts, ultimately leading to the recovery of large amounts of charcoal, fruits and seeds. Most came from secondary or tertiary refuse deposits but some seem to have been actually related to the destruction of granaries by fire.

Carpological results show the predominance of naked wheat (*Triticum aestivum/durum*) while hulled barley (*Hordeum vulgare*) and broomcorn millet (*Panicum miliaceum*) were found in smaller amounts. These crops were stored fully processed, taking into account the almost absence of chaff and the scarce presence of weeds. Charcoal analysis suggest *Pinus pinaster* and *Quercus* evergreen provided most of the wood used in the construction of the granaries.

In this study, this data will be presented, discussed and compared with archaeobotanical and archaeological information from other sites excavated in the Sabor Valley and in the surrounding region. The size and monumentality of Castelinho, combined with the fact that it provided few evidences of other activities besides storage, suggests this site had a relevant role for local communities. This will be discussed together with other evidence of the social relevance of storage for Late Iron Age communities in the region.

1. Introduction

Storage strategies, together with the diversification of food sources, were crucial to assure the resilience of past agricultural and even pre-agricultural communities (Adger, 2000; Tereso, 2012). Besides helping to prevent famine, storage played a relevant role in the establishment of power relations at different levels, within and between communities (Hendon, 2000; Kuijt, 2009; Parcero Oubiña and Ayán Vila, 2009). As such, storage should be addressed on multiple levels focusing the stored goods, the facilities, the social behaviours associated to them, the sites and their regional context. Some approaches have been made on Iron Age and Roman archaeological contexts in NW Iberia, particularly focusing the storage of crops in its technical and social dimensions, whether including (e.g. Parcero Oubiña and Ayán Vila, 2009; Rey Castiñeira et al., 2011) or not (e.g. Fernández-Posse and Sánchez-Palencia 1998; Álvarez González and López González, 2000) archaeobotanical information.

Considering the relevance of plants in human diet, multiple types of storage facilities specifically used to store seeds and fruits, mostly cereals, have been identified in several cultural and chronological contexts, making archaeobotanical studies a crucial tool to address this subject. Besides the identification of what was stored, these approaches can give precious information regarding the way the storage of food was conducted, namely space organization (Ruas et al., 2005), pre-storage processing of crops (e.g. Tereso et al., 2013; Leite et al., 2018; Seabra et al., 2018), materials used to build the structures (Carrión

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Marco, 2003), among others. In the Late Iron Age and Early Roman Period, storage of grain and other products took place in underground structures (pits), aboveground structures (stone and wattle and daub structures, elevated granaries) and vessels of different types and sizes, i.e. both in facilities with confined and renewed atmosphere.

In most of these structures, spelt (*Triticum aestivum* subsp. *spelta*) was the main crop and was usually stored in spikelets. Other crops frequently found are broomcorn millet (*Panicum miliaceum*), hulled barley (*Hordeum vulgare*), naked wheat (*Triticum aestivum/durum*), oat (*Avena* sp.) and faba bean (*Vicia faba*) (Rey Castiñeira et al., 2011; Tereso et al., 2013; Figueiral et al., 2017; Leite et al., 2018; Seabra et al., 2018). Other plant remains occur but are usually rare. Only at Quinta de Crestelos, where storage facilities are elevated granaries, we find a predominance of naked wheat (*Triticum aestivum/durum*) while hulled wheat is completely absent (Tereso et al., 2018). However, it remains unknown whether there is a direct relation between distinct crops, different storage practices and specific facilities.

The integration of storage in the social and territorial organization of past communities in the northwest has been matter of debate, leading some authors to suggest that storage beyond household levels may have occurred at least since the Iron Age and that goods could have been controlled by a part of the community (González-Ruibal, 2003; 2006, Parcero Oubiña and Ayán Vila, 2009; Tereso et al., 2013; Teira-Brión et al., 2016; Teira-Brión, 2019). The hillfort of As Laias/O Castelo (Cenlle, Spain) has been crucial to address this matter. Its upper platform seems to have been used mostly as a storage area by means of rectangular wattle and daub structures, from the 7th-5th century BCE to the turn of the Era. In its final stages, it was protected by a stone wall and earth embankments (Álvarez González and López González, 2000). As Laias and other sites such as Castrovite (A Estrada, NW Spain) have been considered evidence of the dissemination of controlled storage and surplus accumulation throughout the region (González-Ruibal, 2006; Parcero Oubiña and Ayán Vila, 2009; Teira-Brión et al., 2016; Teira-Brión, 2019), but this scenario is far from clear and, due to its complexity, difficult to apprehend.

The presence of a diverse set of storage facilities sometimes concentrated in specific areassuggests Iron Age was a challenging period from social and economic points of view in NW Iberia in which crop protection was a very important issue. Therefore, a site that seems to be of the utmost relevance to address the scale and social context of storage is Castelinho (Fig. 1). During its excavation, several storage structures, mostly elevated granaries, were found surrounded by massive defensive walls, ditches and turrets, while clear domestic contexts were nearly absent both from inside and outside the fortification's perimeter making this a unique site in all NW Iberia (Santos et al., 2012, 2013; Santos, 2015; Santos and Ladra, 2016; Santos et al., 2016, Dinis et al., 2018). During the field work, an ambitious sampling strategy led to the recovery of a great amount of archaeobotanical material that remains unpublished. Here the results of the carpological and charcoal analyses will be presented and will be put in the context of the site and regional dynamics.

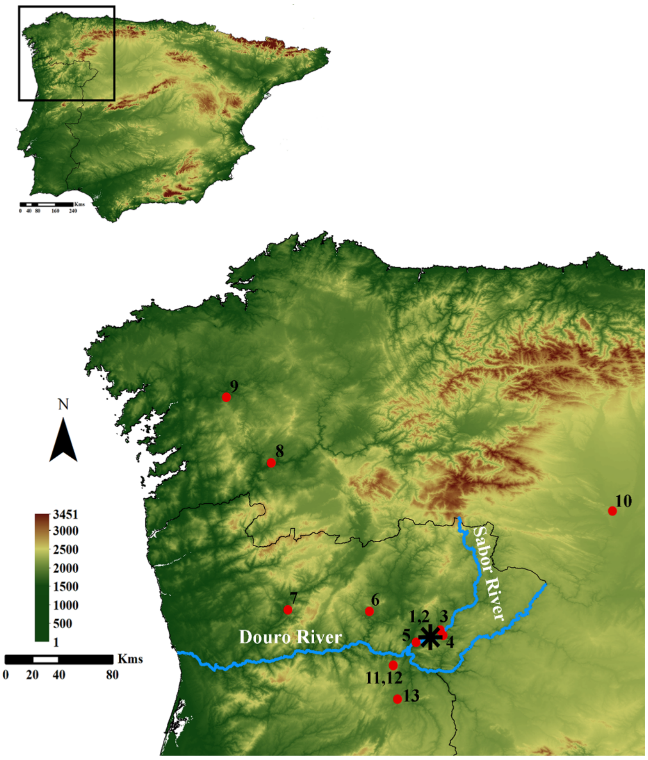

Fig. 1. Location of the sites mentioned in the article (NW Iberia): 1- Castelinho; 2- Cemitério dos Mouros; 3 – Chã; 4 – Quinta de Crestelos; 5 – Terraço das Laranjeiras; 6 – Crasto de Palheiros; 7 – Crastoeiro; 8- As Laias; 9- Castrovite; 10- La Corona /El Pesadero; 11- Quintal da Casa Grande; 12 – Casa do Nelo; 13- Vale do Mouro.

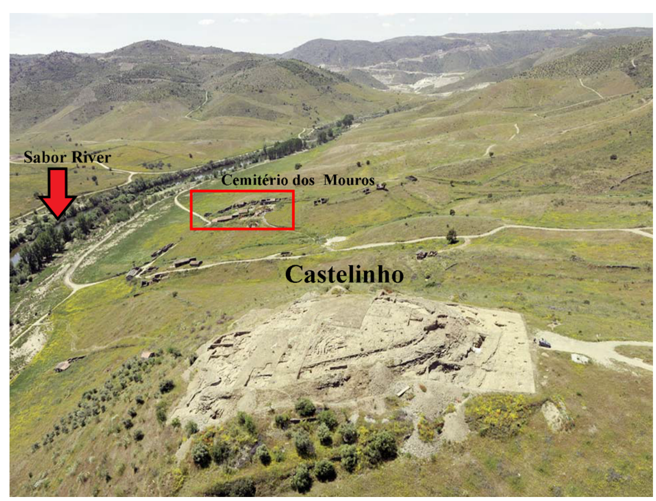

Fig. 2. Castelinho location and its proximity with Cemitério dos Mouros and the Sabor River
(Adapted from Santos and Ladra, 2016).

2. The site: Castelinho

Castelinho (Torre de Moncorvo, Northeast Portugal) is placed on a small spur (6.970034 W/41.24193 N), at 212,5 m high, in the right bank of the Sabor river, a tributary of the Douro river. The valley is characterized by its entrenched morphology in most of its course but Castelinho has a great visual control over one of the few areas where the valley widens significantly and extensive river terraces are found (Fig. 2). Excavations in the site occurred from 2011 to 2013 during the execution of a heritage protection plan related to the construction of a hydroelectric dam that ended up flooding a major area, including this entire archaeological site.

Previously characterized as an Iron Age hillfort (Lemos, 1993), Castelinho is now perceived as a complex fortified site with an oval perimeter of c. 100 m length and 60 m width, mostly related to storage and other activities, providing little evidence of any domestic area (Fig. 3) (Santos et al., 2012, 2013; Santos, 2015; Santos and Ladra, 2016; Santos et al., 2016; Dinis et al., 2018).

Some artifacts suggest a prehistoric phase from the 3rd-2nd millennia BC (Phase I), but no structural elements could be ascribed to it. The major occupation dates from the Late Iron Age and lasted until the Early Roman Empire (for full description see Santos et al., 2012, 2013; Santos, 2015; Santos and Ladra, 2016; Santos et al., 2016; Dinis et al., 2018).

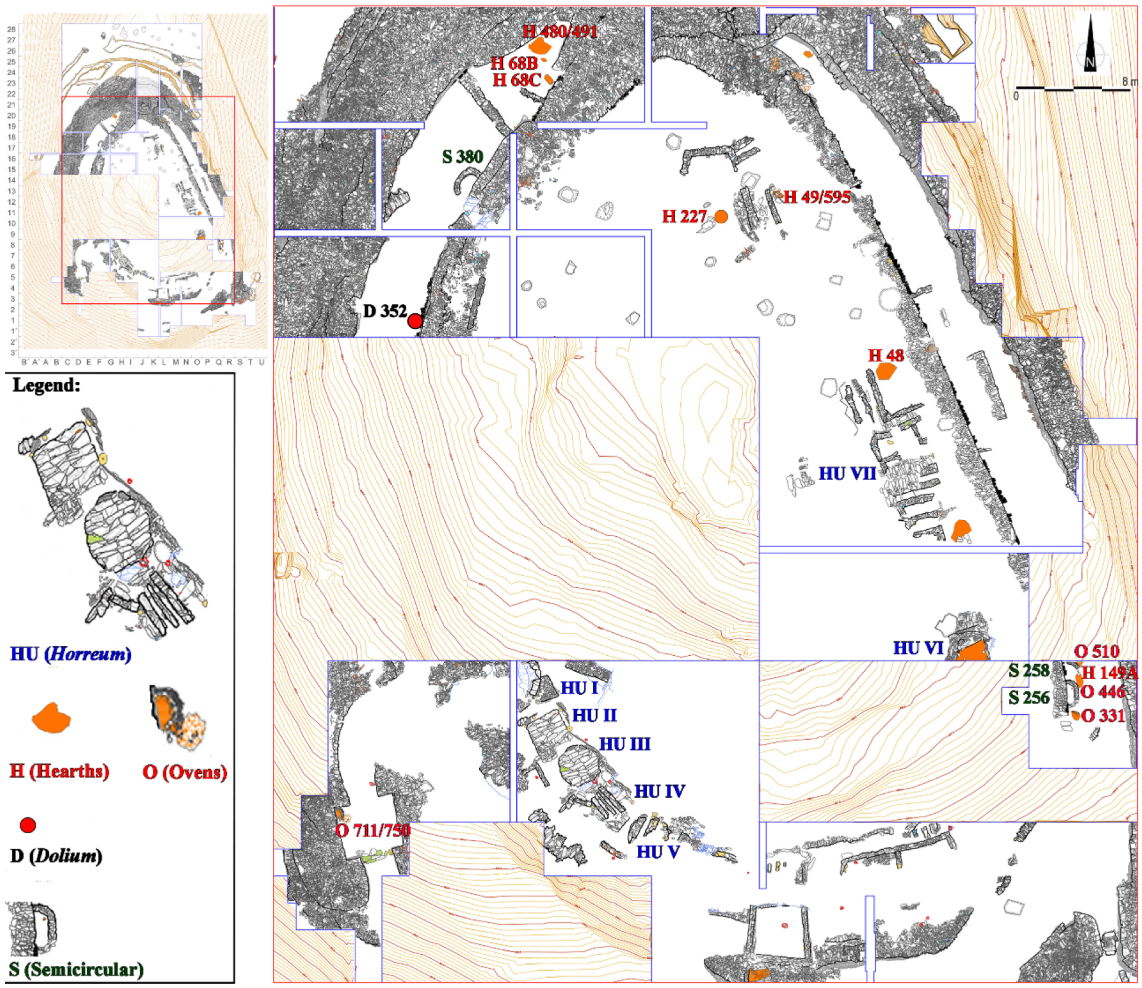

Fig. 3. Castelinho overview plan.

The construction of the earlier defensive stone wall occurred somewhere between the 3rd and the early 2th centuries BC. The monumental apparatus from this Phase II included three entrances and a ditch (Ditch III). Abundant engraved plaques were found both in the condemnation of that ditch and reused in the stone structures from later phases (Santos and Ladra, 2016; Santos et al., 2016; Dinis et al., 2018). However, some caution is necessary regarding a clear relation between the plaques and phase II (see discussion below). Hearths and ovens from this early date were found inside the enclosure.

In the following phases, covering the 2nd century BCE and the first half of the 1st century BCE (Phases III and IV), the site went through several changes. At first, the wall was reinforced and a semicircular turret was built in the most easily accessible area (North). Circulation areas inside the enclosure were modified and two entrances were closed, coinciding with the earlier storage facilities recorded. These were semicircular structures attached to previous walls and to rock outcrops (Santos and Ladra, 2016).

During Phase IV, the site reaches its greatest dimension and monumentalization. The wall and turret were strengthened, ditch III was restructured and a new ditch (Ditch II) and turret (in the southeast flank) were erected. A new entrance was created and several storage facilities were built, namely circular and rectangular elevated granaries (*horrea*). Overall, other structures related to daily life activities are rare and include hearths and ovens (Santos et al., 2012, 2013; Santos, 2015; Santos and Ladra, 2016; Santos et al., 2016). A diverse set of artifacts was recovered and also evidence of small scale metallurgy, namely iron slags found in some layers (Table 1 – supplemental material).

The transition towards the Roman Phase – Phase V, possibly dating from the second half of the 1st century BCE and the 1st century CE – was not abrupt, as the site initially maintained its structure and possibly its function – *horrea* and the *dolium* were still used for storage. Meanwhile, the place ceases to be a fortification and was likely abandoned. The frail signs of Roman occupation do not seem to persist beyond the 2nd century CE (Santos and Ladra, 2016).In a lower platform near the river, c.300 m away, in what is today known as Cemitério dos Mouros, evidences of an occupation dating back to the Iron Age-Roman transition and lasting throughout Medieval and post-Medieval times demonstrates not only that both sites coexisted but also that the nearby area was kept inhabited after the abandonment of Castelinho (Santos and Ladra, 2016; Rosselló Mesquida et al., 2016).

Phases 3 to 5 – Late Iron Age to the Early Roman Empire (2nd century BCE-1st century CE) – represent a short and complex period in the occupation of Castelinho, in which construction and use of structures are sometimes difficult to ascribe to specific a phase (see Table 1 – supplemental material). The radiocarbon dates obtained in these structures also support this idea (Table 1). Moreover, the major changes in space organization that occurred in phases 2–5, in Castelinho, including the construction of new structures and their eventual renovation during the site's occupation, implied the creation and restoration of several earthworks. These led to great and perhaps frequent remobilization of sediments that incorporated archaeological and archaeobotanical material. As such, material from these contexts must be analyzed with due care, as they may incorporate artefacts and biological remains from different periods.

Table 1
Radiocarbon dates from the storage facilities at Castelinho. Calibration Oxcal 4.3 software, Intcal 13 calibration curve (Reimer et al., 2013).

Sample	Structure	Sampled context	Material	Lab. Reference	14C age (yr B.P.)	Calibrated age B.C. - A.D. (1 σ)	Calibrated age B.C. - A.D. (2 σ)
531	*Horreum* II	653A	*Triticum aestivum/durum* (grains)	Beta-387554	2150 ± 30	350–117 BCE	356–61 BC
538		653C	*Triticum aestivum/durum* (grains)	Beta-387553	2120 ± 30	196–106 BCE	345–50 BC
550	*Horreum* III	654B	*Hordeum vulgare* (grains)	Beta-387552	2040 ± 30	92 BC – 3 AD	162 BCE – 46 AD
546		654C	*Triticum aestivum/durum* (grains)	Beta-387551	2060 ± 30	153–39 BC	170 BCE – 4 AD
626	*Horreum* VI	728	*Hordeum vulgare* (grains)	Beta-387559	2040 ± 30	92 BC – 3 AD	162 BCE – 46 AD
656		730B	*Triticum aestivum/durum* (grains)	Beta-38550	2050 ± 30	103–1 BC	166 BCE – 20 AD
8	*Horreum* VII	3	*Quercus*evergreen (charcoals)	GrA-54994	2055 ± 30	150–2 BC	168 BCE – 16 AD
282		397	*Triticum aestivum/durum* (grains)	Beta-387555	2090 ± 30	163–56 BC	195–42 BC
267		397A	*Triticum aestivum/durum* (grains)	Beta-387556	2120 ± 30	196–106 BCE	345–50 BC
510	Semicircular structure 256	257	*Hordeum vulgare* (grains)	Beta-387574	2040 ± 30	92 BC – 3 AD	162 BCE – 46 AD
1168	Semicircular structure 258	259	*Hordeum vulgare* (grains)	Beta-387578	2070 ± 30	155–45 BC	174–1 BC
976		415	*Hordeum vulgare* (grains)	Beta-387572	2060 ± 30	153–39 BC	170 BCE – 4 AD
230	Semicircular structure 380	288	*Triticum aestivum/durum* (grains)	Beta-387581	2110 ± 30	181–92 BC	204–46 BC
328		348	*Triticum aestivum/durum* (grains)	Beta-387583	2120 ± 30	196–106 BCE	345–50 BC
323		359	*Triticum aestivum/durum* (grains)	Beta-387582	2100 ± 30	170–61 BC	198–47 BC
1200		371	*Triticum aestivum/durum* (grains)	Beta-387579	2080 ± 30	157–51 BC	191–3 BC
89	*Dolium* 352	350	*Triticum aestivum/durum* (grains)	Beta-387584	2070 ± 30	155–45 BC	174–1 BC

3. Material and methods

3.1. Sampling strategy and archaeological contexts

Fieldwork at Castelinho included a great sampling effort, with no parallels at that time in Portugal. 1353 samples were recovered from 226 stratigraphic units (s.u.), including sediment samples and a few handpicked remains. The volume of sediment recovered from each s.u. varied substantially between 0,1 L and 314,8 L, which is unsurprising, considering the great diversity of contexts that were sampled. Volume was not recorded in all samples (for full information see Table 1 in supplementary material). Samples were processes through bucket flotation by the archaeological team, using a column of sieves with 2 mm, 1 mm and 0,5 mm meshes.

Judgment sampling was combined with the full recovery of sediment from specific contexts, namely those connected with some storage facilities and hearths. In some cases, judgment sampling seems to have been directed to contexts where plant remains were visible during the field work. However, the variety and number of s.u. sampled covered the diversity of contexts identified in the excavation, its spatial distribution through the site and the site's chronology.

As mentioned before, the chronology of some remains is problematic, in two different ways. First, the cycles of construction, use and abandonment of some structures (i.e. granaries), happened in a short time span, maybe even overlapped periods, making the archaeological phases 3 to 5 difficult to distinguish from a radiometric point of view (see the chronology of storage facilities in Table 1). These different phases were identified both in the stratigraphy and in the construction sequence, although difficulties occurred even in this field. On the other hand, the construction of abundant earthworks (mostly embankments) was done by mobilizing pre-existent sediment in the site and possibly also from outside, making the interpretation of the archaeobotanical remains from these palimpsests particularly problematic. Every embankment may include plant remains from the phase when they were built and used as well as from all previous phases in the site.

Considering these limitations, archaeobotanical results are analyzed first at the level of the type of context and chronological considerations are made whenever possible. For that, all 226 contexts were given a code according to its general typological and functional characteristics (See Table 1 in supplementary material). A two-level typology of contexts stands in the base of all interpretations (Table 2).

A) Fire structures

Despite having architectural similarities, two types of combustion structures, hearths (A1) and ovens (A2) were identified in Castelinho (examples in Fig. 4) and analyzed in the scope of this paper.

Table 2
Typology of contexts.

Typology	Context
A	**Fire structure**
A1	Hearth
A2	Oven
B	**Storage structure**
B1	*Horreum*
B2	Semicircular structure
B3	*Dolium*
C	**Refuse deposit**
C1	Floor
C2	Abandonment/Destruction
C3	Embankment
D	**Filling deposit**
D1	Posthole
D2	Ditch
D4	Wall
E	**Other Concentrated deposit**

Fig. 4. Two fire structures identified at Castelinho: Left – Hearth 480; Right – Oven 750. Photo Credit: Filipe Santos.

Nine Hearths were found in Castelinho (Fig. 3). These structures consist of an irregular red clay base, generally bigger than the ones found in ovens (hearths ranged from 30 cm to 80 cm wide and 30 cm length), and were associated with charcoal and ash deposits. Given the structural similarities with clay bases found in the ovens, it is not possible to rule out the possibility that these structures could also be ovens from which only this evidence was preserved.

In the hearths, samples were recovered in the s.u. directly above the clay base and in layers associated with the structures. A total of 53 soil samples (226,4 L) were processed from these contexts. A sample composed of handpicked material was collected from the construction layer of Hearth 595.

The five Ovens (Fig. 3) identified bear roughly the same characteristics even if in different preservation states. Despite none of them was fully preserved, it was possible to understand their structural architecture and construction method. With a round or elliptic shape, these structures were composed of a levelling base made of small stones covered by a thick layer of even clay (sometimes 10 cm thick) which made the chamber floor of the oven. This clay displayed a bright red, sometimes orangish, coloration as result of becoming in contact with fire and heat. Considering the dimensions of the clay platform in the cases where it is complete – ranging from 30 cm to 60 cm wide – the size of the ovens would have been relatively small. Originally, these structures would have had side and end clay walls and eventually a roof structure similar to a dome, as can be perceived by the remains of its walls still preserved in some cases.

In the case of ovens, the sampling methodology put in practice was the same as in hearths. Thus, a total of 32 samples (152 L) were recovered in the 5 ovens analysed. In the Oven 331 2 different s.u. related with the clay base and with the destruction layer of the wall/dome were sampled. Similarly, the 18 samples collected in Oven 750 refer to its destruction layer, clay base and a charcoal layer beside the mouth of the oven. The samples originated from the 3 remaining ovens were recovered directly above the clay of their respective ovens. Sample size varied according with soil availability.

All the analysed structures were built directly above the circulation layer in several areas of the site (Fig. 4), and refer to 3 continuous occupation phases of the site, between the 2nd century CE until the 1st century BCE. Both these types of fire structures are also very similar in size and characteristics to the ones found in the nearby site of Quinta de Crestelos (Vaz et al., 2017b).

B) Storage facilities

Three types of facilities were defined: Elevated granaries or *Horrea* (B1); Semicircular structures (B2) and a *dolium* (B3) (Fig. 5). A great part of the sampling effort was concentrated in these contexts.

Six *horrea* (B1) were included in this study. They were characterized by the typical parallel support walls made in schist, on top of which large schist slabs made up the floor (*tabulatum*). The number of support walls varied according to the structures' dimensions. The outside walls and ceiling were likely built with perishable materials, namely wood and clay, as in the nearby site of Quinta de Crestelos (Tereso et al., 2018). Postholes were found in association with the *horrea*.

The elevated granaries were found in two main areas (Fig. 3): *Horrea* I, II, III, IV and V were aligned in a middle platform in the southwest area of the site (Fig. 6), while *Horrea* VI and VII were in the upper/central platform in the eastern part of the site. These structures displayed quadrangular or circular formats. No samples were retrieved in *Horreum* V.

Horrea II, IV, VI and VII had quadrangular plans. *Horrea* II and IV, showed four support walls and a schist floor with a usable area of c. 7,3 m^2 and 6,3 m^2 respectively. *Horreum* VI was not fully excavated and *Horreum* VII, although being clear it had more than one construction phase, was badly preserved. As such the true dimension of these structures is unknown. Three of these *horrea* (II, IV and VI) had a single posthole placed near the granary. Baked clay was recovered in the floors of *Horrea* II and VI. *Horrea* II and VI showed a set of fixed slabs surrounding the structure, which should work as safety measure, eventually to divert water from the building.

Horrea I and III had circular plans. *Horreum* I was too poorly preserved to allow a proper characterization but *Horreum* III had a usable area of c. 7,6 m^2, delimited by schist slabs and associated to three postholes, which were also identified around this granary. For structures of such dimensions few postholes were found, however these should also be evidences of supporting systems.

In *Horrea* II and IV and VII granite millstones were reused as construction material and in *Horreum* VI one slab in the floor was engraved, also suggesting it was reused material.

In the granaries, sediment samples were recovered from the deposits between the parallel walls of their foundations and between these and the delimitation slabs of some *horrea*. In *Horreum* I a quadrangular structure attached to a curved wall was sampled. Additionally, in *Horreum* VII samples were also collected in the preparation layers (i.e. embankments) and abandonment levels covering the structure.

Three semicircular structures (B2), attached to preexistent walls, were interpreted as storage facilities (Santos and Ladra, 2016). These are clearly smaller than the *horrea*. The well-preserved semicircular structure 256 (in the East corridor) had an usable area of 1,75 m^2. Structure 380 (Fig. 5), although incomplete, had an usable area of 1,40 m^2 and structure 258 was too badly preserved to allow an accounting. Sediment samples were collected inside each structure and probably derive from their use and/or abandonment (see discussion below). A deposit with abundant plant remains was sampled in a circulation area in the vicinities of structure 380 and, although defined as a scattered deposit (type C context), may be related to the storage structure (*vide infra*).

One *dolium* (B3) was found *in situ* in the West corridor (Fig. 5). Four soil samples were retrieved inside.

Fig. 5. Storage facilities found at Castelinho. Above: Left – *Horreum* III; Right – *Horreum* II. Below: Left – Semicircular structure 380; Right – *Dolium* 352. Photo Credit: Filipe Santos.

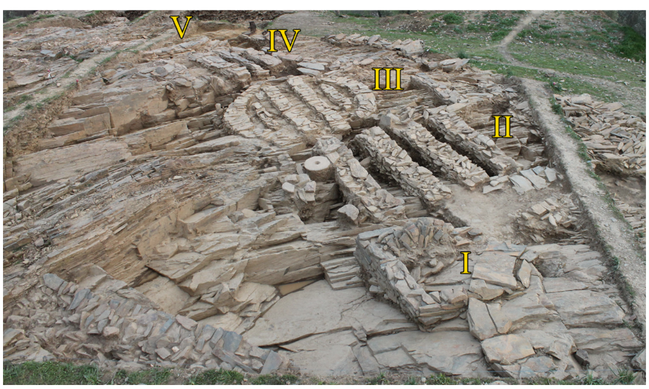

Fig. 6. *Horrea* in the southwest area. Photo Credit: Filipe Santos.

C) Refuse and D) Filling deposits

Scattered deposits (C) and filling deposits (D), both usually secondary or tertiary refuse (*apud* Schiffer, 1996, La Motta and Schiffer, 1999), are frequently heterogeneous contexts characterized by the accumulation of remains from distinct fire events and activities, thus providing relevant information regarding the long-term use and charring of plants (Hubbard and Clapham, 1992; Chabal et al., 1999; Figueiral, 1994; Asouti and Austin, 2005; Goldberg and Macphail, 2006; van der Veen and Jones, 2006; van der Veen, 2007; Tereso, 2007; Théry-Parisot et al., 2010; Fuller et al., 2014; Vaz et al., 2017a,b). Overall, scattered and filling deposits were sampled throughout all the site.

Plant remains have been recovered from structures such as floors (C1) and embankments (C3) as well as dispersed in several areas of the site (C2). Considering several platforms were built and reshaped throughout the occupation of the site, the number of samples from different floors and embankments must be stressed (Table 1 in supplementary material). The difficulties in their chronological interpretation has already been addressed (*vide supra*).

Filling deposits (D) were collected in diverse types of structures: postholes (D1), ditches (D2) and two small cavities in the walls (D3). Three depressions in the bedrock, of man-made or natural origin, have been sampled, but considering the difficulties in their interpretation, were not ascribed to any specific type of structure, being thus considered an undetermined fill deposit, i.e. a D) type context.

E) Other concentrated deposits

Concentrated deposits other than fire structures and storage facilities have been found throughout the site, although some are difficult to interpret. These include plant remains concentrated in circulation areas, niches, small areas between walls and layers with residues of metallurgical activities (Table 1 in supplementary material).

3.2. Methods

3.2.1. Carpological analysis

The sorting of the light fractions and identification of carpological remains were performed using a stereoscopic microscope. Generally, samples were fully sorted. Only in few cases were the light fractions subsampled due to their large volume (see Table 2 in supplementary material). Due to technical limitations at the time, a variation of the spoon method was applied: the light fractions were kept in bags that were gently mixed to diminish vertical distribution of remains according to size; several portions were taken with a spoon and put in containers; each container had several portions from different vertical levels of the bag. The containers that were studied were chosen randomly.

Taxonomic diagnose was carried out by comparison with modern material of the reference collections of University of Porto Herbarium (PO) and CIBIO and the help of morphological atlases and specialized bibliography (e.g. Beijerinck, 1976; Hillman et al., 1996; Buxó, 1997; Jacomet, 2006; Nesbitt, 2006; Neef et al., 2012; Zohary et al., 2012).

Whole or fragmented remains with scutellum or hilum were considered units. Longitudinal fragments of cereals were often found and in Table 3 each two longitudinal fragments were counted as a unit. Original data is discriminated in supplemental material table 3. Separated embryos and scutella were also counted. Regarding chaff fragments,

Table 3
Carpology: results per storage facility (units only, for data including fragments see supplemental material table 3).

Type of context	B1 – *Horreum*							B2 - Semicircular structure				B3
Context	H1	H1/2	H2	H3	H4	H6	H7	SS 256	SS 256/258	S258	S380	*Dolium* 352
Cereal (grains)												
Hordeum vulgare	11	13	14	34	63	46	19	9		32	47	2
Panicum miliaceum				1	13	4	25		1	5	1066	1
Panicoideae					2						46	
Triticum aestivum/durum	17	5	843	181	340	267	784	9	1	34	2279	93
Triticum sp.			1		1		4				5	
Triticeae	1		31	9	55	35	81		1	9	252	8
Cereal (chaff)												
Triticum aestivum/durum (rachis node)					1						1	
Other Poaceae (grains)												
Avena sp.										1		
Lolium sp.	1	1	17	5	15	22	51		2	6	315	19
Poaceae				4	24	12	9	1	3	5	50	8
Other Poaceae (chaff)												
Lolium sp. (spikelet with grain)			1								1	
Fabaceae												
Vicia/Lathyrus (seed)							1	1			2	
Fabaceae - *Medicago* type (seed)											1	
Fruits												
Vitis sp. (seed)	1					41	3	3	1	4	3	
Other remains												
Asteraceae (achene)											4	
Asteraceae - *Chrysanthemum* type (achene)											1	
Asterolinon linum-stellatum (seed)											1	
Cyperaceae (achene)					1							
Galium aparine (mericarp)							1				3	
Malva sp. (seed)							1				8	
Raphanus raphanistrum (loment segment)											1	
Rumex sp. (achene)						1					1	
Rumex conglomeratus/crispus (achene)											5	
Sherardia arvensis(mericarp)											2	
Undetermined (seed/fruit)			1				2				4	

Fig. 7. Main crops at Castelinho: *Triticum aestivum/durum* (1), *Hordeum vulgare* (2), *Panicum miliaceum* (3). Scale (1 mm).

rachis nodes, spikelet bases and glume bases were considered in this approach. When grains were found within the spikelet, they were discriminated. Full results can be observed in supplementary material (Table 3). The latter includes a calculation of the concentration of seeds and fruits per litre. This included only units and for this purpose each pair of longitudinal fragments of cereal grains were considered a unit.

3.2.2. *Charcoal analysis*

The charcoal fragments retrieved in the 2 mm sieve were sectioned manually to obtain the three diagnostic sections (cross, tangential and radial) and examined under a stereomicroscope and reflected light microscope following the standard methodology (e.g. Schweingruber, 1990; Marston et al, 2014). Taxa identification was based on several wood anatomy atlases (Schweingruber, 1990; Hather, 2000) but in the case of the genus *Erica*, the criteria described by Queiroz and van der Burgh (1989), adapted by Tereso (2007), were followed. Whenever charcoal preservation did not allow the retrieval of enough anatomical information, the identification remained as Dicotyledon, Gymnosperm or as Undetermined in the worst preservation cases. A minimum number of 100 charcoal per stratigraphic unit was analysed. Every time a new taxon was identified in the last 50 charcoal analysed in a sample, additional 50 fragments were identified. This process could be repeated multiple times per sample.

4. Results

4.1. *Carpology*

Grains of domestic cereals are by far the most abundant carpological remains found in Castelinho (Tab. 3 and supplementary material-Table 3). Results are consistent throughout all the types of contexts that were studied and showed a predominance of naked wheat (*Triticum aestivum/durum*). Other cereal crops, namely hulled barley (*Hordeum vulgare*) and broomcorn millet (*Panicum miliaceum*) were also found but are much less abundant (Fig. 7). Highly fragmented grains were identified at the tribe level – Triticeae or Panicoideae.

Chaff is almost absent in the entire site. Only few rachis nodes of naked wheat, a single glume base of *Triticum dicoccum/spelta* and one lemma base (with grain attached) from hulled barley were identified, not allowing much considerations. It is relevant, though, the presence of hulled wheat, of which no grains were recovered. It is possible that some Triticeae or *Triticum* sp. include grains of hulled wheat.

A single grain of *Avena* sp. appeared, as well as few awns. However, without floret bases it is impossible to know whether these remains belong to domestic or wild plants (Ruas and Pradat, 2001; Ruas, 2005; Jacomet, 2006).

Faba bean (*Vicia faba*) is the only cultivate d legume identified and only three fragments were found in semicircular storage structure 380.

Close to the *horrea* and semicircular storage structures, some grape pips (*Vitis vinifera*) were also found. They are too few to allow biometric or morphometric analyses (e.g. Bouby et al., 2013) to discriminate between wild and cultivated varieties.

Weeds were not very abundant. Wild grasses are dominant, mostly *Lolium* sp., the most frequent weed in Castelinho, recovered in 40,7% of the s.u. sampled. They are particularly rare in A1, A2, D1 and D2 contexts, the only exception is Oven 750 where 41 caryopses of *Lolium* sp. were found together with abundant grains of wheat (see above).

Due to preservation issues or simple overlapping morphologies, identification of several remains was not precise enough to allow a proper interpretation of the wild taxa (e.g. Apiaceae, Asteraceae, Cyperaceae, Polygonaceae, *Trifolium* type, *Medicago* type). These are likely to include mostly weeds and ruderal taxa. Among the possible weeds, we stress *Galium aparine*, *Polygonum aviculare*; *Raphanus raphanistrum*; *Sherardia arvensis*; *Silene gallica*, although these taxa can also be found today in other ecologies (Castroviejo, – 1986-2010; Aguiar, 2000). They are generally rare and do not allow detailed considerations but some are likely weeds from winter crops.

Surprisingly, the context with more seeds/fruits from wild taxa is s.u. 79 from Ditch 2, the layer that provided abundant engraved schist slabs (Santos, 2015; Santos and Ladra, 2016). Here, more than 300 carpological remains from wild taxa have been found, including more than two hundred achenes of Apiaceae and also *Sherardia arvensis*, *Raphanus raphanistrum*, *Ornithopus* sp. (seeds and lomenta), *Malva* sp., capsule fragments of *Malva nicaeensis*, among others. Cereal grains are restricted to three fragments of Triticeae but some chaff (awns of *Avena* sp. and wheat rachis) has also been found, suggesting this assemblage could be a residue from post-harvest processing. The relation with the rock art, if any exists, is unknown.

The predominance of naked wheat is clear also at the ubiquity level. It is present in 68,6% of the studied s.u., while barley was found in 50,9% and broomcorn millet in 30,1%.

Comparison between different contexts must take into consideration eventual biases related to sampling strategy. Number of remains per litre is usually low in all type of contexts (supplemental material Table 3) and contexts where more volume of sediment was collected were frequently those where more carpological remains were recovered. Still, there are several exceptions, suggesting a more complex scenario.

Sediments associated with storage facilities, mostly *horrea* (B1) and semicircular structures (B2), are usually those with more abundant grains, but some of these provided very few remains (Table 3). In the case of the *horrea*, sediments from between the supporting walls were those that provided more cereals. Again, there was a dominance of naked wheat over a residual presence of barley and broomcorn millet. In the semicircular structures, naked wheat is also predominant but in one of these structures – semicircular structure 380 - millet grains are much more frequent than in the rest of the storage facilities. In *dolium* 352 remains are less abundant and are almost all naked wheat grains. However, the concentration of fruits and seeds (units per litre) in the storage facilities is very low (see supplemental material Table 3) and their abundancy is partially related to a greater sampling effort in those contexts. Still, the scenario can be quite complex. When we compare s.u. of the different *horrea* and within single *horreum*, there is no clear relation between volume of sediment and number of fruits/seeds, i.e., contexts that were more intensively sampled, eventually fully collected and processed, are not necessarily the ones that provided more remains. The amount of sediment recovered is also related to the preservation of each structure. When we compare B2 structures the pattern is the same: overall, there are more carpological remains from contexts where more samples were analyzed but there isn't a proportional relation between litres and remains.

Carpological remains are usually rare in contexts other than the storage structures, but some exception must be pointed out. That is the case of oven 750. Although fire structures usually do not contain much fruits and seeds, almost 500 grains of cereals, mostly free-threshing wheat, have been recovered in oven 750. The presence of *Lolium* sp. caryopsis is also noteworthy. Again, number of remains per litre is low but still higher in this oven than in all other ovens and hearths.

The scarcity of carpological remains outside the granaries seems to be only partially related to the sampling strategy. In fact, regarding C type contexts, the s.u. with more volume analyzed in each category – [303] from C1, [237] from C2, [495] from C3 - provided results similar to other contexts from the same type, where much less sediment was studied. The same for the context of type E where more samples were recovered - s.u. 521. On the other hand, some contexts with greater number of remains per litre that are not storage facilities correspond to small samples (below 10 L, sometimes even below 5 L or 1 L), suggesting occasional sampling directed to visible and highly concentrated assemblages of plant remains.

Concentrations of charred grains that are not directly associated with granaries include type C, D and E contexts. Two of these deposits may represent dismantled storage structures or tertiary refuse (*sensu* La Motta and Schiffer, 1999) with abundant grains. Being of difficult interpretation, they were considered undetermined contexts with great concentration of plant remains (Type E). A small deposit located over one of the walls, deposited between construction phases, showed a concentration of around 1200 grains, mostly naked wheat. It was associated with a great amount of ceramics and baked construction clay. Whether this corresponds to tertiary refuse, related to the construction of the walls or to a highly destroyed structure located in a peculiar place is unknown. The same can be said about s.u. 31, found in a circulation area, associated with baked construction clay with marks of branches and c. 1500 grains, mostly wheat.

One of the filling deposits (type D contexts) – s.u. 611 - provided the larger set of carpological remains in the whole site, if we do not sum the contents of different s.u. of semicircular storage structure 380. Deposit 611 filled a natural or man-made depression in the bedrock where over 3000 grains were identified. Naked wheat is again predominant but this is the context with larger amount of barley in the site (139 grains).

These are peculiar contexts since carpological remains in the great majority of A, C, D and E type of contexts are very rare, as can be seen in the following numbers: a single oven out of the 14 fire structures (A type contexts) provided 83% (488 out of 591) of the grains, while the other structures showed an average of 8 cereals each; 6 of the 110C type contexts comprise 67% (2131 out of 3200) of the cereals, while the other s.u. have an average of 10 grains each; 2 of the 42 D type contexts provided 99% (5751 out of 5832) of the cereals, while the remaining 40 s.u. show an average of 2 grains each; 2 of the 12 E type contexts had 97% (2558 out of 2649) of all cereals and the remaining s.u. had an average of 9 grains each.

As seen above, it is possible that these numbers are partially related to the sampling strategy. Field team concentrated most sampling effort in structures they suspected more remains could be retrieved (e.g. storage facilities, hearths) and other contexts where plant remains were clearly visible. The latter include multiple type of grain-rich contexts, that, as mentioned above, are sometimes difficult to interpret, with concentrations of grains per litre higher than those of the storage facilities. But these derive from small samples intending to collect visible concentrations of plant remains, since, overall, dispersed contexts show very low concentrations of carpological remains.

4.2. Charcoal analysis

A substantial number of charcoal, 28,434 in total, was found and analysed in the 208 stratigraphic units sampled in the site of Castelinho (Table 4 in supplementary material). The data will be presented according to the type of structure due to the large number of contexts analysed.

Among hearths and ovens, the most recurring taxa identified were Cistus sp. (24,2%), *Pinus pinaster* (19,7%) and *Quercus* sp. evergreen

Table 4
Charcoal and taxa ubiquity per context typology (Ubi = ubiquity).

	A (12 contexts)			B (10 contexts)			C (101 contexts)			D (37 contexts)			E (12 contexts)		
	N	%	Ubi	N	%	Ubi	N	%	Ubi	N	%	Ubi	N	%	Ubi
Acer sp.	2	0.14	1	54	0.37	2	96	0.98	4	2	0.10	1	2	0.23	1
Alnus sp.	8	0.55	5	105	0.73	7	65	0.67	15	5	0.26	4	3	0.35	2
Alnus/Corylus				7	0.05	2	5	0.05	1						
Arbutus unedo	82	5.65	6	275	1.91	9	321	3.29	34	65	3.35	9	10	1.17	3
Cistus sp.	352	24.24	8	1112	7.71	9	650	6.65	61	158	8.14	16	84	9.82	10
Corylus avellana				1	0.01	1	1	0.01	1						
Erica arborea/australis	25	1.72	2	632	4.38	8	304	3.11	25	51	2.63	5	22	2.57	4
Erica scoparia/umbellata	9	0.62	1	40	0.28	4	124	1.27	11	10	0.51	2	3	0.35	2
Erica sp.	67	4.61	5	353	2.45	8	217	2.22	36	41	2.11	10	19	2.22	6
Fabaceae	105	7.23	9	379	2.63	8	261	2.67	44	14	0.72	6	17	1.99	5
Fagaceae				1	0.01	1	1	0.01	1	80	4.12	1			
Ficus carica							8	0.08	1	3	0.15	1			
Fraxinus sp.	15	1.03	6	559	3.88	9	236	2.42	42	98	5.05	11	23	2.69	5
Hedera sp.	1	0.07	2	1	0.01	1									
Juglans regia							12	0.12	1						
Juniperus sp.	8	0.55	5	84	0.58	7	185	1.89	23	154	7.93	8	10	1.17	4
Laurus nobilis				5	0.03	1	33	0.34	5						
Olea europaea	3	0.21	1	47	0.33	5	28	0.29	9	8	0.41	3	4	0.47	1
Pinus pinaster	286	19.70	9	2946	20.44	9	2103	21.53	77	457	23.53	16	266	31.11	9
Pinus pinea/pinaster	31	2.13	2	661	4.59	8	262	2.68	32	16	0.82	8	6	0.70	2
Pinus sp.	5	0.34	4	709	4.92	7	139	1.42	15	9	0.46	3	16	1.87	3
Pistacia lentiscus				26	0.18	2				2	0.10				
Pistacia terebinthus				26	0.18	1									
Pistacia sp.				6	0.04	2	2	0.02	2	1	0.05	1			
Populus sp.				1	0.01	1	36	0.37	3						
Prunus avium/cerasus				2	0.01	1	1	0.01	1						
Prunus sp.				36	0.25	3	136	1.39	13	1	0.05	1			
Quercus suber				73	0.51	6	221	2.26	33	30	1.54	1	6	0.70	2
Quercus sp. - deciduous				213	1.48	8	57	0.58	15	7	0.36	4	2	0.23	2
Quercus sp. - evergreen	304	20.94	10	3372	23.39	9	1305	13.36	77	304	15.65	19	241	28.19	9
Quercus sp.	4	0.28	3	323	2.24	9	324	3.32	41	15	0.77	5	3	0.35	2
Rhamnus/Phillyrea	2	0.14	2	2	0.01	2	2	0.02	1						
Rosaceae Maloideae	1	0.07	1	94	0.65	4	13	0.13	5	2	0.10	1			
Salix sp.	6	0.41	1	20	0.14	2	186	1.90	14	4	0.21	2	2	0.23	1
Salix /Populus				5	0.03	2	4	0.04	3				1	0.12	1
Ulmus sp.						2	20	0.20	3						
Vitis vinifera				3	0.02	1									
Dycotiledon	124	8.54	12	2036	14.12	10	2315	23.70	82	385	19.82	23	115	13.45	5
Angiosperm	2	0.14	1	3	0.02	2	1	0.01	1			1			
Gymnosperm				111	0.77	7	56	0.57	14	18	0.93	5			
Undetermined	10	0.69	3	93	0.65	4	39	0.40	12	2	0.10	2			
Total	1452	100%		14,416	100%		9769	100%		1942	100%		855	100%	

(20,9%), comprising almost 2/3 of the 1452 charcoal analysed and being also the most ubiquitous (Table 4). These were followed by Dicotyledon (8,5%), Fabaceae (7,2%), *Arbutus unedo* (5,6%) and *Erica* sp. (4,6%). Remaining taxa were always scarce (greater than1%), consistent with their lower recurrence per structure. The presence of capsule fragments of *Cistus ladanifer* suggests *Cistus* sp. charcoal are mostly from this species.

In the storage structures (category B), 14,416 charcoal fragments, were analysed, comprehending 26 taxa (Table 4 in supplementary material). The charcoal contents among the samples recovered in the *horrea* (B1) was mostly dominated by *Pinus pinaster* and *Quercus* sp. evergreen, which depending on the structure, varied from 16,1% to 40,2% in the first taxon, and 22,4% to 43,6% in the latter (Table 4 – supplemental material). Despite this trend, significant differences between each *horreum* could be perceived. Such was the case of the high taxa diversity existing in *horreum* VII and, on the contrary, the low taxa diversity in *horreum* I. These differences are surely related to discrepancies in the number and volume of the samples recovered in each context, and thus should not be over-emphasized. The presence of two taxa of *Pistacia* in the *horreum* VII deserves special mention.

B2 (semicircular) structures also provided relevant charcoal data, but the vast majority was concentrated in three s.u. of structure 380. The charcoal contents of these structures closely resemble the *horrea*: they comprised mostly *Quercus* sp. evergreen (25%), *Pinus pinaster* (16,9%) and *Cistus* sp. (10,4%), also with high percentages of Dicotyledon (15,4%) (Table 4 – supplemental material). Charcoal data from the contents of the only *dolium* (B3) analysed was insufficient, with only 49 fragments analysed.

Ubiquity data shows a wide group of taxa found in 8 or more of the 10 storage facilities, including: *Arbutus unedo*, *Cistus* sp., *Erica arborea/australis* and *Erica* sp., *Fraxinus* sp., Fabaceae, *Pinus pinaster*, *Quercus* spp. and Dicotyledons.

Given their similar archaeobotanical significance, the results from disperse and secondary contexts such as the sediment sampled in floors (C1), abandonment layers (C2) and earth embankments (C3) will be displayed as a whole (Table 4). In the site of Castelinho, 101 s.u. belonging to these contexts categories were sampled and 9769 fragments were analysed. *Pinus pinaster* (21,5%), *Quercus* sp. evergreen (13,4%) and Dicotyledon (23,7%) were, once again, the most frequent taxa. With the exception of *Cistus* sp. (6,7%), each of the remaining 32 taxa did not surpass 3.3% of the total.

P. pinaster and *Quercus* sp. evergreen are the most ubiquitous and were identified in 77 of the 101 s.u. Several taxa displayed significant ubiquity values despite their low absolute number. Such were the cases of *Arbutus unedo* (comprising only 3,3% of the charcoal recovered but present in 34 out of 101 s.u.), *Cistus* sp. (6.7% – 61/101), *Erica* sp. (2,2% – 36/101), Fabaceae (2,7% – 44/101), *Quercus suber* (2,3% – 33/101).

Filling deposits such as those present in postholes (D1) and ditches (D2) also displayed similar results: *Pinus pinaster* (23,5%), *Quercus* sp. evergreen (15,6%), *Cistus* sp. (8,1%) and Dicotyledon (19,8%) comprised almost ⅔ of all the charcoal content analysed from these contexts. A similar trend is recorded in at the ubiquity level since these taxa were also, by far, the most frequent in all the 36 s.u. sampled.

It is clear, thus, that despite being recovered in a wide variety of archaeological contexts, charcoal assemblages from different contexts displayed a high degree of similarity (Table 4 in supplementary material). Almost all contexts were dominated by a set of three taxa (*Pinus pinaster, Quercus* sp. evergreen and *Cistus* sp.) followed by a wide diversity of taxa, each rarely exceeding 5% of the total.

5. Discussion

5.1. Crops, charcoal and storage structures: how are they related

Carpological remains and wood charcoal have been recovered throughout the site, in contexts of varied typology and chronology. However, the deposits associated to the storage facilities provided different plant assemblages, characterized by a noteworthy amount of cereal grains and charcoal of *Quercus* sp. evergreen and *Pinus pinaster*.

Looking at Table 3 and supplemental Table 3, it is clear that grains of cereals are abundant in the storage facilities but also in contexts difficult to interpret such as the depression in the bedrock [611] and the concentration of charred plant remains over the wall [825], among few others. Although grains of cereals have been recovered in type C, D and E contexts, it is clear that most of these provided few remains, even considering eventual sampling bias (see Results section).

Assuming that the charring of cereals occurred accidentally, their concentration in some contexts, the abundant deposits with charred grains distributed throughout the site and the sités stratigraphy suggests that the loss of grains occurred periodically, sometimes in great amounts, either during the processing or after storage or as result of major fires. The rich grain assemblage found in Oven 750 is suggestive of this kind of events.

The abundancy of plant remains in some storage structures and in secondary refuse deposits suggests that massive fires might have occurred. The resulting charred plant remains could have been remobilized to assure that the structures were rebuilt, possibly originating some of the grain-rich secondary refuse deposits (type C and D) found in Castelinho. In more intense rearrangements of the site, connected to the opening/closing of entrances and the creation of new embankments to be used as circulation areas and platforms for other structures, the sediments with the charred plant remains were likely relocated and incorporated in the new earthworks as tertiary refuse (*apud* La Motta and Schiffer, 1999). This could justify the grains found in many s.u. of the embankments (Table 3 in supplementary material), reinforcing the idea that much caution is necessary while considering the incorporation of these assemblages in the sités phases.

In such scenario we would expect to find the archaeobotanical assemblages from the highly mobilized sediments to be quite similar to the ones from less remobilized accumulations of charred remains due to their similar origin. However, ovens, hearths and evidences of metallurgy demonstrate that activities involving fire took place in the site, originating charred plant remains. Their eventual incorporation in the same secondary and tertiary refuse deposits mentioned above could make their archaeobotanical assemblages more heterogeneous.

We must question whether the natural deposition of sediment during the site's occupation or the day to day occasional charring of grains as a result of processing activities explain the amount of plant remains, mostly cereal grains, in some of the storage structures. It is possible, that the presence of charred cereal grains in the sediments from the storage structures, such as the deposits accumulated between the supporting walls of the *horrea*, may actually be related to the destruction of the constructions to which they are associated. Alternatively, they can derive from the secondary or tertiary accumulation of material from previous destruction events from that or other nearby structures, while the structure was rebuilt and reused. However, the sediment between the supporting walls of the *horrea* would jeopardize their proper functioning. Either way, despite some mixture that may have occurred throughout time, it is likely that plant remains from these contexts are not as reworked as those from the embankments and fillings of feature interfaces. The charcoal assemblage further supports this idea.

As mentioned above, charcoal assemblages from the different type of contexts in the site show great similarities, but some differences must be pointed out. The relative and absolute values of *Pinus pinaster* and *Quercus* spp. charcoal found in the *horrea* are higher than those of the hearths and ovens. In some of these storage facilities they comprise 2/3 of all charcoal identified. As such, if these sediments contain plant remains that were in fact connected to eventual fires affecting the *horrea*, the concentration of *Quercus* spp. (mostly *Quercus* sp. evergreen) and *Pinus pinaster* recorded there suggests wood from these taxa was the main construction material of these storage facilities, besides schist. This is most likely to have occurred in *Horreum* VII, given the large charcoal assemblage found among its abandonment layers, comprising 77% of all the carbonized wood remains found in all the *horrea*. These structures' walls would have been made of wood and clay, supporting a light roof structure, which could also be constructed with branches, culms, foliage and other perishable elements. Nevertheless, no *in situ* carbonized wood poles were found in the postholes associated with the *horrea*.

As happens with the carpological assemblages and as expected in this interpretive model, charcoal content of the *horrea* show similarities with those of the refuse and filling deposits although the latter are slightly more diverse. The diversity of taxa in the charcoal assemblages connected to the *horrea* could be indicating that, besides the presence of wood from the structures, these may have incorporated a mixture of plant remains from other contexts and activities carried out in their surroundings. Considering the great percentages of *Quercus* spp. and *Pinus pinaster* wood in the *horrea*, the incorporation of peripheral material probably was not significant.

There are some differences between these assemblages and those from hearths and ovens (type A contexts). As mentioned above, in the latter there is less diversity of taxa, which is common in primary refuse deposits resulting from short-term events (Figueiral, 1994; Chabal et al., 1999; Fuller et al., 2014) and Cistus sp. (likely *Cistus ladanifer*) is the predominant taxon. This particular pattern of fuelwood used in combustion structures such as these, consisting of branches and twigs of scrubland species (*Cistus* sp.) to ignite the fire, combined with wood from potentially arboreal species (*Pinus pinaster* and *Quercus* sp.) to maintain the combustion, has been repeatedly reported both archaeobotanically (e.g. Vaz and Tereso, 2012; Vaz et al., 2017b) and ethnographically (e.g. Carvalho, 2005).

As seen, both the carpological and charcoal assemblages suggest the sediments found in association with the storage structures are likely connected to fire events that led to their destruction, allowing their interpretation as stored goods and construction material, respectively, although some admixture with outside material might have happened.

5.2. What and how were the crops stored

Considering what was mentioned above, it is possible that the carpological remains found in association with the storage facilities were in fact stored in those or in nearby structures and, as such, may be related to few uses of these facilities. However, assemblages from the storage facilities and the abundant and diverse contexts in the site are quite homogeneous suggesting some conservatism in terms of crops throughout the whole Late Iron Age at Castelinho. As such, the main crop stored inside the fortification was naked wheat but other cereals were recurrently kept in those structures, namely broomcorn millet and hulled barley. Other edible fruits and seeds are rare but we must stress the presence of grapevine.

Cereals seem to have been stored fully processed, considering the extreme rarity of chaff remains. While the post-harvest processing of naked wheat (Hillman, 1981) and millet (Moreno-Larrazabal et al., 2015) is able to swiftly and with little effort produce clean grain, the same cannot be said regarding hulled barley. Further dehusking activities need to be carried out after threshing to free the grain from the hull, which can be done using different techniques (Hillman, 1981; Alonso et al., 2014; Alonso, 2019). Although spikelets are fragile and much less resistant to fire than grains, the presence of a single hulled grain of barley and an absence of lemma and palea fragments in the entire site, in over 1000 samples, can hardly be justified by differential preservation towards fire. Cereal grains seem to have been taken inside the fortification already processed, ready for consumption. Remains of weeds, mostly Poaceae, although not uncommon are far from abundant and most of these are particularly big caryopses of *Lolium* sp. that due to their size and weight could have survived several processing stages and end up stored.

The presence of several ovens in the site led Santos (2015) to suggest these structures could have been related to some processing stages prior to storage. The abovementioned Oven 750, where nearly 500 cereal grains and 41 *Lolium* sp. were found, could support this hypothesis. Carpological remains in the other ovens are very scarce but not only these could have been cleaned but also we would expect accidents leading to major loss of grain to be rare. Considering most of the assemblage is composed of free-threshing wheat, the structure was not likely used for freeing the grains by parching and, again, chaff is almost absent in the site. The oven could have been used to roast the grain prior to storage, however, while several ovens are located near the storage structures, oven 750, with its rich carpological assemblage, is located in the quadrangular hall of the main entrance of the site, away from the storage areas (Figs. 3 and 4). Ovens could be used simply to cook the grains and eventually other food for consumption by the people kept in the fortification guarding and maintaining the crops and the structures. The eventual relation of these structures to some kind of feasting is also a possibility, although again, no other archaeological data supports it.

The hearths and ovens identified in Castelinho bear strong resemblances to those found in the site of Quinta de Crestelos, just 7 km upstream in the Sabor River. Here, a concentration of ovens has been found inside a ditch, dating somewhere between the 4th and the 3rd century BCE, thus being older than those of Castelinho (Vaz et al., 2017b). Carpological remains here seem to be mostly refuse from domestic activities used as fuel. Similar hearths and ovens have been found in domestic Late Iron Age contexts throughout the lower platform of the settlement but carpological remains are almost absent (unpublished material by the authors). On the other hand, in a small compartment attached to a 2nd-1st century *horreum* in the upper platform of the same site, an oven and a hearth have been registered (Tereso et al., 2018) suggesting these kind of structures may have been in fact used to process cereals stored in these structures. One must notice that this upper platform by the end of the Iron Age and transition to the Roman period seems to have used mostly or almost exclusively for storage using *horrea*, since no clear domestic structures have been found. Few cereals, mostly free-threshing wheat, have been found in this compartment of Quinta de Crestelos, but their relation with the hearth and oven is unclear and such kind of remains are found in many deposits throughout the platform (Tereso et al., 2018).

5.3. Castelinho in a regional perspective

A variety of storage facilities has been identified in Iron Age sites in Northwest Iberia and these comprise underground and aboveground structures, with or without controlled atmosphere. Still, only in few sites were crops directly associated with particular storage facilities. That happened in the pits of Crastoeiro (Seabra et al., 2018), the wattle and daub structures of As Laias (Tereso et al., 2013) and Castrovite (Rey Castiñeira et al., 2011), the wattle and daub and stone structures of Crasto de Palheiros (Figueiral et al., 2017; Leite et al., 2018). With the exception of Crastovite, where broomcorn millet was the dominant crop, in most of these, hulled wheat was the major crop and was stored in spikelets. It was mostly found together with naked wheat, broomcorn millet and hulled barley, usually stored as clean grain.

Elevated granaries were found at Castelinho and Quinta de Crestelos (Pereira et al., 2015; Dinis et al., 2018; Tereso et al., 2018). These are the oldest granaries of this kind in the region and were built in the 2nd century BCE, although such kind of structures have been found in other areas of Iberia at least since the 5th century BCE (Salido Domínguez, 2017). During Roman times these type of facilities became more common. They are found in several military sites and also settlements even in the western Meseta such as testified in the sites of La Corona/El Pesadero (Manganeses de la Polvorosa), dating between the 1st and the 2nd century CE (Misiego Tejeda et al., 2013) as well as Vale do Mouro (Coriscada), where elevated granaries were dated to the 1st-2nd century CE and the 3rd-4th century, and in sites such as Quintal da Casa Grande and Casa do Nelo (Freixo de Numão), in Côa valley, dating to Roman times (Coixão, 2017).

At Castelinho and Quinta de Crestelos the main stored cereal was naked wheat, followed by broomcorn millet, both stored as clean grain. Hulled wheat is absent from the granaries of Quinta de Crestelos while at Castelinho, in 1353 samples, only two small fragments of chaff from hulled wheat were recovered. It is uncertain, however, whether this means that elevated granaries were mostly directed to store naked wheat, contrary to the other type of facilities. The two sites are located in the same valley, separated by mere 7 km, and the preference for free-threshing wheat can be related to very local environmental or cultural reasons not allowing an extrapolation to a regional level. Hulled wheats are absent from other Late Iron Age sites in the same valley such as Chã (Vaz et al., 2016) and Terraço das Laranjeiras (unpublished) but carpological remains are scarce in both making a joint interpretation for the whole valley a difficult task. Differences between hulled and naked wheat have been highlighted by several authors (e.g. Hillman, 1981; 1984; Peña-Chocarro, 1999; Peña-Chocarro and Zapata, 2003) and will not be addressed in detail here. Besides different environmental requirements (e.g. in terms of soils and humidity), there are profound differences concerning post-harvesting processing. These factors, among others, could have been taken into consideration by Iron Age communities in their agricultural strategies, but cultural factors may had been involved too. However, in the current stage of our knowledge regarding the Iron Age communities in the Sabor valley it is difficult to fully understand this issue.

Despite their proximity, Castelinho and Quinta de Crestelos had different characteristics and evolved differently. Both occupy dominant topographical positions, each in one of few open areas in the usually narrow and steep Sabor valley. The granaries are similar in both sites, being built in schist and comprising rectangular and circular plans (see above). However, at Quinta de Crestelos, the granaries were concentrated inside the settlement and by the time they were being used, its fortification apparatus was already largely abandoned. In fact, the Late Iron Age granaries were found in the summit of the site's prominent crest, while in its the lower and wide platform several Iron Age huts and Roman buildings were recorded (Pereira et al., 2015; Larrazabal, 2017; Vaz et al., 2017b; Tereso et al., 2018). The *horrea* were dated from the 2nd century BCE to the late 1st/early 2nd century CE, i.e. they were built in the Late Iron Age but some were still used up until the Roman times. By this time, another large *horreum* was being used next to a *cella vinaria* and other buildings and functional areas in the lower platform (Tereso et al., 2018). Big storage vessels from before and after the turn of the Era are abundant in the site. Some have traces of pitch in their inner surfaces, suggesting they were used as liquid containers, probably for wine or olive oil (Báez et al., 2016), but other uses cannot be excluded.

Castelinho, on the other hand, is itself a fortification with storage facilities and scarce structural traces of other activities. The granaries were used mostly in the Late Iron Age, in the 2nd and 1st centuries BC. Roman materials in Castelinho date from the early moments of Romanization suggesting the site was abandoned at that time. A domestic area, eventually related to the fortification, is located around 300 m away, next to the river (Fig. 2) and provided evidences of an apparently small-size but long-lasting occupation from the Late Iron Age to Medieval and Modern times (Rosselló Mesquida et al., 2016; Santos and Ladra, 2016).

Castelinho seems to confirm the idea, already proposed by several authors, that specialized and possibly controlled storage might have existed in the region (González-Ruibal, 2006; Parcero Oubiña and Ayán Vila, 2009; Tereso et al., 2013; Teira-Brión et al., 2016; Teira-Brión, 2019). Several contexts confirm that large-scale storage existed in Northwest Iberia during the Late Iron Age, but understanding its social context is a challenging task. Sites such as Castrovite and As Laias have been considered aggregation centres where elites centralized the storage and redistribution of goods (González-Ruibal, 2006; Parcero Oubiña and Ayán Vila, 2009; Teira-Brión et al., 2016; Teira-Brión, 2019). As such, they had more than an economic role, being places for the development and display of social status and relations of power. However, that is not the only interpretation possible. Based on the size and capacity of the facilities, Álvarez González et al., (2009) suggested that each structure of As Laias belonged to a family. Rey et al., (2011) and Mora-González et al., (2019) suggest the same for Castrovite. This hypothesis implies a communal management of the area but a household ownership of the contents of each structure and, possibly, a less hierarchical organization of these communities (Tereso et al., 2013). As mentioned in a previous study, both hypotheses are valid although they imply opposite theoretical perspectives regarding fundamental social aspects of the Iron Age communities of NW Iberia (Tereso et al., 2013).

The case of Castelinho helps to improve our perspective on this subject. A defensive apparatus such as the one recorded in Castelinho would have demanded immense labour, both for its construction and management and, as mentioned before, the site shows extensive evidences of architectural modifications. Such efforts were probably beyond the capacity of a small community like the one that might have inhabited the nearest residential areas. This suggests Castelinho was built to protect the crops of a population wider than the one that lived in its vicinities. It could have been an aggregation place for people from different settlements, in a spatial and population scale difficult to ascertain. The abundant rock art recovered in Castelinho also points to the special character of the site.

Salido Domínguez (2017) suggested that the storage areas of Quinta de Crestelos might have been used to fulfil the requirements of the Roman armies, which gives a different perspective to the concentration of storage facilities in the region, particularly if we extend this consideration to Castelinho. In fact, traditionally, elevated granaries were built throughout the empire in association with the presence of the Roman army (Salido Domínguez, 2017). This question arises because of the doubts regarding the way and the timing of the Romanization process in the region between the late 2nd century BCE and the turn of the Era, in which military actions had some relevance, together with commercial and political contacts (Currás et al., 2016). Still, while we cannot exclude storage facilities and the accumulation of crops were, at some time, used or favoured by the Romans, the chronologies of As Laias (Tereso et al., 2013) and Castrovite (Rey Castiñeira et al., 2011) suggest this already happened in an indigenous context.

The concealing of the engravings in the ditch at Castelinho reinforces this idea. *Circa* 150 engraved schist slabs have been recovered in the site, most of them in the intentional filling of a ditch. Although is difficult to position the art in one of the phases of the site, the engravings are likely from the Late Iron Age. The sealing of the ditch which included the deposition of the engraved slabs is considered to have occurred in the second half of the 1st century BCE, when the site entered a new phase with greater Roman influence (Santos et al., 2012; Santos and Ladra, 2016; Santos et al., 2016). At this time, several storage facilities were probably ruined. This is inferred by the fact that most radiocarbon dates point to such a chronology. These dates (Table 1) were obtained mostly on cereal grains recovered in association with the *horrea*, although not necessarily in a primary position. No radiocarbon date obtained over cereals points to a period later than the late 1st century BCE or the transition of the Era, which suggests that fire events involving grain, that were common in previous stages, ceased to occur. Although it is not possible to exclude changes in the way crops were processed and the structures were managed might have occurred leading to such absence, it seems more likely that the structures were in fact abandoned.

6. Conclusions

The joint interpretation of archaeological and archaeobotanical data at Castelinho proved crucial to the understanding of storage strategies in the site and its integration in the discussions regarding the social role of storage in the Late Iron Age of Northwest Iberia.

The carpological remains found in the site were abundant and some seem to have been associated with the storage facilities. They were mostly composed of cereal grains and no relevant differences among the contents of each studied *horrea* were found. There was a clear predominance of naked wheat in all structures, followed by broomcorn millet and a residual presence of hulled barley. All these cereals were being stored fully processed. These results tally those of Quinta de Crestelos and both contrast with other sites in the region with similar chronologies, where hulled wheat is recurrently found and frequently predominates. By now, it is difficult to understand the full meaning of this difference but results may reflect a local trend.

The charcoal identified throughout Castelinho was likely originated in the hearths and ovens identified in the site, but probably also from occasional fires that took place in the granaries - an hypothesis particularly probable in *Horreum* VII. These structures would have been partially constructed using perishable materials in their walls and roofs. All the samples recovered, displayed similar taxa diversity despite some differences in the predominant taxon of each context. Overall, *Pinus pinaster* and *Quercus* sp. evergreen were dominant in most contexts. Especially large assemblages of these taxa were found in the *horrea*, being most likely used as construction material in these storage structures.

It is difficult to understand the full scale of storage in Castelinho due to preservation issues, however a site such as this must be interpreted beyond the level of storage to assure a communitýs subsistence. The hypothesis that Castelinho was a relevant storage site where few other activities might have also taken place, in a context past the domestic sphere, is consistent with other information available for northwest Iberia (González-Ruibal, 2006; Parcero Oubiña and Ayán Vila, 2009; Tereso et al., 2013; Teira-Brión et al., 2016; Teira-Brión, 2019). However, a site as Castelinho enhances the scale of the efforts these communities were willing to make in this social endeavour to a level without parallels in the region.

CRediT authorship contribution statement

L. Seabra: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **F. Santos:** Conceptualization, Investigation, Resources, Writing - original draft, Writing - review & editing. **F.C. Vaz:** Conceptualization, Methodology, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **J. Leite:** Methodology, Formal analysis, Writing - review & editing. **J.P. Tereso:** Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Supervision.

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Appendix A. Supplementary data

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