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Roman and medieval crops in the Iberian Peninsula: A first overview of seeds and fruits from archaeological sites

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This work is dedicated to Lydia Zapata for her many inspiring works and stimulating discussions leading to the development of archaeobotany in the Iberian Peninsula.

ABSTRACT

This paper presents an overview of the current state of research on Roman, Late Antique and medieval agriculture in the Iberian Peninsula through the study of archaeobotanical samples (seeds and fruits) collected on a large number of rural and urban sites spread throughout Iberia's geography. It includes published and unpublished data. The plant taxa of economic interest are grouped into various categories: cereals, cereal chaff, legumes, domesticated fruits, oil/fibre plants, condiments and spices, and wild species. According to the data, naked wheats and hulled barley are the dominant cereal species throughout the Iberian Peninsula. There are, nonetheless, particularities like the prevalence of hulled wheats (mainly emmer and spelt) in the North-west. Cultivated fruits also show a great diversity, and new species such as *Morus nigra* or *Prunus armeniaca* appear for the first time in the archaeobotanical record. There are also novelties regarding herbs and spices.

1. Introduction

Although the record of plant subsistence during Prehistoric and Protohistoric times in the Iberian Peninsula is incomplete, an enormous effort over the past two decades has been carried out to improve understanding of plant use in the societies of these periods (Alonso et al., 2016; Antolín, 2016; Montes Moya 2014; Peña-Chocarro et al., 2009; Pérez Jordà, 2013; Tereso et al., 2016; Zapata and Ruiz, 2013). Archaeobotanical research focused on the Roman and medieval periods, by contrast, lags far behind due in part to research traditions as researchers of the earlier periods are usually more concerned with environmental archaeology, while researchers on the historical periods largely ignore this aspect. Consequently, most Roman and medieval sites do not include archaeobotanical studies, let alone application of strategies for sampling and recovering plant remains. This situation in the Iberian Peninsula contrasts with the promotion afforded to Roman and medieval archaeobotanical research elsewhere in Europe (e.g. Brombacher and Hecker, 2015; Karg, 2007; Kühn, 2007; Livarda, 2011; Märkle, 2005; McClatchie et al., 2015; Moffet, 2006; Rösch, 2008; Rottoli, 2014; Ruas, 2005; Ruas et al., 2015). Moreover, there are still many classical and medieval archaeologists in the Iberian Peninsula who consider that archaeobotanical research only provides supplementary information to that of texts, denying the discipline a role in stimulating historical narratives.

This is particularly surprising when taking into account the current vast and profound transformations in scientific-based knowledge applied to archaeology. New integrative approaches and developments provide archaeology with a wide range of

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powerful tools and techniques serving to reconstruct past societies (DNA, isotopic studies, residue analysis, etc.) that if properly combined with historical knowledge can lead to great advances in the knowledge of Roman and medieval societies.

The long time span covered by this study (ca. 1500 years) comprises a period of major economic, social and political transformations that concerned every aspect of peoples' lives (economy, demography, culture, religion, social organisation, etc.) taking place across the whole Iberian Peninsula. Furthermore, profound changes in the socio-cultural, economic and political contexts were far from homogeneous across Iberia leading to a complex scenario with clear regional differences. The Roman conquest from 218 BC to 19 BC saw different effects from region to region (Blázquez Martínez, 1963). As in other areas of the Empire, it implied the arrival of armies, new elites and a huge and unprecedented urban development. Equally significant was the arrival to the conquered territories of new plant species and new culinary traditions as documented in certain other areas of the Empire (Bakels and Jacomet, 2004; Van der Veen et al., 2007; Livarda, 2011).

From the 5th century AD, the Roman political structure was again altered by the arrival of Germanic groups that settled in the region leading to the ultimate formation of the Christian kingdoms. 711 AD saw yet another major change with the influx of North African Islamic population throughout Hispania conquering the lands ruled by the Visigoths. These new circumstances brought about changes and transformations at many levels (political, social, cultural, religious, commercial, technological, etc.). Substantial changes also took place in the agricultural world with the introduction of new crops accompanied by innovative techniques. Watson, in his seminal work published in 1974 (Watson 1974, 1983), proposed the term "green revolution" to describe the remarkable agricultural transformation that followed the introduction of 18 new species, including several staples (durum wheat, sorghum, rice and cotton), accompanied by new farming techniques, mainly irrigation. Watson's hypothesis, nonetheless, is the object of criticism (Dembińska and Woys Weaber, 1999) as some of the species reputedly introduced during the Islamic domination (hard wheat, rice, sorghum and artichoke) were already present in earlier periods.

The south of the peninsula remained under Islamic domination from the beginnings of the 8th to the end of the 15th century AD, while domination in the most northern regions was much shorter. The Iberian Peninsula therefore became an arena of encounters, exchanges and transfers of diverse cultures becoming a unique zone of cultural diversity (García Fitz, 2002).

This paper is thus the first overview of the archaeobotanical evidence available for the Iberian Peninsula during the Roman, the Late Antique and medieval periods. It aims at providing data on the range of plant species (cultivated and wild) used by ancient communities across a varied landscape and yield new insights into Roman and medieval agriculture. Apart from identifying the specific cultivated crops and wild food plants from each period and region, this study attempts to identify the introduction of new species as well as describe the evolution of the main taxa or group of taxa. Data are presented in regional sequences (Fig. 1) in order to explore the patterns of geographic species distribution. Likewise, cultural differences are also considered when comparing Christian and Islamic sites during the medieval period. Archaeobotanical research, in fact, appears as an ideal tool for exploring the introduction of new species and transformations taking place in agriculture after the arrival of Muslim populations.

The great geographic diversity of the Iberian Peninsula and the diverse historical evolution of its different territories, coupled with the dissimilar information available from site to site, prevents from delving deeper into other aspects shaping agriculture. Future studies and regional surveys will eventually break new ground in this field.

2. Materials and methods

A total of 83 published and unpublished sites (Table 1), some spanning more than one chronological phase, were taken into consideration for this survey (Table 2). The data comprises a total of 1353 samples: 594 from the Roman period (2nd century BC - 5th century AD); 275 from Late Antiquity (5th - 8th centuries AD); 484 from the Middle Ages (8th - 13th centuries AD) with 254 from Christian and 230 from the Islamic contexts. Overall, this study covers a period of *ca.* 1500 years. It should be borne in mind that the beginnings of the Roman period varies from region to region, and therefore the starting point of this analysis in some regions coincides with the Iron Age in others. Similarly, the boundaries between Roman and Late Antiquity are blurred according to region. Another important issue is the distinction between Christian and Islamic spheres within the medieval phase, a division that is not chronological but cultural. Although most of the Iberian Peninsula was under Islamic rule from the 8th century AD onwards, the subsequent expansion of the Christian kingdoms ending in the 15th century meant that a number of territories fell under Christian control at different times.

Although most of the plant remains considered in this study were preserved by charring, some waterlogged and mineralised remains are also included. In order to organise the data geographically, the Iberian Peninsula was divided into sectors (Fig. 1): the N–W (North-west) comprising the north of Portugal and Galicia, the N (North) corresponding to the Cantabrian fringe (excluding Galicia), the N-E (North-east) including Catalonia, the W (West) defined in this paper as the Central Portuguese region, the C (Central Iberian Plateau), the E (East) or Valencia and Murcia region, the S–W (South-west) corresponding to southern Portugal, and finally the S (central Andalusia). These areas coincide to a large extent with the bases of the different collaborators of this study therefore where most of the research was carried out.

The sites were divided into rural and urban categories (Table 1) so as explore their differences and similarities of the two settlement types. Moreover, in spite of not serving as a chronological partition, the medieval sites were grouped into Christian and Islamic due to the potential of differences between the practices of the two faiths. In order to map the features that characterise plant use for each period, the results are presented diachronically, period by period.

It is evident that the data are not homogeneous due to the different means of sample collection. Systematic sampling and flotation (to collect charred remains) was carried out at most sites. Yet the corpus also includes casual finds and modest, hand-picked samples. The flotation method for the most part applied a 250μ mesh. Moreover, conditions of preservation also vary from site to site and while most of the samples are preserved by charring, there are cases of mineralised or waterlogged material. The listing of the type of preservation in Table 3 reveals the generalised disparity from site to site.

As to dating, the sites are broken down as follows: 38 Roman, 17 Late Antique and 40 medieval (21 Christian and 19 Islamic). Sites with mineralised plant remains are less common as there is only a single case for each of the Roman, Late Antique and Christian periods, and 4 for the Islamic domination. Regarding waterlogged sites, there are 5 from the Roman period, 2 from Late Antiquity and 3 medieval (2 Christian and 1 Islamic).

The current study is limited to crops and plants of economic value. The 70 taxa identified are grouped according to their main use in the following categories: cereals, legumes, cultivated fruits,

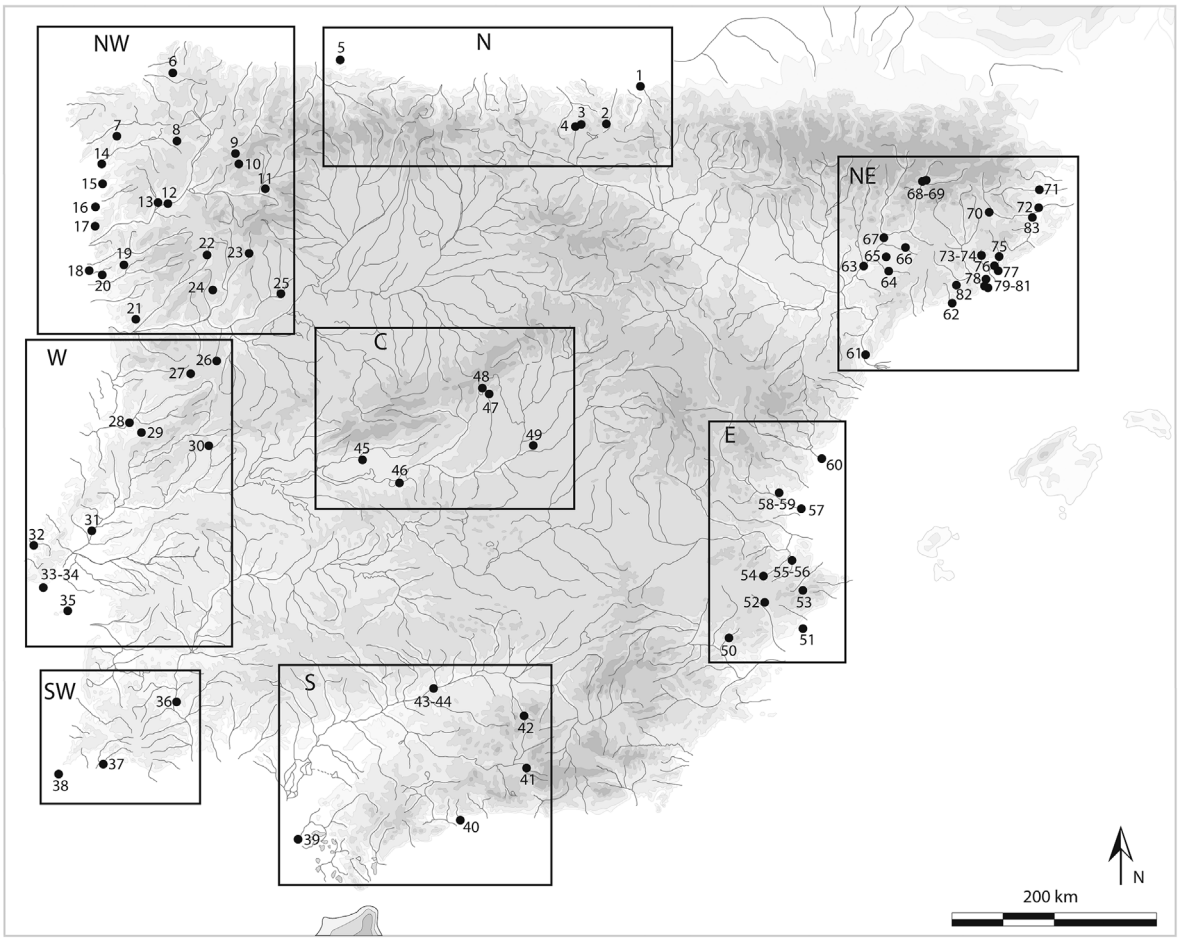

Fig. 1. Map of the Iberian Peninsula showing the distribution of sites considered for this study. 1. C/ Tadeo Murgia, 2. Zornoztegi, 3. Catedral Vitoria, 4. Zaballa, 5. Tabacalera, 6. Mourela, 7. Banco de España, 8. A Pataqueira, 9. Cova Eirós, 10. Cova do Xato, 11. Castro de Orellán, 12. Reza Vella, 13. San Cibrán de Las, 14. Rúa Ferreiría nº59, 15. Agro de Deus, 16. O Areal, 17. A Burgueira, 18. São Lourenço, 19. Briteiros, 20. Ermidas, 21. Monte Mozinho, 22. Aquae Flaviae, 23. Terronha de Pinhovelo, 24. Crasto de Palheiros, 25. Vale da Bouça, 26. S. Gens, 27. Penedo dos Mouros, 28. Terlamonte, 29. Quinta da Torrinha, 30. Poço de Idanha a Vella, 31. Convento de S. Francisco, 32. Paços do Concelho, 33. Casa dos Bicos, 34. Rua dos Correiros, 35. Travessa da Portuguesa, 36. Castelo de Mértola, 37. Castelo de Silves, 38. Martinhal, 39. Pocito Chico, 40. Fondeadero C/ Sebastián Souvirón, 41. Villa Romana de Gabia, 42. Marroquíes Bajos, 43, al-Rummaniyya, 44. Madinat al-Zahra, 45. El Saucedo, 46. Melque, 47. Gózquez, 48. C/ Nuncio 13, 49. Segóbriga, 50. Cipreses, 51. Tossal de les Basses, 52. Castillo de Villena, 53. Mas d'Is, 54. Faldetes, 55. Racó d'Ènova, 56. Alters, 57. Plaça de l'Almoina, 58. En Bic, 59. Horta Vella, 60. Torre la Sal, 61. Tortosa, 62. Solicrup, 63. Lleida, 64. La Fogonussa, 65. Tossal del Moro, 66. Iesso, 67. Pla d'Almatà, 68. Roc d'Enclar, 69. Camp Vermell, 70. L'Esquerda, 71. Vilauba, 72. Camp de Can Massot, 73. Can Bonvilar, 74. Torre Bonica, 75. Pla del Serrador, 76. Can Gambús, 77. Ca n'Oliver, 78. Els Mallols, 79. Ajuntament/Església Cornellà, 80. Foneria, 81. Teuleria dels Albers, 82. Can Cabassa, 83. Can Gelats.

fibre and oil plants, spices and gathered fruits. Calculations and comments of the variations in data are based on the frequency of appearance of each taxon. In fact, the number of remains was not taken into account in the calculations as quantification is based on ubiquity (percentage of samples where each taxon is present) and percentage distribution of each taxon (number of mentions of each taxon $\times 100/\Sigma$ of mentions of all taxa).

3. Results

Cereals are generally the most abundant and frequent category of plant remains in all periods and regions (Fig. 2). Naked wheats (*Triticum aestivum/durum*) and hulled barley (*H. vulgare* sp. *vulgare*) are the main cereal species. Although several species of legumes are identified, they are always in modest numbers in archaeological contexts. An important group of plants widely recorded in both charred and waterlogged contexts corresponds to cultivated fruits. Equally interesting is the presence of oil/fibre plants, herbs and spices. Finally, gathered plants include several food species used by human communities throughout the period in question.

Most of the sites (38) in this study (Table 2) are from the **Roman period** (2nd BC–5th AD). They comprise urban and rural sites spread more or less throughout all the regions of the Peninsula except the centre. With the exception of the Basque region, rural sites dominate. Waterlogged contexts, by contrast, are exclusively in urban contexts. In the case of charred plant remains, the most frequent categories are cereals and cultivated fruits (58% and 31%). It is evident that in the waterlogged and mineralised cases, the frequency of fruits, whether cultivated or wild, is much higher than that of sites where preservation is due to charring.

The species identified include (Table 3) hulled barley (*Hordeum vulgare* ssp. *vulgare*), naked barley (*H. vulgare* var. *nudum*), naked wheats (*Triticum aestivum/durum*), hulled wheats such as einkorn (*T. monococcum*), emmer (*T. dicoccum*) and spelt (*T. spelta*), broomcorn millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), rye (*Secale cereale*), and oat (*Avena* sp.). Hulled barley and naked wheat are dominant in all regions except in the NW where *P. miliaceum* reaches significant levels. This region is also characterised by the highest occurrence of *T. spelta* accompanied by *S. italica*, *T. dicoccum*, *S. cereale* and *Avena* sp. Emmer seems to have played a significant role also in the South. Moreover, this is the sole region where naked barley is present. Rye is identified in the NE

Table 1
List of the sites with archaeobotanical studies mentioned in the study.

N.	Site	Municipality	Province/District	Bibliography	Sector	Type of site	Period	Chronology	N. of seeds	Samples	Mode conservation		
											Waterlogged	Charred	Mineralised
1	C/ Tadeo Murgia	Irún	Guipúzcoa	Peña-Chocarro and Zapata, 1996; 2005	N	URBAN	RO	I-II AD	5880	47	X		
2	Zornoztegi	Savatierra-Agurain	Álava	Sopelana and Zapata, 2009	N	RURAL	MCH	VIII-XI AD	8497	10		X	
3	Catedral Vitoria	Vitoria	Álava	Pérez Díaz et al., 2015	N	URBAN	MCH	VIII-XII AD	1408	56		X	
4	Zaballa	Iruña de Oca	Álava	Queiroz and Mateus, 2011	N	RURAL	LA	V-VII AD	12	4		X	
							MCH	VIII-XIII AD	642	61		X	
5	Tabacalera	Gijón	Asturias	Carrión Marco et al, 2015	N	URBAN	LA	VI-VIII AD	4830	18	X	X	
6	Mourela	As Pontes	A Coruña	Antolín and Alonso, 2009	NW	RURAL	MCH	VII-X AD	175	3		X	
7	Banco de España	Santiago de Compostela	A Coruña	Teira Brión, 2015	NW	URBAN	MCH	XI-XII AD	565	1	X		
8	A Pataqueira	Palas de Rei	Lugo	Teira Brión, 2013	NW	RURAL	MCH	VIII-X AD	150	10		X	
9	Reza Vella	Ourense	Ourense	Unpublished	NW	URBAN	RO	I-VII AD	18	38		X	
10	Cova do Xato	Folgoso do Caurel	Lugo	Teira Brión et al, 2012	NW	RURAL	RO	IV-V AD	4	2		X	
11	Castro de Orellán	Orellán	León	López-Merino et al., 2010	NW	RURAL	RO	I-II AD	1115	5		X	
12	Cova Eirós	Triacastela	Lugo	Teira Brión et al, 2012	NW	RURAL	MCH	X-XI AD	238	1		X	
13	San Cibrán de Las	San Amaro	Ourense	Tereso et al, 2013a	NW	RURAL	RO	I BC- I AD	30	3		X	
14	Rúa Ferreiría nº59	Caldas de Reis	Pontevedra	Unpublished	NW	RURAL	RO	I–V AD	46	14		X	
15	Agro de Deus	Pontevedra	Pontevedra	Unpublished	NW	RURAL	LA	VI-VII AD	160	28		X	
							MCH	XII-XIII AD	15	1		X	
16	O Areal	Vigo	Pontevedra	Teira Brión, 2010	NW	URBAN	RO	III-IV AD	1005	63	X	X	
17	A Burgueira	Oia	Pontevedra	Unpublished	NW	RURAL	RO	I BC- III AD	20	5		X	
18	São Lourenço	Esposende	Braga	Tereso et al., 2010	NW	RURAL	RO	IV AD	74	5		X	
19	Briteiros	Guimarães	Braga	Tereso and Cruz, 2014	NW	RURAL	RO	I BC- IAD	87	6		X	
20	Ermidas	Vila Nova de Famalicão	Braga	Queiroga and Dinis, 1992	NW	RURAL	RO	I AD	2275	17		X	
21	Monte Mozinho	Penafiel	Porto	Tereso et al., 2013a	NW	RURAL	RO	III-V AD	11579	21		X	
22	Aquae Flaviae	Chaves	Vila Real	Vaz et al., 2016	NW	URBAN	RO	IV AD	145	6	X		
23	Terronha de Pinhovelo	Macedo de Cavaleiros	Bragança	Tereso 2007, 2009	NW	RURAL	RO	IV-V AD	4930	19		X	
24	Crasto de Palheiros	Murça	Bragança	Figueiral, 2008	NW	RURAL	RO	I AD	72142	10		X	
25	Vale da Bouça	Mogadouro	Bragança	Unpublished	NW	RURAL	RO	III-V AD	11	10		X	
26	S. Gens	Celorico da Beira	Guarda	Queiroz, 2009	W	RURAL	MCH	IX-X AD	1	1		X	
27	Penedo dos Mouros	Gouveia	Guarda	Leeuwaarden and Queiroz, 2003	W	RURAL	MCH	X-XI AD	724	21		X	
28	Terlamonte	Covilhã	Guarda	Queiroz, 2004; Carvalho, 2007	W	RURAL	RO	I-II AD	1			X	
29	Quinta da Torrinha	Gois	Coimbra	Queiroz and Leeuwaarden, 2004	W	RURAL	MCH	XI-XII AD	103	1		X	
30	Poço de Idanha a Vella	Idanha a Nova	Castelo Branco	Almeida and Ferreira, 1967	W	RURAL	RO	I-II AD	121	1	X		
31	Convento de S. Francisco	Santarém	Santarém	Queiroz (2001)	W	URBAN	MIS	VIII-XII AD	2366	8		X	
32	Paços do Concelho	Torres Vedras	Lisboa	Queiroz, 2004	W	URBAN	MIS	X-XI AD	17	5		X	
33	Casa dos Bicos	Lisboa	Lisboa	Queiroz and Mateus, 2011	W	URBAN	MCH/IS		4257	11	X		
34	Rua dos Correeiros	Lisboa	Lisboa	Bugalhão and Queiroz, 2005	W	URBAN	MIS	XI-XII AD	28598	1	X		
35	Travessa da Portuguesa	Setúbal	Setúbal	Pais, 1996	W	URBAN	MCH	XIII-XIV AD	1	2		X	
36	Castelo de Mértola	Mértola	Beja	Pais, 1996	SW	URBAN	MIS	XI-XII AD	608	23		X	
37	Castelo de Silves	Silves	Faro	Pais, 1996	SW	URBAN	MIS	XII-XIII AD		2		X	
38	Martinhal	Vila do Bispo	Faro	Queiroz, 2010	SW	RURAL	RO	III-V AD	14	6		X	
39	Pocito Chico	Puerto de Santa María	Cádiz	Unpublished	S	RURAL	MIS	XII-XIII AD	46	4		X	
40	Fondeadero C/ Sebastián Souvirón	Málaga	Málaga	Unpublished	S	URBAN	RO	II-III AD	79	1		X	
41	Villa Romana de Gabia	Gabia La Grande	Granada	Rodríguez and Montes Moya, 2010; Montes Moya, 2015	S	RURAL	RO	I-II AD	7927	14		X	
42	Marroquíes Bajos	Jaén	Jaén	Montes Moya, 2014	S	RURAL	RO	II BC- I AD	3432	67		X	
43	al-Rummaniyya	Córdoba	Córdoba	Rodríguez-Ariza and Montes Moya, 2015	S	RURAL	MIS	X AD	668	21		X	
44	Madinat al-Zahra	Córdoba	Córdoba	Unpublished	S	URBAN	MIS	X-XI AD	731	38		X	

45	El Saucedo	Talavera la Nueva	Toledo	Castelo Ruano et al., 2009	C	RURAL	LA	V-VIII AD	4	1			X	
46	Melque	S. Martín de Montalbán	Toledo	Caballero Zoreda and Fernández Mier, 1999	C	Rural	MIS	IX-X AD	79953	4			X	
							MCH	X-XIII AD	1102	2			X	
47	Gózquez	San Martin de la Vega	Madrid	Vigil-Escalera Guirado et al., 2014	C	RURAL	LA	VI-VIII AD	4164	38			X	
48	C/ Nuncio 13	Madrid	Madrid	Unpublished	C	URBAN	MIS	X-XII AD	893	7			X	X
49	Segóbriga	Saelices	Cuenca	Unpublished	C	RURAL	LA	VI-VII AD	29	1			X	
50	Cipreses	Jumilla	Murcia	Unpublished	E	RURAL	RO	IV-V AD	167	7			X	
51	Tossal Basses	Alacant	Alacant	Unpublished	E	RURAL	LA	VI-VII AD	169	18			X	
							MIS	XII-XIII AD	29	4			X	
52	Castillo de Villena	Villena	Alacant	Unpublished	E	URBAN	MIS	XII AD	7	2			X	
							MCH	XIII-XIV AD	5	3			X	
53	Mas d'Is	Penàguila	Alacant	Unpublished	E	RURAL	MIS	VII-IX AD	1307	8			X	
54	Faldetes	Moixent	València	Pérez Jordà, 2012	E	RURAL	RO	II-III AD	377	10			X	
55	Racó d'Ènova	Ènova	València	Unpublished	E	RURAL	MIS	X AD	8	1			X	
56	Alters	Ènova	València	Unpublished	E	RURAL	RO	I-III AD	25	9			X	
57	Plaça de l'Almoina	València	València	Unpublished	E	URBAN	RO	II BC- V AD	3824	47			X	
							MIS	X-XII AD	25	5			X	
	En Bic	Bétera	València	Unpublished	E	URBAN	MIS	XI-XIII AD	426	22			X	
58	Horta Vella	Bétera	València	Unpublished	E	RURAL	RO	I-IV AD	82	9			X	
							LA	V-VII AD	225	15			X	
59	Torre la Sal	Ribera de Cabanes	Castelló	Pérez Jordà, 2009	E	RURAL	MIS	X-XI AD	138	8			X	
60	Tortosa	Tortosa	Tarragona	Alonso et al., 2014	NE	URBAN	MIS	X-XII AD	5233	37			X	X
61	Solicrup	Vilanova i la Geltrú	Barcelona	Unpublished	NE	RURAL	RO	I AD	1340	10			X	
62	Lleida	Lleida	Lleida	Alonso, 2005	NE	URBAN	RO	I BC - 5 AD	1753	38			X	X
							LA	V-VI AD	43	1				
				Alonso et al., 2014	NE	URBAN	MIS	X-XII AD	545	15			X	X
							MCH	XII-XIII AD	486	5			X	
63	La Fogonussa	St. Martí de Riucorb	Lleida	Unpublished	NE	RURAL	LA	VI-VII AD		46			X	X
64	Tossal del Moro	Castellserà	Lleida	Unpublished	NE	RURAL	LA	VI-VII AD	159	8			X	
65	Iesso	Guissona	Lleida	Canal et al., 2004	NE	URBAN	RO	I-II AD	7508	2	X			
66	Pla d'Almatà	Balaguer	Lleida	Alonso et al., 2014	NE	URBAN	MIS	X-XI AD	1431	16			X	X
67	Roc d'Enclar	Sta Coloma	Andorra	Buxó and González, 1997	NE	RURAL	LA	VI-VIII AD	4183	10			X	
68	Camp Vemell	Sant Julià de Lòria	Andorra	Alonso et al., 2010	NE	RURAL	RO	II-IV AD	7	2			X	
							LA	V-VII AD	1516	15			X	
							MCH	VIII-XII AD	227	10			X	
69	L'Esquerda	Osona	Barcelona	Cubero et al., 2008	NE	RURAL	MCH	XIII AD	1035	23			X	
70	Vilauba	Camós	Girona	Colominas et al., in press	NE	RURAL	RO	I–V AD	14436	19			X	
							LA	V-VII AD	136724	4			X	
71	Camp de Can Massot	Fornells de la Selva	Girona	Unpublished	NE	RURAL	MCH	VIII-XII AD	174	5			X	
72	Can Bonvilar	Terrasa	Barcelona	Unpublished	NE	RURAL	RO	I–V AD	390	9			X	
73	Torrebonica	Terrasa	Barcelona	Unpublished	NE	RURAL	RO	I-II AD	245	13			X	
							MCH	IX-XI AD	20	6			X	
74	Pla del Serrador	Les Franqueses	Barcelona	Unpublished	NE	RURAL	MCH	VII-X AD	441	9			X	
75	Can Gambús 2	Sabadell	Barcelona	Unpublished	NE	RURAL	MCH	VIII-XII AD	2057	9				X
76	Can Gambús 3	Sabadell	Barcelona	Unpublished	NE	RURAL	RO	II BC- I AD	119	15			X	
77	Ca n'Oliver	Cerdanyola del Vallès	Barcelona	Unpublished	NE	RURAL	MCH	IX-X AD	318	3			X	
78	Els Mallols	Cerdanyola del Vallès	Barcelona	Alonso, 2008	NE	RURAL	LA	V-VI AD	3788	61			X	
79	Ajuntament/Església Cornellà	Cornellà de Llobregat	Barcelona	Unpublished	NE	RURAL	RO	II AD	275	18			X	
80	Foneria	Barcelona	Barcelona	Ravotto et al., 2014	NE	RURAL	LA	VI AD	1118	4	X		X	
81	Teuleria dels Albers	Barcelona	Barcelona	Unpublished	NE	RURAL	RO	I-III AD	178	14			X	
82	Can Cabassa	Sant Cugat del Vallés	Barcelona	Unpublished	NE	RURAL	RO	I–V AD	33	11			X	
83	Can Gelats	Aiguaviva	Girona	Unpublished	NE	RURAL	LA	V-VII AD	452	3			X	

Table 2
Number of sites and samples of each site and chronological/cultural phase.

		Roman	Late Antiquity	Medieval Islamic	Medieval Christian
		2nd BC - 5th AD	5th - 7th AD	8th - 13th AD	8th - 13th AD
NW	Sites	15	1		5
	Samples	224	28		16
N	Sites	1	2		3
	Samples	47	22		127
NE	Sites	11	9	3	8
	Samples	151	152	68	70
W	Sites	2		3	5
	Samples	2		14	36
C	Sites		3	2	1
	Samples		40	11	2
E	Sites	5	2	7	1
	Samples	82	33	49	3
SW	Sites	1		2	
	Samples	6		25	
S	Sites	3		3	
	Samples	82		63	
Total	Sites	38	17	20	23
	Samples	594	275	230	254

(1.6%) and in the NW (4.8%). Oats, at less than 6%, are present in all sectors from this period except the SW.

Legumes (Fig. 2), in turn, appear in low numbers (8%) and are represented by grass/red pea (*Lathyrus sativus/cicera*), lentil (*Lens culinaris*), pea (*Pisum sativum*), broad bean (*Vicia faba*), bitter vetch (*Vicia ervilia*), vetch (*Vicia sativa*) and chickpea (*Cicer arietinum*) (Table 3). Legumes are only known in four sectors (E, NE, NW and S) in different proportions. While broad bean dominates in the E and NW, lentil is the main species in the NE and grass pea in the S. Legume diversity in the NW is lower and only *V. faba*, *V. sativa*, *P. sativum* are present.

Domesticated fruits at Roman dry sites are typical Mediterranean species (Table 3): fig (*Ficus carica*), olive (*Olea europaea*, and grape (*Vitis vinifera*). Other domesticated fruit species are peach (*Prunus persica*), plum (*P. domestica*), sweet cherry (*P. avium*), apple (*Malus domestica*), pomegranate (*Punica granatum*) and walnut (*Juglans regia*). Waterlogged contexts yield melon/cucumber (*Cucumis melo/sativus*) and almond (*Prunus dulcis*). Grapes and figs are dominant among charred remains. Olive is also important in the E and S and less manifest in the N and NE. Other fruit species appear in much lower percentages. In waterlogged contexts, the percentages of the different taxa are more or less equivalent, with the exception of *P. persica* or *Juglans regia* that present higher values in the NW.

Flax (*Linum usitatissimum*) is also documented along with herbs such as rosemary (*Rosmarinus officinalis*), celery (*Apium graveolens*), and vervain (*Verbena officinalis*). A member of the mint family (*Mentha* sp.) is also identified in both charred and waterlogged contexts.

Wild species at Roman sites consist of a wide variety of fruits such as strawberry tree (*Arbutus unedo*), hackberry (*Celtis australis*), stone pine (*Pinus pinea*), mastic (*Pistacia lentiscus*) and two elders (*Sambucus nigra* and *S. ebulus*). In addition, strawberries (*Fragaria vesca*), acorns (*Quercus* sp.) and blackberries (*Rubus fruticosus*) are also present. Wet sites contribute to the corpus with chestnuts (*Castanea sativa*), hazelnuts (*Corylus avellana*), beechnuts (*Fagus sylvatica*) and sloe berries (*Prunus spinosa*).

In general there are fewer sites from **Late Antiquity** (5^{th}- $8th^{AD}$) (Table 2) of which 17 contain charred remains. The single site with mineralised remains and the two with waterlogged remains yield interesting results. Although most of the research is centred on the NE, where most of the sites are located, there are also interesting data coming from the N (rural and urban sites) and the E. The sites are all rural apart from a single urban example in the N. The frequency of each category (Fig. 2) indicates that cereals are again dominant (71%), followed by cultivated fruits (16%) and legumes (11%). From the long list of cereals recorded in the previous period, only spelt is missing (Table 3). Hulled barley and naked wheats are dominant, although it appears that naked wheats overcome barley in some sectors. Einkorn, emmer and rye also play a role in the central area and oats are also present in several regions.

All the legumes documented in the Roman phase are also present in Late Antiquity. It is interesting that most legume findings are in the NE, the region where more sampling took place. Other examples are known in the E, while none is documented in the remaining regions.

The charred assemblages of cultivated fruits in Late Antiquity evidence the lack of several species known earlier in the Roman period. This is the case of the apple, sweet/sour cherry, peach, and pomegranate. Some missing taxa such as the sweet cherry, the melon/cucumber or the almond, together with the taxa already documented in charred contexts, are also found in waterlogged contexts. *Morus nigra* is identified at Vilauba (Green 1988) in the NE although no information is given as to how it is discerned from *Morus alba*.

The only evidence of oil/textile plants comes from waterlogged sites in the form of three taxa: *Brassica nigra*, *Brassica* sp. and *Linum usitatissimum*. To this can be added two herbs: *Apium graveolens* and *Mentha* sp. Wild fruits possibly exploited by humans are *Corylus avellana*, *Quercus* sp., *Cornus sanguinea* and *Rubus fruticosus*.

Medieval Christian sites are relatively abundant (23 sites) (Table 2) throughout the Peninsula except in the South. Most are found along the northern fringe with some exceptions such as Melque (Toledo) in the centre, Castillo de Villena (Alicante) in the E and Setúbal, Portugal, in the W. All charred remains were collected on rural sites except for those of Lleida in the NE and Setubal (Travessa da Portuguesa) in Portugal. Waterlogged remains, by contrast, are only found on medieval urban Christian sites (Casa dos Bicos and Banco de España).

Among the charred samples, cereals (Fig. 2) represent 64% of the total plant category followed by legumes (22%) and cultivated fruits (10%). The remaining categories comprise less than 3%. Cereals correspond to the same species documented in earlier periods. Looking into the cereal taxa in more detail (Fig. 3), einkorn is scarce and foxtail millet is only identified in the NE and NW. The dominant species are hulled barley and free-threshing wheats. Yet other

Table 3
Table listing the presence/absence of each taxon in the different chronological periods in each region and indication of their mode of preservation.

	NW				N				NE				W				C				E				SW				S			
	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS
Cereals																																
Avena sp.	●		◆				●		●	●	●	●						●			●	●							●			
Hordeum vulgare ssp. *vulgare*	●		●			●	●		●	●	●	●				●		●	●		●	●	●	●	●				●			●
Hordeum vulgare var. *nudum*							●			●	●																		●			
Panicum miliaceum	●	●	● ◆			●	●		●	●	●				◆	●						●							●			
Secale cereale	●		●				●		●	●	●				●	●		●		●								●				
Setaria italica	●		◆			●				●	●	●				●					●											
T. aestivum/durum	●		●			●	●		●	●	●	●			●	●		●	●	●	●	●		●				●	●			●
Triticum dicoccum	●		●				●		●	●	●	●						●											●			●
Triticum monococcum	●						●				●							●											●			●
Triticum spelta	●		●																													
Legumes																																
Cicer arietinum											●																		●			
Lathyrus sativus/cicera							●		●	●											●	●						●	●			●
Lens culinaris							●		●	●	●	● □									●								●			
Pisum sativum	●						●		●	●	●																	●	●			●
Vicia ervilia							●			●	●										●								●			●
Vicia faba	●		●				●		●	●	●										●								●			●
Vicia sativa	●								●	●	●										●	●										●
Fruits																																
Cucumis melo/ sativus	◆		◆						◆	◆		● □				◆																
Ficus carica	◆		◆		◆			●	● □ ◆	● ◆	● □	● □			◆	◆		●		● □	●			●				●				●
Juglans regia	◆				◆		●		● ◆	● ◆		□	◆		◆			●			●								●			
Malus domestica			◆						●			□																	●			
Morus nigra										●					◆	◆																
Olea europaea	● ◆				◆			●	● ◆	● ◆		●	◆		◆				●	●	●								●			●
Prunus armeniaca								●																								
Prunus avium	● ◆		●			◆		●	◆		◆	●			◆														●			
Pruus cerasus					◆																											
Prunus avium/cerasus	◆		◆		◆						□																					
Prunus domestica	◆				◆		●	●	◆				◆		◆	◆					●								●			
Prunus dulcis					◆			●	◆			●	□		◆																	●
Prunus persica	◆				◆			●	● ◆			●	●	◆	◆														●			
Punica granatum													●	◆							●											
Vitis vinifera	● ◆				◆	◆	●	●	● ◆	● □ ◆	● □	● □	◆		◆	◆		●	●	● □	●							●	●			
Oil/fibreplants																																
Brassica nigra						◆									◆	◆																
Brassica oleraceae															◆																	
Brassica sp.	●				◆	◆										●																
Camelina sativa											●	● □																				
Linum usitatissimum/Linum sp.			●			◆	●			●		● □				◆				●	●							●	●			
Papaver somniferum																				●												
Stipa tenacissima																					●	●	●	●					●			
Spices																																
Apium graveolens					◆	◆						● □			◆	● ◆																
Apium sp.															◆																	
Coriandrum sativum			●												● ◆	●																●
Daucus carota						◆									◆								●									●
Foeniculum vulgare												□			◆	●												●				

(*continued on next page*)

Table 3 (*continued*)

	NW				N				NE				W				C				E				SW				S			
	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS	R	LA	MCH	MIS
Lavandula sp.															◆	●																
Mentha sp.					◆	◆									◆	●																
Nigella sp.												□																				
Rosmarinus officinalis									●			●			◆	●													●			
Verbena officinalis						◆					●	●																				
Gatheredfruits																																
Arbutus unedo					◆																				●							
Castanea sativa	◆		◆																													
Celtis australis									●		●																					
Corema album															◆	◆																
Cornus mas																																
Cornus sanguinea						◆																										
Corylus avellana	◆		●		◆				● ◆		● ◆				◆																	
Fagus sylvatica					◆																											
Fragaria vesca									●			●			◆	● ◆																
Myrtus communis															◆																	
Pinus pinea	● ◆											● □	◆		◆	●					●	●	●	●					●			
Pinus sp.					◆					●		□																				
Pistacia lentiscus																					●											
Prunus spinosa	◆				◆		●																									
Prunus sp.	◆																															
Quercus sp.	●								● ◆		◆					●		●				●						●				
Rubus fruticosus	● ◆		●		◆				●		◆	●									●	●										
Rubus idaeus												●			◆	● ◆																
Rubus sp.	● ◆					◆																										
Sambucus ebulus	●								□		◆	●																				
Sambucus nigra	◆					◆			◆																							

●Charred remains.
□Mineralised remains.
◆Waterlogged remains.

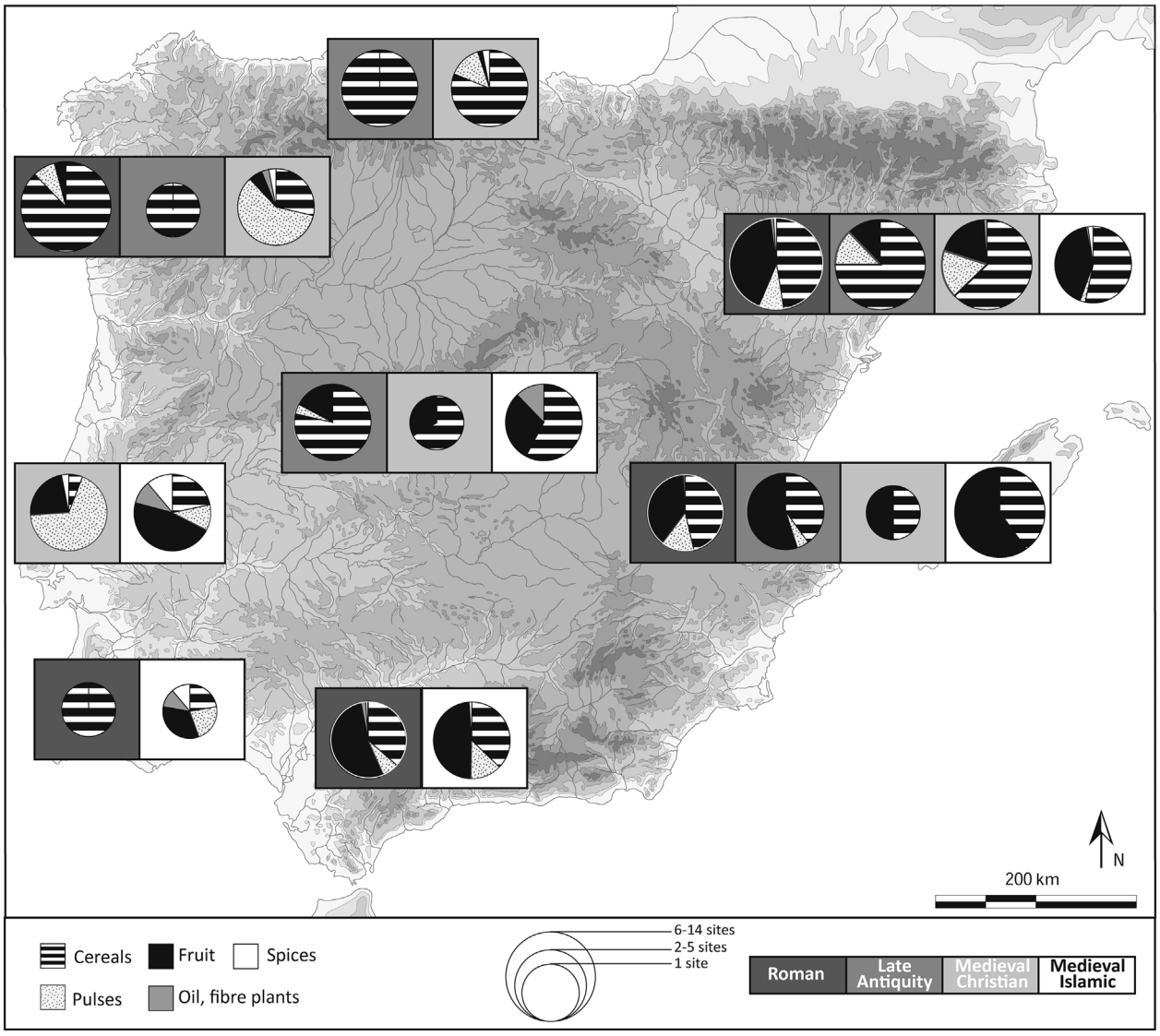

Fig. 2. Map of the Iberian Peninsula illustrating the distribution in percentage of the different groups of taxa preserved by charring.

species such as rye begin to be better represented, at least in the northern part of the Peninsula. Spelt is again present in the NW at almost identical percentages as hulled barley, broomcorn millet and rye. Here, the most frequent taxa are the naked wheats. These values, however, could result from the small size of the sample. Oat is only documented in the N and naked barley in the NE, as is the case of Late Antiquity.

Data regarding legumes come from four sectors of the Peninsula (NE, N, NW, and W). Broad bean is the only species in the NW and W, while in the NE the main species are bitter vetch followed by vetch. In the N, lentil is dominant, followed by broad bean and bitter vetch. The NE and the N are the areas with the greater diversity of legumes.

Fruits (Fig. 2) are represented by a total of 13 taxa from sectors E, NE, NW, C, N and W. While some species (Table 3) such as pomegranate are only present in charred contexts, several other taxa (grape, fig, olive, walnut, almond sweet cherry, plum and peach) are from both charred and waterlogged contexts. Furthermore, other taxa are solely recorded in waterlogged contexts: apple, melon/cucumber and black mulberry (*Morus nigra*).

Oil plants (Table 3) such as camelina (*Camelina sativa*), flax (*Linum usitatissimum*), and Brassica spp (*B. nigra* and *B. oleracea*), as well as herbs such as celery (*Apium graveolens*), coriander (*Coriandrun sativum*), fennel (*Foeniculum vulgare*), rosemary, a mint species (*Mentha* sp.), lavender (*Lavandula* sp.), thyme (*Thymus* sp.) and wild parsley (*Petroselinum segetum*), are identified in medieval Christian sites. Other garden plants include vervain and a new arrival, the carrot (*Daucus carota*). The wild species with economic use are hazelnuts, chestnuts, pine nuts, myrtle, sloe, strawberries, raspberries and blackberries, elder, *Corema album* and *Vaccinium* sp. Although many were retrieved from charred contexts, waterlogged sites have also provided many species.

There are 20 sites with plant remains from the **Islamic period** (Table 2). The samples for the most part (19) are charred (only one is waterlogged). Four sites yielding mineralised seeds also contained charred remains. Their distribution is wide (E, NE, S, SW, W and C) with the exception of N and NW where the Islamic occupation was apparently short (no settlements identified). The East, nonetheless, shows the highest concentration. All Islamic sites throughout the Peninsular are urban except for the five rural cases in the E and S.

As in the previous periods (Fig. 3), hulled barley and naked

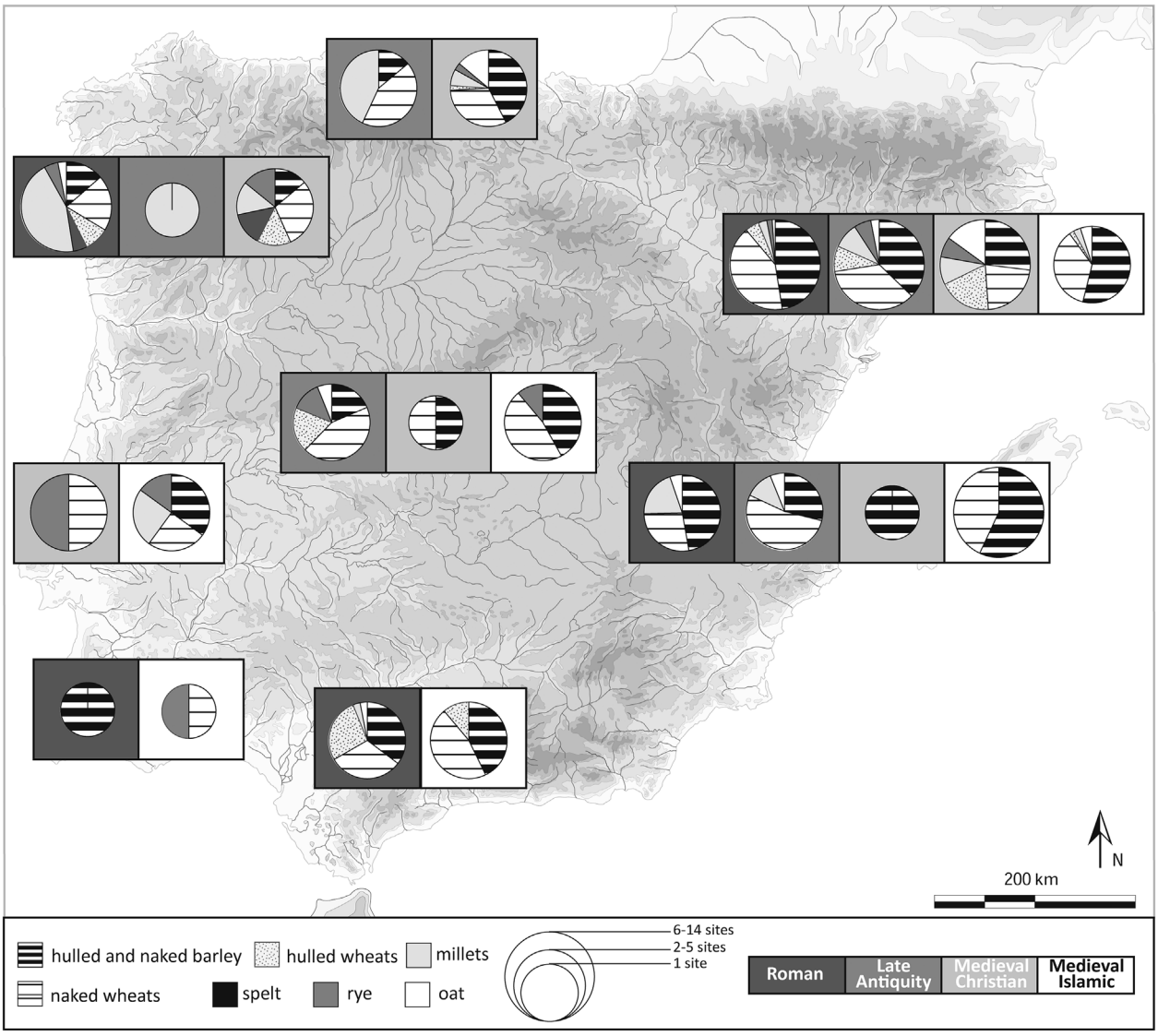

Fig. 3. Map of the Iberian Peninsula illustrating the distribution in percentage of the different cereals preserved by charring.

wheats dominate across the whole area. Naked barley and spelt, in turn, are not recorded, and the remaining species (millets, rye, oat and hulled wheats) are represented in lesser proportions. This is probably due to the scarce number of sites from this period in the N. Exceptions are broomcorn millet (25%) and rye (15%) in the W. Einkorn is only present in the S, broomcorn millet only in the W, and foxtail millet in the NE. The main pattern of this period is the reduction of cereal species in most areas.

Seven different pulses (Table 3) are recovered in this period: broad bean, lentil, grass and red pea, pea, common vetch, bitter vetch and chickpea together with a fodder crop, *Medicago sativa* (lucerne) in the S.

The presence of cultivated fruits (Fig. 2) under Islamic rule is significant. Compared to the taxa (Table 3) from the Christian sites, the only species missing is the walnut, while a new species, the apricot (*Prunus armeniaca*), is recorded. This last species appears for the first time at Mertola during the 11th and 12th century AD. Like other periods, grape is the predominant species at Islamic sites followed by fig.

Oil seeds (Table 3) are represented by camelina, flax and poppy. *Brassica* sp. is also recorded in a single case. As far as spices are concerned, the Islamic contexts reveal the same species as Christian sites (celery, coriander, fennel, lavender, mint, rosemary, thyme, verbain and carrot). The only missing species is wild parsley (*Petroselinum segetum*). It is also of note that *Nigella* sp. appears for the first time in this period in the NE.

The wild species from Islamic contexts include *Fragaria vesca*, *Pinus pinea*, *Quercus* sp., *Rubus idaeus* and *Corema album*. It cannot be excluded that certain (*Fragaria*, *Pinus*) were cultivated or managed in this period.

4. Discussion

4.1. Cereals

In Roman, Late Antique and medieval Iberia, cereals (Fig. 2) were the most common food plant whether for human or animal consumption. The evidence in the form of caryopses and chaff comes from many sites with charred remains. The range of cultivated species is large (Table 3) and includes naked and hulled wheats, barley, millets, rye and oat. Although their proportion varies in relation to other crops throughout the different periods and

regions, cereals are, nonetheless, the most represented species except in mineralised and waterlogged contexts. It is therefore assumed that they were the bulk of the population's diet providing most of the calorie intake.

Hulled wheats*: einkorn (T. monococcum), emmer (T. dicoccum) and spelt (T. spelta)*

Hulled wheats, namely einkorn, emmer and spelt, rarely played a major role in Iberia's prehistoric agriculture. Einkorn and emmer, founder crops of agriculture in the Near East, are documented since the beginnings of the Iberian Neolithic. Yet throughout Prehistory these crops gradually lost importance in favour of naked species, and by the Roman period they were marginal (Fig. 3).

Einkorn, in fact**,** represents only 1.6% of the total cereals in Iberia and it is only present in the NW (1.6%) and in the S (8.1%) at rural sites, whereas during the Late Antique period it is only known at Segóbriga in central Spain. In medieval Christian times it is only evidenced in the NE at L'Esquerda (Cubero et al., 2008) and in the N, in the Basque Country, at Zaballa (Sopelana, 2012). During the Islamic period, einkorn is recorded in the S at Medina Azahara in the Province of Córdoba where it represents 2.7% of the region's total cereal group. In any case its presence since Roman times is limited across the Iberian Peninsula.

Although einkorn was always a secondary crop, its cultivation was maintained until very recently in areas of the Iberian Peninsula (Peña-Chocarro, 1999) for straw production serving for thatching and animal fodder. Even in the most recent past, einkorn was a minor crop reserved for specific activities. This is also the case in other areas where einkorn was cultivated until very recently such as the Carpathians (Gunda, 1983; Hajnalová et al., 2007), Morocco (Peña-Chocarro et al., 2009) and Turkey (Ertug, 2004; Hillman, 1984). Einkorn's limited presence could be related to its use for other purposes besides food, a situation that would have left few traces in the archaeobotanical record.

Emmer was an important crop for the Romans according to classical agronomists. However, in the Iberian Peninsula it was rarely dominant. It appears in the archaeobotanical record of several areas (Fig. 3) at around 4–7%. The exception is the S where it represents 19% of all the cultivated cereals. Emmer is usually linked to rural sites. In Late Antiquity, it is present in two regions, the Central Plateau and the NE, where it represents about 8.9% of all the cereals. In medieval times, emmer is present at Christian sites according to data from the NE, particularly the site of l'Esquerda (Cubero et al., 2008) from the NW, and from the N. It is also present at Islamic sites in the NE and the S. In this last sector it represents 8% of all cereals.

The case of spelt wheat is somehow different as in Europe it is only recorded since the mid-late 3rd millennium BC (Akeret, 2005; Marinova and Valamoti, 2014). This species in the Iberian Peninsula (Table 3, Fig. 3) dates to the Iron Age in the NW (Tereso et al., 2013b). In Portugal it is evidenced at Castro de Palheiros (Figueiral, 2008), and in Galicia at Castrovite (Rey Castiñeira et al., 2011) and As Laias (Tereso et al., 2013b). This species is patent in Roman times according to the archaeobotanical record of Terronha de Pinhovelo in Portugal (Tereso, 2007, 2009), and Castro Pedro (Buxó 1997) and Castromaior in Galicia.

Spelt is therefore a latecomer to the north of Iberia. After introduction during the Iron Age, it is recorded in the Roman period before vanishing from the archaeobotanical record until the medieval period when evidence of *T.* cf *spelta* turns up in the NW. This scant evidence, however, seems to contrast with textual records. At the end of the 9th century, the *Chronicon Albendense* (a Latin manuscript describing the Hispano-Visigothic kingdom, the Arab invasion and the dawn of the Asturian kingdom) cites "scanla" (*escanda* is spelt in Spanish) among the foremost products of Asturias suggesting wide cultivation. In fact, Asturias is nowadays the only region in Spain where spelt is still cultivated (Peña-Chocarro, 1999). It is, in fact, likely that the scarcity of archaeobotanical studies in northern Spain is masking the true role of a species that has survived until present day.

4.2. Naked wheats (Triticum durum, Triticum aestivum)

Naked wheats and hulled barley are the most common cereal species in the Iberian Peninsula throughout the whole period under study (Fig. 3). In the majority of cases, since grains are the only remains, they are classified as *T. aestivum/durum.* Yet basing identification solely on the evidence of caryopses is not enough to separate the species. However, when the chaff is also preserved it is nonetheless possible to distinguish hexaploid *T. aestivum* (bread wheat) from tetraploid *T. durum* (hard wheat). The scarcity of chaff remains prevents exploring the distribution of tetraploids and hexaploids in the Roman period. In this period both *T. durum* and *T. aestivum* chaff are documented in the NE, while in the NW only *T. aestivum* is recorded. The distribution of each species for the later periods is also irregular and we cannot confirm the preference of *T. durum* in the Mediterranean regions.

Naked wheats in the Roman period represent 26% of all cereals, a figure that will persist in the remaining periods. From the point of view of distribution, naked wheats are spread throughout all regions where plant remains were studied except the sparsely sampled SW. In the NE, naked wheats and hulled barley show similar percentages, while in the E, naked wheats are less frequent, dominated by hulled barley. The difference between the NE and E is observed in earlier periods and may relate to better soil quality in the NE. Hulled barley is also predominant (27%) in the Roman period with the third position occupied by broomcorn millet (13%). The situation in Late Antiquity is quite similar to that of naked wheat, however, slightly more frequent than hulled barley and the remaining cereals with percentages below 10%. In medieval Christian sites, naked wheats remain predominant, while there are clear variations in the percentages of the remaining taxa. Finally, naked wheat among Islamic samples, along with hulled barley, is dominant although differing from region to region.

Naked wheats play a key role in agriculture in this period. Even if their cultivation may have varied from region to region due to different factors, their consumption by human groups was fundamental as they provided most of the calories required for survival. Naked wheats were consumed differently. In the form of bread they were probably destined to the upper classes and as gruel to the lower classes. They may have had other uses such as for animals. There is no evidence of bread remains in the Iberian Peninsula, but vestiges from other areas (Heiss et al., 2015) suggest that bread was rarely made of a single species, but of a mixture of cereals or of cereals mixed with legumes or other plants.

Hulled barley (*Hordeum vulgare* ssp. *vulgare*) and naked barley (*H. vulgare* var. *nudum*)

Hulled barley and naked wheats dominate all of Iberia's regions and periods (Fig. 3). As mentioned above, the percentage of hulled barley in Roman times in the NW appears to decrease when compared to other areas, whereas the values of other crops (spelt, millets and rye) increase. It is noteworthy that the NW is the only Iberian region where hulled wheats, and particularly spelt, played an important role.

Hulled barley was consumed both by humans and animals. Although wheat is considered as the primary cereal for human consumption, hulled barley must have also been important. Furthermore, the current archaeobotanical record cannot explain the use of hulled barley solely as fodder. Hulled barley's abundance in Iberia's archaeobotanical record suggests that it could have in fact served to feed the poorer classes and possibly even part of the

higher classes (Portela Silva, 1976). Its enormous adaptability made it major player in the agricultural system. In fact, during the Roman period, following a trend already observed in the Iron Age, hulled barley was better represented in areas with poor soils not particularly apt for the cultivation of naked wheats (such as areas in the East). The soils in the NE, NW and S, by contrast, are better and both taxa are more or less equally represented. In the Late Antique period this pattern dissipates. Yet it must be highlighted that the sample studied is small. However, in the remaining territories this trend seems to continue. Based on these observations, one wonders whether the quality of soils may have conditioned the choice of where to sow crops.

Naked barley is much less frequent in Iberia's archaeobotanical record. At about 1% it is a minor species in Roman times and Late Antiquity. While in Roman times it is only found in the S, in Late Antiquity it appears only in the NE. Finally during the Middle Ages it represents 6.5% in the E, the N and NE. It is also noteworthy that naked barley is absent from Islamic sites.

4.3. Rye (*Secale cereale*)

The earliest evidence of rye cultivation in the Iberian Peninsula can securely be placed in the Roman period (Table 3) with both grains and chaff identified in the NW of Portugal. Two indigenous sites established in Roman times, Monte Mozinho and Cruito (Tereso et al., 2013a, 2013c), and an Iron Age site with an Early Roman phase, Crastoeiro (Seabra, 2015), offer Iberia's earliest evidence of cultivated rye. The radiocarbon dating of Crastoeiro points to the 1st century BC (Seabra, 2015). The chronology of Cruito is based on a charcoal dating with a range covering the transition to the first millennium, while its archaeological material seems to conform with to 1st century AD dating (Tereso et al., 2013a). A direct AMS dating of one of the grains from Monte Mozinho suggests a date between the end of the 3rd and beginning of the 4th centuries AD. There are also a few remains of rye in the NE. The site of Vilauba (Buxó, 1993; Colominas et al., submitted) also yields rye grains dated to the 4th-5th centuries AD.

Rye is highly appreciated in areas of northern Europe for its resistance to drought, adaptability to winter temperatures and capacity to grow in acid soils (Zohary et al., 2012). This crop was therefore successful where other cereals failed to survive. It is found in different areas of Iberia throughout the period under study (Fig. 3). The archaeobotanical data suggests that in Late Antiquity it was cultivated in the NE as it was collected at sites such as Vilauba (Buxó, 1993; Colominas et al., submitted), Els Mallols (Alonso, 2008), Roc d'Enclar (Buxó and González, 1997) and Can Gelats (Table 3). It is also present in the centre at Gózquez (Vigil-Escalera Guirado et al., 2014).

Much later rye is found at medieval Christian sites in the NE, NW, N and W, while in Islamic contexts it is recorded in the C, W and SW, as well as in Aragon (Ros, in press). Although the archaeobotanical evidence is still scant and strongly influenced by sampling strategies, it does indicate that this new crop arrived in Iberia during the Roman period and subsequent spread across the peninsula. Yet there is no evidence that it was largely cultivated. The only region where rye seems to have thrived is the NW due to the region's environmental characteristics. This region as late as the 20th century planted rye in deep soils and as part of the slash and burn systems practiced to open forests to agriculture in poor, marginal mountainous soils (Balboa López, 1990; Vázquez Varela et al. 2016). Rye in these regions may have played a role similar to that of the hulled wheats. It is likely that its survival up to recent times in mountainous areas where it is the feature of agriculture responds to a tradition dating to the Roman period.

4.4. Millets (*Panicum miliaceum and Setaria italica*)

Broomcorn millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*) form part of the archaeobotanical record of the Iberian Peninsula since the Bronze Age (Alonso and Buxó, 1995; Tereso et al., 2016). In the NW they are common since the Late Bronze Age and their presence is recurrent since the Iron Age (Alonso, 1999; Pérez Jordà, 2013; Tereso et al., 2013b).

During the Roman period millets spread throughout Iberia (Table 3). The most remarkable presence of *P. miliaceum* is in the NW (Fig. 3) where it represents 30% of all the cereals. This total, compared to 3% in other areas, evidences its importance. Besides, *Setaria* in the same sector represents almost 15% of the total cereals reinforcing the important role of millets in the NW. Yet whether each species of millet served a different purpose remains unclear. The situation in the E is also striking as *Setaria italica* represents 19.5% of all cereals. However, the great presence of foxtail millet is linked to the only urban site in the region and millet is not known at any of the sector's four other sites. During Late Antiquity, millets are also present in variable percentages.

It is beyond a doubt that millets attained great importance in Europe during medieval times. Archaeobotanical data demonstrate a wide cultivation throughout Europe of both *P. miliaceum* and *S. italica* (Castiglioni and Rottoli, 2013; Dembińska and Woys Weaber, 1999; Ros, 2013; Ruas, 2005). In the Middle Ages, broomcorn millet is far more frequent than foxtail millet which is only found in the NE and in the NW. *P. miliaceum* in the NW increases up to 14%, a scenario similar to that in earlier Roman times. Broomcorn millet increases together with spelt, emmer and rye. The importance of millet, rye and hulled wheats in the NW seems once again to be confirmed.

Panicum at Islamic sites stands out in the western region, particularly at Convento de S. Francisco (Santarém) (Queiroz, 2001), while *Setaria* is only represented in the NE.

Millets are versatile nutritious species that can grow in a wide variety of climates due to their tolerance to stress and high level of performance in marginal soils. The resistance to drought and adaptation to cold environments rendered broomcorn and foxtail millet a secure option to farmers in the past. Both species are generally spring sown with a short life cycle which allows remediating the eventual loss of winter-sown cereals.

Millets are consumed by humans, animals and fowl. Waterlogged remains were retrieved at the site of Banco de España in the NW (Teira Brión, 2015). Paleas and lemmas in a coarsely fragmented state suggest that the remains may have been animal fodder, a notion backed by the ethnographic record (Moreno-Larrazabal et al., 2015). Mixed with other cereals or legumes, millets served to make bread in Antiquity. Millets also served for porridges, soups and gruel-like foods. These species are most often associated with the lower classes, particularly in the Middle Ages, as tithes to feudal lords were often settled with rye in areas where millets were common such as in the NW (Andrade Cernadas, 2009) or paid with wheat, the most valued cereal (Portela Silva, 1976).

4.5. Legumes

The cultivation of legumes is recorded in the Iberian Peninsula since the Early Neolithic. They played an important role as food for humans and animals due to their rich protein content. Legumes also played an essential role in agriculture due to their ability to convert atmospheric nitrogen into ammonia which operates as natural fertiliser in symbiosis with the root bacterium *Rhizobium.*

The range of legumes cultivated in Iberia in Roman times is very diverse (Table 3). A part from cereals, farmers grew a number of pulses including eight different species: peas (*Pisum sativum*), lentil

(*Lens culinaris*), broad bean (*Vicia faba*), grass and red pea (*Lathyrus sativus/cicera*), bitter vetch (*Vicia ervilia*), common vetch (*Vicia sativa*) and chickpea (*Cicer arietinum*). While cereals in Roman times are ubiquitous in every area, legumes, by contrast, are only known in the E, NE, NW and S. In the NW the evidence suggests a lower diversity than in the rest of Iberia with only *V. faba*, *V. sativa* and *P. sativum*. Furthermore, species better adapted to Mediterranean environments such a *L. culinaris*, *C. arietinum* or *L. sativus/cicera* are absent.

Broad bean appears to be significant in the assemblages from the E and NW, and lentil is dominant in the NE. In the S, on the other hand, the predominant species is grass pea. The most interesting find in the archaeobotanical record of Iberia due to its rarity is the chickpea identified in the S at the Roman villa of Gabia (Granada) (Montes Moya 2014; Rodríguez-Ariza and Montes Moya 2010). Likewise, a fodder plant, *Medicago sativa* (Lucerne), is identified in the NE.

In Late Antiquity legumes are only found in the E and NE. In the E only grass pea and common vetch are identified, whereas the NE shows are wide range of pulses. Peas and lentils dominate, followed by similar percentages of common vetch, grass pea and bitter vetch. Broad bean in this case is poorly represented.

Legumes are present in medieval times in more areas in spite of its limited range of species. Broad bean is the only legume in the W and the NW. In the latter case this is probably due to the small number of samples. In the NE bitter vetch, common vetch and lentil dominate, while broad bean and pea are less represented. The discovery of chickpea at the site of L'Esquerda (Cubero et al., 2008) is also a rarity in the Iberian archaeobotanical record.

Finally, lentil followed by broad bean and bitter vetch, is the most common species at the site of Zaballa (Sopelana, 2012) in the N, while pea is less represented and grass/red pea is marginal.

Sites in the S provide an interesting assemblage of legumes including especially pea followed by three species of equal proportions: grass pea, vetch and broad bean. Red pea, bitter vetch and lucerne, in turn, play less important roles.

Although difficult to identify, other members of the *Vicia* and *Lathyrus* genera should perhaps be added to this list as they were probably exploited by these communities. Furthermore, the ethnographic record suggests an earlier use of species such as *V. narbonensis* (Enneking and Maxted, 1995) or *V. articulata* (Laghetti et al., 2000) or different types of *Lathyrus* spp. (Regnault-Roger, 1987; Sarpaki and Jones, 1990). Some of the legumes recovered and classified as *Vicia*/*Lathyrus* spp could include some of these species. Yet only future research will throw light on this question.

From the point of view of pulses, the only true fodder species is *Medicago sativa*. *V. ervilia*, *V. sativa* and *L. cicera*, in turn, probably also served to feed animals, while most of the remaining species were intended for human consumption.

4.6. Cultivated fruits

Fruit remains are a common food category throughout the three periods analysed in this study (Fig. 2). The variety of cultivated fruits during this long time span includes several species that are considered staple products: fig, olive and grape. These, together with the pomegranate, belong to the first wave of domesticated fruits. Other species such as apples, pears, sweet cherries, and plums were domesticated much later during the 1st millennium BC. Different Mediterranean groups from the East are responsible for their spread across the western Mediterranean, together with the spread of the technical advances needed for their propagation. In the Iberian Peninsula, the archaeobotanical evidence for domesticated fruits dates to the Iron Age as a consequence of contacts with Greek and Phoenician colonists. Most fruit species were introduced in this period, although some taxa only appeared later in either the Roman or medieval periods.

There is s significant number of cultivated fruit species during the Roman period (Table 3) and the archaeobotanical record suggests that species such as *Prunus persica* appear for the first time. Others such as *Morus nigra* are recorded since Late Antiquity, while a new species, the apricot (*Prunus armeniaca*), is only identified during the medieval period. In sum, at least 11 fruit species are identified for the Roman period, 8 for Late Antiquity and 14 for the Middle Ages.

An unusual pattern is observed in the E which repeats itself throughout all periods: fruit species reach high values as compared to cereals. The widespread presence of cultivated fruits results from the fostering of arboriculture by Roman and medieval societies. The enormous investment required in rearing fruit trees has been already pointed out (Bouby and Ruas, 2014; Zohary et al., 2012) stressing that delayed returns (fruit production only occurs several years after planting) require continuous care, protection, etc. This rendered large scale arboriculture an expensive and dedicated activity probably only possible for the upper classes of society. Yet, this does not exclude the notion that small orchards in rural areas or fruit trees in home gardens were intended for household subsistence or local markets.

Fig (*Ficus carica*), grape (*Vitis vinifera*) and olive (*Olea europaea*)

The most common cultivated fruit species are fig, grape and olive (Fig. 4) with samples ubiquitous throughout the Peninsula's Mediterranean regions and in all periods. Their presence in this area is well-recorded since Protohistory. Yet it is only in Roman times that the three species become particularly significant in many Mediterranean assemblages and dominant in the fruit spectra of the other Iberian regions. All are preserved in charred, mineralised or waterlogged conditions.

These species in charred Roman assemblages represent more than 85% of the cultivated fruits. Among the waterlogged samples, however, the percentages diminish in favour of other fruit species that are commonly preserved in these contexts (Rosaceae family). The current state of research, however, does not differentiate between the recordings of the three species at rural and urban sites. While *Olea* gains importance in areas of the South, *Vitis* increases in the North. *Vitis* and *Olea* in the Late Antiquity maintain their supremacy, while *Ficus* declines at least in the NE and the E. It represents only 8.7% of the total domesticated fruits at Lleida in the NE (Alonso, 2005) and 2.78% in the East at the rural sites of Tossal de les Basses and Horta Vella. There are also waterlogged samples dating to Late Antiquity in the NE. At La Foneria (Ravotto et al., 2014), for example, *Ficus* does not appear to decrease with respect to the previous period.

Vitis in charred medieval Christian contexts attains high percentages in many areas, while *Olea* is only recorded in the Centre. *Ficus*, in turn, is recorded in the NE and in the W. The Christian waterlogged site of Casa dos Bicos in Lisbon (Portugal) (Queiroz and Mateus, 2011) reveals that the percentages of the three species are still significant and that they dominate the assemblage. In Galicia, in turn, *Ficus* only is identified at the waterlogged site of Banco de España (Teira Brión, 2015) where it represents 25% of the total fruit species.

Figs, olives and grapes reach the highest values, nonetheless, in areas under Islamic domination. These species are the most significant across the whole area, except in the N and NW. Due to the presence of only one waterlogged site; most of the evidence comes from charred remains. *Vitis* is predominant in almost all regions except in rural sites in the C, in the S where *Olea* occupies the first position, and in rural sites in the E and NE where fig is dominant.

The recurrence of fig across the Peninsula is probably related to

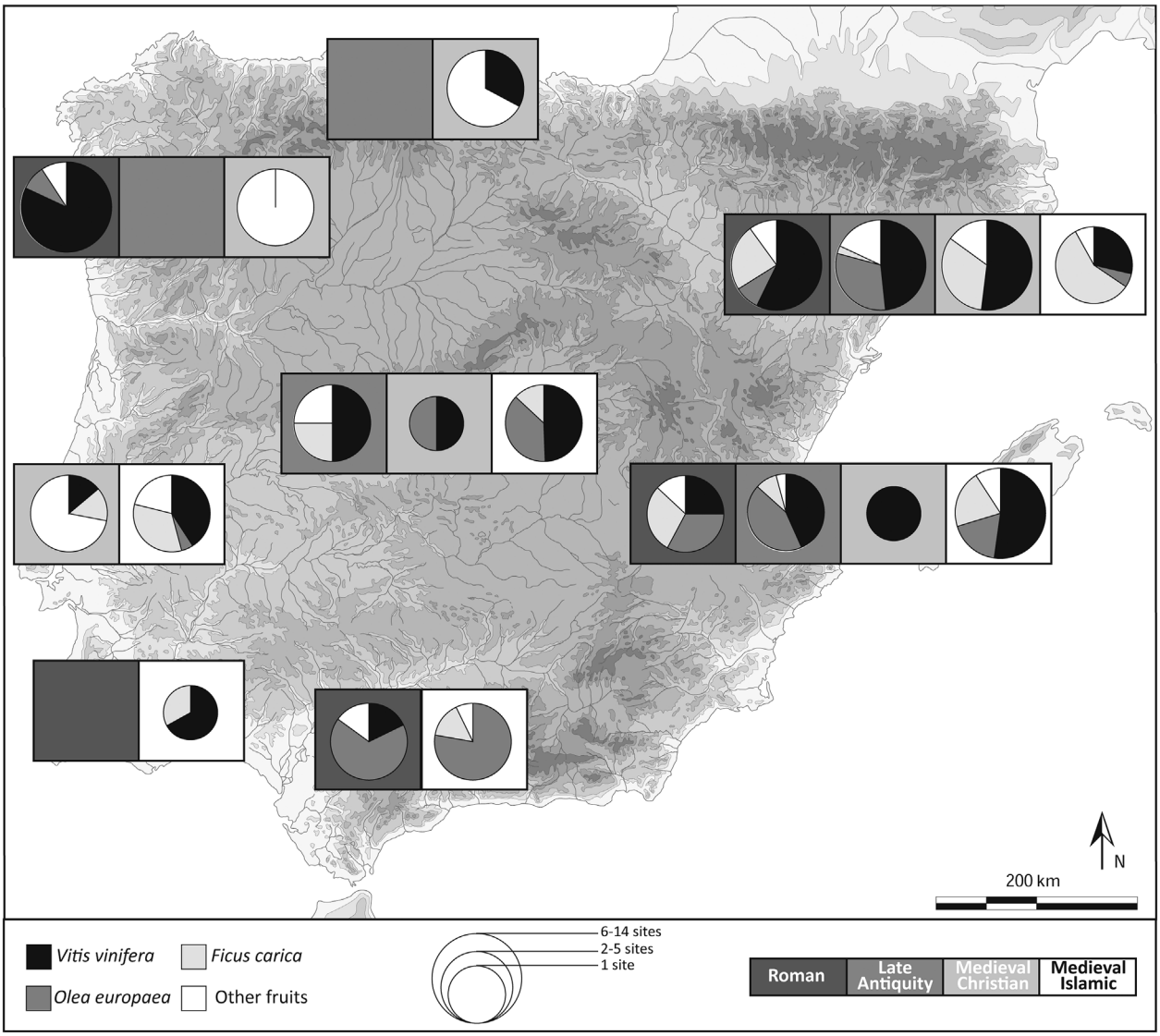

Fig. 4. Fig. 3 Map of the Iberian Peninsula illustrating the distribution in percentage of the different fruit species preserved by charring.

its versatility as it is consumed fresh during the summer and can be dried and stored for later consumption during the winter. Dried figs were traded in both Roman times and the Middle Ages. In fact, dried figs appear among the products traded from Valencia to Genoa and other Mediterranean ports at least from the 12th century (Ferrer, 2012). Olives and grapes were also extensively traded during Roman and medieval times either as a fruit or derivatives (oil, vinegar and wine).

The presence of *Vitis* is more remarkable at sites in the North, while findings of *Olea* are more common in the South. The presence of *Olea* and other Mediterranean species in the northern sites can in fact be explained by commercial exchange. This is clearly the case of the Roman port of Irun (Basque Country) (Peña-Chocarro and Zapata, 1996, 2005).

The situation of the olive is compelling. *Olea* in Andalusia from the Roman period onwards spread from the Thermo-to the Meso-Mediterranean zone as evidenced by charcoal data (Rodríguez-Ariza and Montes Moya, 2005). In Catalonia, during the Late Antique period, *Olea* spread further from the Thermo-Mediterranean zone toward the inland. This could indicate that varieties more adapted to colder climates were progressively being developed.

The Rosaceae family: apple (*Malus domestica*), apricot (*Prunus armeniaca*), sweet/sour cherry (*Prunus avium/cerasus*), plum (*Prunus domestica*), almond (*Prunus dulcis*) and peach (*Prunus persica*)

The Rosaceae family includes many species (Table 3) producing edible fruits highly appreciated by human communities of the ancient world. The archaeobotanical record from the Iberian Peninsula shows several members of this family appearing for the first time in archaeological contexts between the Iron Age and the Roman period. Almond (*Prunus dulcis*), for instance, is documented in Iron Age contexts (Pérez Jordà, 2013). The same is the case of sweet/sour cherry (*P. avium/cerasus*) in Catalonia and in the South at Puente Tablas (Montes Moya 2015). *Prunus* wood is recorded in the NW prior to the Roman period suggesting a possible use of a fruit in the form of wild species (Martín Seijo, 2013). Plum (*P. domestica*) and peach (*P. persica*) seem to appear only under Roman influence, while apricots (*P. armeniaca*) are recorded for the first time at a single site during the Middle Ages.

Waterlogged Roman contexts provide most of the data regarding Rosaceae. Sweet/sour cherries, almonds, plums and peach are widely observed at sites such as O Areal (Teira Brión,

2010) and the spa of Aqua Flaviae (Vaz et al., 2016) in the NW, in Irun (Peña-Chocarro and Zapata, 2005) in the N, and at the city of Iesso (Canal et al., 2004) in the NE. Evidence of these species, with the exception of almond, are also among the charred assemblages of this period although in modest numbers. Dry sites in Late Antiquity reveal remains of plums in the E at Horta Vella. Surprisingly, the waterlogged contexts of this period do not provide evidence of the Rosaceae family apart from *P. avium* in the NE and the N.

The Middle Ages witnessed an outburst of Rosaceae fruit species. Christian sites include sweet/sour cherry, almonds, plums and peach in both charred and waterlogged contexts. Islamic contexts are also rich in these species. In the W, *Prunus armeniaca* (apricot) is recorded for the first time in a charred context. The site of Castelo de Mértola (Pais, 1996) yielded an interesting assemblage of *Prunus* spp. which, besides apricot, included peach, sweet/sour cherry, plum and almond. Conversely, *P. domestica* is the only Rosaceae known in waterlogged contexts of this period.

4.7. Melon/cucumber (*Cucumis melo/sativus*)

This taxon is known in all three study periods. Although collected in the different forms of preservation (Table 3), it is most commonly found in waterlogged contexts. In charred assemblages, in fact, it is only known at Islamic sites. In the Roman period it is recorded in the NE at the urban sites of Iesso (Canal et al., 2004) and in the NW at O Areal (Teira Brión, 2010), while in Late Antiquity it is known in the NE at La Foneria (Ravotto et al., 2014). In the Middle Ages (*ca.* 11th and 12th centuries), *Cucumis* is recorded in the NW at the Christian site of Banco de España (Teira Brión, 2015). Mineralised *Cucumis* samples were collected a two Islamic sites in the NE: Lleida (Alonso, 2005) and Pla d'Almatà (Alonso et al., 2014). This species is also known in a waterlogged context at Rua dos Correeiros (Bugalhão and Queiroz, 2005).

4.8. Oil/fibre plants and condiments

Oil/fibre plant remains, albeit modest (Fig. 2), are identified in samples from all periods (Table 3). Flax (*Linum usitatissimum*) and a member of the mustard family, *Brassica* sp., are recorded in the Roman period. Flax is well known since prehistoric times for its fibres for textiles and for its seeds for oil. The evidence of oil/fibre plants from Late Antiquity is only available in waterlogged contexts, in particular at the site of La Tabacalera in the N in the form of flax capsules (Carrión Marco et al. 2015). Although this species is present in all periods, it is more frequent and distributed throughout a wider area in the Middle Ages.

Other oil plants include *Camelina sativa* (gold of pleasure) which is documented in the NE in both medieval Christian and Islamic sites. This species is widely spread across Europe since the 3rd-2nd millennia (Zohary et al., 2012). In the Iberian Peninsula remains are recorded since the Iron Age in the NE (Buxó, 1997) and E (Pérez Jordà, 2013). Other species that could have served as oil plants are certain members of the Brassica genus. *Brassica nigra* (black mustard), for instance, can be used either for its oil or as a spice as is the case of other members of its family. The archaeological record also provides evidence of *B. oleracea* which includes several cultivars such as cabbage, cauliflower, etc. that were probably garden crops in Greek and Roman times (Zohary et al., 2012).

4.9. Condiments and spices

Several different spices are identified (Table 3) apart from the black mustard (cited above). The Roman period yields rosemary (*Rosmarinus officinalis*), celery (*Apium graveolens*), mint (*Mentha* sp.) and vervain (*Verbena officinalis*). Vervain is a novel addition. The variety of spices and condiments increases in the Middle Ages. At Christian sites they include: coriander, celery, fennel (*Foeniculum vulgare*), lavender (*Lavanda* sp.), rosemary, mint, thyme (*Thymus* sp.). This group most likely reflects new ways of food preparation and a greater sophistication in meals. Finally, the same species are documented in Islamic contexts where the new addition appears to be *Nigella* sp.

4.10. Wild plants

Apart from crops, the different sites analysed in this study provide a corpus of wild plants (Fig. 2) serving mainly for food. In most cases they are fruits such as the strawberry tree (*Arbutus unedo*) and a variety of nuts such as hazelnut, acorns, chestnut, pine, as well as strawberry, sloe (*P. spinosa*), elder, etc (Table 3). Yet it still remains unclear if certain were cultivated or managed.

5. Conclusions

Agriculture during the circa 1500 years of Roman, Late Antique and medieval times is characterised fundamentally by a great diversity of species. The trend that emerges from the analysis of the archaeobotanical data points to a long continuum of plant use, punctuated by certain introductions and disappearances.

The data suggest the existence of a diverse agriculture dominated by naked wheats and hulled barley in more or less similar proportions at both rural and urban sites. Moreover, no major differences are observed in these cereals in the two types of sites. Hulled barley appears to be linked to regions with soils of poorer quality where this species thrives. Its abundance in the archaeological records also suggests use for human consumption, perhaps by the less favoured classes. Yet these notions require further research. Furthermore there is the question of the use of barley as fodder. Columella, for example, cites barley as cattle fodder in the *Book of Agriculture* (Col 6.3.). Yet, once again, the current state of research does not allow exploration of the issue.

Hulled wheats, particularly emmer and spelt, played an important role in the NW. Spelt gained in importance since its cultivation in the Iron Age. The successful adaptation and thriving of spelt in humid climates and marginal regions where other species could not develop is noteworthy in the Roman period.

The role of millets in the NW is also important. Rye, in turn, occupies a more limited sphere but will develop during the Middle Ages, in particular in the NW. The role of oats is less clear as in most cases the identifications are limited to the genus level. Most of the cereal crops were already cultivated in previous periods. The exception is rye which, although sporadically identified in earlier periods in certain areas, became widespread in Roman times. Neither rice, a medieval crop, nor sorghum, are yet found in the Iberian Peninsula although sorghum is known in south-western France, near Bordeaux (Pradat and Ruas, 2017), as well as in northern France and Morocco.

The variety of legumes is the same as in previous periods with differences of proportions from area to area. Broad beans and peas are only present in the NW probably as a result of environmental conditions. Certain legumes were cultivated for human consumption (broad bean, pea, lentil, chickpea, and grass pea), while others served for fodder (vetch, bitter vetch, red pea). Although literary sources (Columella, Book II) indicate the sowing of forage legumes for animals, at least in large villas, the evidence remains scant. Besides, remains of certain species such as lupin or members of the *Vicia* genus such as *V. articulata* or *V. narbonensis* are still missing in the Iberian Peninsula. Equally absent from the archaeobotanical record is *Lathyrus clymenum*.

Most of the novelties concern fruit crops. The Roman period

witnessed the flourishing of many fruit species, some of which were already present elsewhere in the Mediterranean since the Iron Age. The Roman period saw the introduction of fruit remains in other heretofore unknown regions such as the N and the NW. These include peach, plum, and vegetables such as *Cucumis sativus/melo*. *Morus nigra*, in turn, first appears in Late Antiquity and apricot is only recorded in the Middle Ages. This is proof of the development of arboriculture in the different regions after adopting and mastering grafting techniques. Produce from trees in rural home orchards were most probably intended for local household subsistence, whereas large scale production in vast estates was aimed at a wider market. This does not exclude that the fruits produced at small scale in rural areas were not also be marketed in smaller circuits.

The olive scattered beyond its climatic zone to the North beyond the Thermo-Mediterranean toward the Meso-Mediterranean zone during Late Antiquity.

The different trends mentioned above are the result of research based on incomplete corpus differing from region to region. The data are at times scarce in certain zones, and heterogeneous as far as recovery techniques are concerned. Moreover, although charring is the most common means of preservation, the data gleaaned from waterlogged samples increases the representation of fruits. *Morus nigra*, or *Cucumis melo/sativus* appear to have been introduced in the Roman period while apricot is first detected in the medieval period. The development of arboriculture across the Iberian Peninsula characterises the farming system of this wide region during the Roman and medieval periods. Moreover, many Mediterranean species spread from Iberia to northern areas through commercial exchanges, while others were introduced into Iberia from elsewhere. Evidence of the trade of perishable products such as fruits preserved in different ways are legion, demonstrating the possibilities of transporting fragile food.

The similarities and differences observed in the data respond to a series of intertwined factors that have shaped the way we view the agriculture of these periods. In the first place, it must be taken into account that there are still large areas devoid of data that require future investigation. This situation is a barrier to our understanding of the different developments characterising each area. Secondly, differences and similarities may be also related to cultural traditions that can explain the persistence of a certain crop in a particular area. Moreover, the presence/absence of specific taxa may relate to preservation as is the case of many of the condiments and spices that are identified only in waterlogged conditions.

Yet the limited data available for this study does not bolster the notion of profound changes in the agricultural activity during the Roman or the medieval periods. Continuity seems to better define the pattern that emerges from this research. The archaeobotanical data also does not reveal significant differences between Christian and Islamic regions. We are therefore unable to determine whether the Iberian Peninsula's integration into Muslim rule brought about the arrival of new crops and species, as well as a number of technological improvements, the so-called agricultural revolution that led to the intensification of agricultural production.

Despite these limitations, the surge of archaeobotanical research over the past 10 years yielding data from different regions and periods represents a significant step to a better understanding of the agricultural developments taking place between the Roman and medieval periods.

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