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The Origins of Millet Cultivation (*Panicum miliaceum* and *Setaria italica*) along Iberia's Mediterranean Area from the 13th to the 2nd Century BC

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Abstract: The introduction of the cultivation of millets (*Panicum miliaceum* and *Setaria italica*) along Iberia's Mediterranean zone appears to stem from different origins which themselves hinged on their own specific historical developments. The earliest traces in the northeast, presumably of trans-Pyrenean origin, were brought to light in Bronze Age contexts (13th century BC) in Western Catalonia, notably in the Cinca River Valley. The different species of millets from southern and eastern Iberia, by contrast, come from later 10th–8th century BC contexts under Phoenician influence. Their expansion can be linked to the cultivation of fruit trees (vineyards and others) throughout the 9th–7th centuries BC. The cultivation of millets into the intermediate geographical zone between these two areas is difficult to characterise as it is not possible to identify either a northern or southern in-fluence. In any case, different types of millet saw a wide expansion from the 7th century BC onwards, especially in settlements in the hinterland of the colony of Emporion. This study thus focuses on the history of the cultivation of millets along Iberia's Mediterranean zone from the Late Bronze Age to the Second Iron Age.

Keywords: archaeobotany; broomcorn millet; foxtail millet; Iberian Peninsula; Bronze Age; Iron Age

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1. Introduction

A series of articles focusing on the origin and spread of the cultivation millets (broomcorn millet, *Panicum miliaceum*, and foxtail millet, *Setaria italica*) based on archaeobotanical data have seen the light in recent years in Europe. These studies are either specifically centred on the subject of millet or form part of overviews of ancient crops [1–5]. The current state of research indicates that the cultivation of millets originated in eastern Asia in the 6th millennium BC and spread throughout Eurasia from the end of the 3rd millennium BC and become a key crop during the 2nd millennium BC [1,6].

Recent studies on the expansion of broomcorn millet throughout eastern and central Europe incorporating radiocarbon analyses suggests that the first cultivated specimens date to precisely in the middle of the 2nd millennium [3,7]. The study likewise reveals how the crop spread from east to west in just a few centuries. The oldest recorded cases are in Ukraine (1780-1450 cal BC) followed by the Carpathian Basin (1510-1410 cal BC) and northern Italy (1570-1410 cal BC). The crop subsequently spread rapidly throughout Central Europe (1490-1330 cal BC) before attaining the north of Germany (1230-1160 cal BC) [3]. Although cultivation of broomcorn millet in western Europe, specifically in central and northern France, is known at certain Early Bronze Age sites preceding 1650 BC, this crop, as well as foxtail millet [2,8] is only widely present since the Late Bronze Age (from 1350 BC). It must nonetheless be noted that the radiocarbon datings in this case were not directly carried out on millet seeds. The data from the British Isles, in turn, reveal that the introduction of broomcorn millet came later, at the outset of the 1st millennium (910-800 cal BC) [9].

The current article therefore intends to fill the gap of the question of the history of the cultivation of millets in the Western Mediterranean by offering both an overview of the archaeobotanical data regarding seeds and fruits from the Mediterranean area of the Iberian Peninsula (Figure 1) in combination with new radiocarbon datings. In fact, the history of the cultivation of millets throughout this vast expanse appears to have experienced different roots and to have followed differing dynamics depending on each region and their own historical evolution.

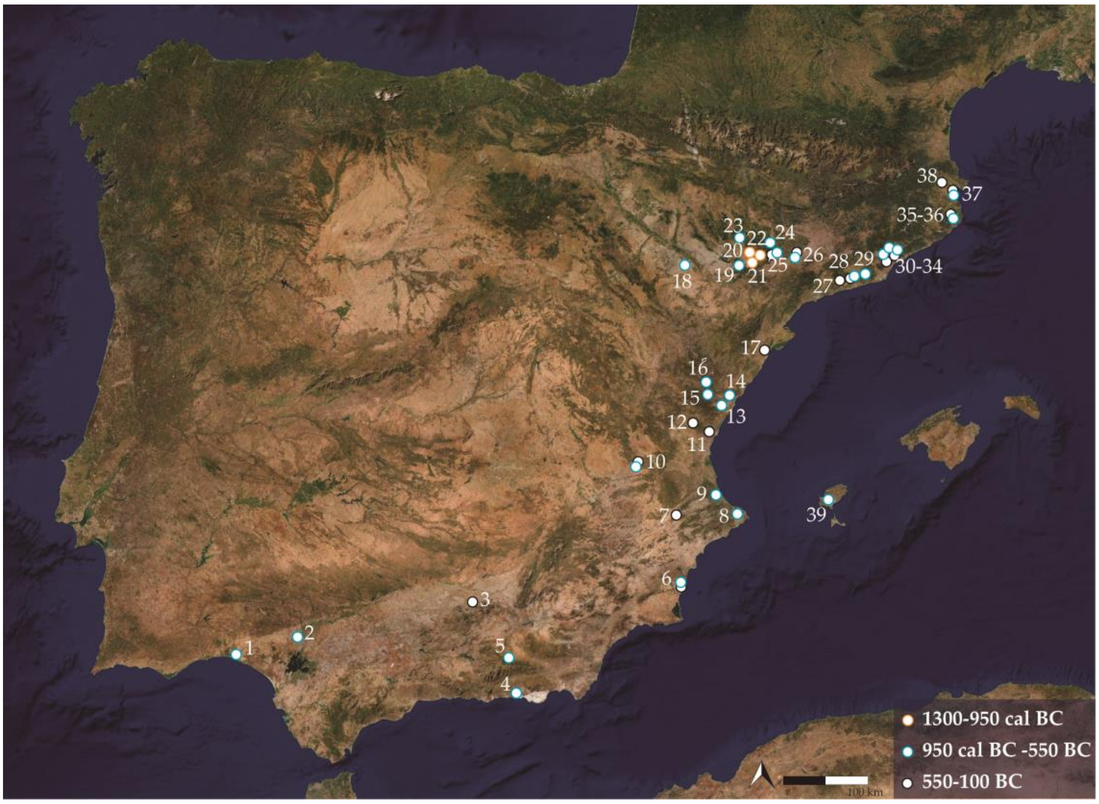

Figure 1. Map indicating the position of sites yielding broomcorn or foxtail millet: 1, Huelva (Huelva); 2, Jardín de Alà (Salteras, Sevilla); 3, Puente Tablas (Jaén); 4, Abdera (Adra, Almería); 5, Guadix (Granada); 6, Fonteta (Guardamar del Segura, Alacant); 7, La Bastida de les Alcusses (Moixent, Valencia); 8, Alt de Benimaquia (Denia, Alacant); 9, La Vital (Gandia, Valencia); 10, *Kelin* (Caudete de las Fuentes, Valencia); 11, Castellet de Bernabé (Llíria, Valencia); 12, Tos Pelat (Moncada, Valencia); 13, Vinarragell (Borriana, Castelló); 14, Torrelló el Boverot (Almassora, Castelló); 15, Monte Calvari (Montan, Castelló); 16, Los Morrones (Cortes de Arenoso, Castelló); 17, Puig de la Nau (Benicarló, Castelló); 18, Cabezo de la Cruz (La Muela, Zaragoza); 19, Tozal de los Regallos (Candasnos, Huesca); 20, Masada de Raton (Fraga, Huesca); 21, Cova de Punta Farisa (Fraga, Huesca); 22, Vincamet (Fraga, Huesca); 23, La Codera (Alcolea de Cinca, Huesca); 24, El Vilot (Alcarràs, Lleida); 25, Gebut (Soses, Lleida); 26, Els Vilars (Arbeca, Lleida); 27, El Pontarró (Tarragona); 28, Font de la Canya (Avinyonet del Penedès, Barcelona); 29, Bòbila Madurell (Sant Quirze del Vallès, Barcelona); 30, Olèrdola (Olèrdola, Barcelona); 31, Can Gambús 2 (Sabadell, Barcelona); 32, Ca n'Oliver (Cerdanyola del Vallès, Barcelona); 33, Can Xercavins (Cerdanyola del Vallès, Barcelona); 34, Sitges de la UAB (Cerdanyola del Vallès, Barcelona); 35, Illa d'en Reixac (Ullastret, Girona); 36, Puig de Sant Andreu (Ullastret, Girona); 37, Sant Martí d'Empúries (*Emporion*) (Sant Martí d'Empúries, Girona); 38, Mas Castellar (Pontós, Girona); 39, *Ebusus* (Ibiza).

2. Materials and Methods

This overview is based on published and unpublished work from 39 sites from between 1300 cal BC and 150 BC yielding broomcorn millet or foxtail millet remains extending from the Pyrenees to the south of the peninsula (Figure 1). The sites can be broken down into the three following periods: 1300 to 950 cal BC (Late Bronze Age), 950 cal BC to 550 BC (First Iron Age) and 550 to 150 BC (Second Iron Age) (Table 1). The last corresponds to the Second Iron Age, also known as the Iberian period. Certain are marked by occupations spanning the second and third periods. Most are open-air settlements with a variety of features and systems of urbanisation.

The current analysis took into account sites yielding at least one sample sieved with a 0.5 mm mesh containing the remains of *Panicum miliaceum* or *Setaria italica* (or both). The study nonetheless excluded isolated and undated data, and problematical finds. This is the case of the identifications at certain Bronze Age Argaric settlements of southeastern Iberia such as Fuente Álamo (Almería) [10] and Las Pilas [11] that appear to be too large to correspond to broomcorn or foxtail millets. Furthermore, the finds identified as *Panicum/Setaria* at Peñalosa (Jaén) [12] are now uncertain as neither of the two species are cited in recent unpublished analyses. The same applies to the isolated case identified Cerro de la Virgen (Granada) [13]. A similar problem occurs in southern Italy yielding potential millets (*Panicum* sp.) devoid of datings that might confirm their antiquity [14].

Table 1. Data related to the sites along the Mediterranean area of the Iberian Peninsula yielding remains of broomcorn and/or foxtail millet.

	Site	Samples	Total *N*	*Panicum miliaceum*		*Setaria italica*		Reference
				Number	Ubiquity	Number	Ubiquity	
1300–950 BC								
21	Cova de Punta Farisa	1	962	21	-	70	-	[15]
20	Masada de Raton	4	892	66	3	485	3	[16]
22	Vincamet II	12	1139	4	3	2	1	[17]
950-550 BC								
4	Abdera/C.Montecristo	3	29	4	2			G.P.-J. unpubl.
8	Alt de Benimaquia	24	14,917	2	1			[18]
29	Bòbila Madurell	32	326	16	1	23	1	[19]
18	Cabezo de la Cruz II-III	79	87,523	65,884	27			[20]
31	Can Gambús 2	13	658	1	1	10	3	[21]
39	Ebusus	6	60	4	3			[22]
54	El Vilot	20	4510	10	4	4	3	[23]
26	Els Vilars 0-I	86	495	1	1			[16] N.A. unpubl.
38	Font de la Canya	12	9501	112	8	104	8	[24]
6	Fonteta	52	2298	16	4	4	2	[25] G.P.-J.unpubl.
5	Guadix	10	354	16	4			[11]
1	Huelva	11	9020	1	1			[26]
34	Illa d'en Reixac I-II	1	80	6	1	76	1	[19]
2	Jardín de Alá	37	1116	1	1			G.P.-J. unpubl.
10	Kelin 1	53	236	5	4			[18]
23	La Codera	11	323	5	3	8	6	N.A. unpubl.
9	La Vital	7	94	1	1			[27]
16	Los Morrones	12	21,523			4	1	[28]
15	Monte Calvari	14	4206			15	2	G.P.-J. unpubl.
30	Olèrdola	2	24	2	1	1	1	[29]
37	St M. Empúries I-IIIc	17	11,783	787	15	479	13	[30] N.R.&R.B.unpubl.
34	Sitges UAB	21	495			4	4	[31]
14	Torrelló del Boverot	5	1613	58	2	1241	1	[32]
19	Tozal de los Regallos	5	115	2	1	1	1	[16]
13	Vinarragell	1	20,452	7	1	4	1	[33]

Table 1. *Cont.*

	Site	Samples	Total *N*	*Panicum miliaceum*		*Setaria italica*		Reference
				Number	Ubiquity	Number	Ubiquity	
550-150 BC								
32	Ca n'Oliver	48	1200	1	1	1	13	[34]
33	Can Xercavins	20	676	1	1	1	23	[34]
11	Castellet de Bernabé	15	14,581	16	1	1		[18]
27	El Pontarró	2	4			1	1	N.A. unpubl.
26	Els Vilars II-III	139	4106	10	6	110	11	[35] N.A. unpubl.
28	Font de la Canya	21	1772	5	3	34	5	[24]
25	Gebut	11	501	11	3	1	1	N.A.&M.T. unpubl.
35	Illa d'en Reixac III-V	36	544	15	7	34	10	[19]
10	Kelin 2-3	35	5085	559	9			[18]
7	Bastida Alcusses	35	52,391	3	3	1	1	[18]
38	Mas Castellar	126	88,516	2077	55	44972	86	[36] D.L. unpubl.
3	Puente Tablas	119	1518	1	1			[37]
17	Puig de la Nau	3	4	1	1			[38]
36	Puig de Sant Andreu	23	26,646	9	2	3496	12	[19]
37	St M. Empúries IIId	1	92	36	1	37	1	[30] N.R.&R.B.unpubl
12	Tos Pelat	57	1637	4	4	696	7	[18]

Thus the quantification of the finds for this study applies only to materials from sites yielding five samples or more following two parameters: number of remains and ubiquity of the two taxa.

3. Results

The seeds of both broomcorn millet and foxtail millet collected on the different sites do not follow any geographical or chronological pattern. Of the 44 'site-phases', 60% ($n = 26$) comprised the two species, 33% ($n = 14$) only broomcorn millet and 7% ($n = 3$) only foxtail millet (Figure 2). It is thus clear that they were introduced at the same time and that no preponderance of one or another can be established for any period or region.

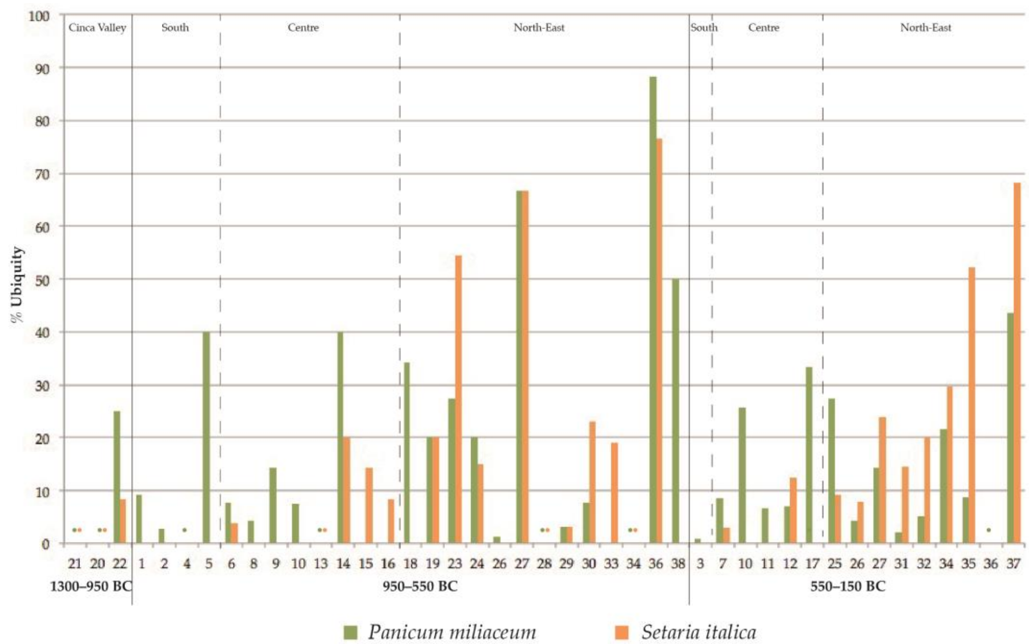

Figure 2. Graph illustrating the percentage of ubiquity ((*N* samples with taxon/*N* total samples) × 100) of broomcorn and foxtail millet from sites yielding more than five samples (those with lesser numbers are represented by a dot). The numbers correspond to the sites from Table 2.

Table 2. Radiocarbon datings of millet seeds and other materials directly related to some of the earliest recorded remains. Calibrated with CALIB Rev 8.2.

Site	Archaeological Reference	Material	Lab. Number	Radiocarbon Age	cal BC 2 sigma	Median Probability
Cova Punta Farisa	sample 1	foxtail millet seeds	Beta-585562	3000 ± 30 BP	1380-1125 cal BC	1240 cal BC
Vincamet II	SU 1138 SU 1251	animal bones human bone	Beta-193480 Beta-164905	2830 ± 80 BP 2810 ± 40 BP	1212-822 cal BC 1107-835 cal BC	1002 cal BC 964 cal BC
Masada de Raton	S2C13JN1b	broomcorn millet seeds	FTMC-HK14-2	2759 ± 28 BP	983-828 cal BC	897 cal BC
Huelva	sample 7	grape seeds	CNA-3773	2795 ± 30 BP	1041-837 cal BC	950 cal BC
Jardín de Alá	FA SU 5	grape seeds	Beta 485551	2790 ± 30 BP	1012-836 cal BC	943 cal BC

On the other hand, as noted in Table 1, most of the sites yielded a limited number of remains. The numbers of broomcorn millet do not exceed 50 remains among 83% of the sites while foxtail millet only exceeds this value in 34% of the cases. Certain sites also reveal great concentrations (more than 1000) of each taxon. However, assemblages of *Panicum miliaceum* assemblages were only brought to light at Cabezo de la Cruz (8th–7th century BC) in two of the three houses and in smaller numbers in several open spaces. These two concentrations, preserved by charring, correspond to 3384 remains from different groups unearthed in House 1 and a single large assemblage of 62,457 from House 6.

The remaining cases correspond to concentrations of *Setaria italica*. This is the case of the 1241 finds from stratigraphical unit 92 at Torrelló d'Almassora (7th–6th century BC), 3496 from Puig de Sant Andreu, and above all the lot from Mas Castellar de Pontós [36] which can be broken down into three concentrations. The first (21,537) associated with an oven (FR-19) consists for the most part of foxtail millet (3162) and a scant number of broomcorn millet (14). The second (16,444) was recovered in a pit (FS-6) related to cereal storage and domestic handling. It basically contained a combination of hulled barley (*Hordeum vulgare*) and foxtail millet. The third (7572 foxtail millets and 355 broomcorn millets) was collected in a waste heap (Ab-38). The three appear to be the outcome of random charring.

It must also be noted that when taking into account the sites benefitting from archaeobotanical analyses throughout the area, millets were only recovered at 12% from the 26 sites of the Late Bronze Age (1300-950 BC), 61% from the 38 of the First Iron Age (950-550 BC), and 40% of the 52 from the Iberian period (550-150 BC). This confirms, that the First Iron Age is the period when these crops saw their greatest surge and expansion, a notion advanced in other research [39,40].

Certain of the chronological ranges published here for the first time are direct datings carried out on the oldest millet specimens, notably those from Cova de Punta Farisa and Masada de Raton, while others were gleaned from analyses carried out on other types of materials (bone, other seeds) from the same contexts (Table 2). The oldest seeds are foxtail millets from the site of Cova de Punta Farisa with a mean of 1240 cal BC (1380-1125 cal BC). This assemblage is followed in time by the dating of phase 2 of the site of Vincamet at 974 cal BC (mean of the maximum probability intervals of the two dating listed in Table 2, 1056-892 cal BC). Each of these sites is located in the Lower Valley of the Cinca River in the northeast of the Iberian Peninsula. Masada de Raton, also in this geographical area, yielded broomcorn millets corresponding to a mean probability of 897 cal BC (983-828 cal BC). Although the assemblage of Masada de Raton is traditionally considered contemporary to those of Punta Farisa [16,39], the current findings reveal them to actually be more recent (Figure 3).

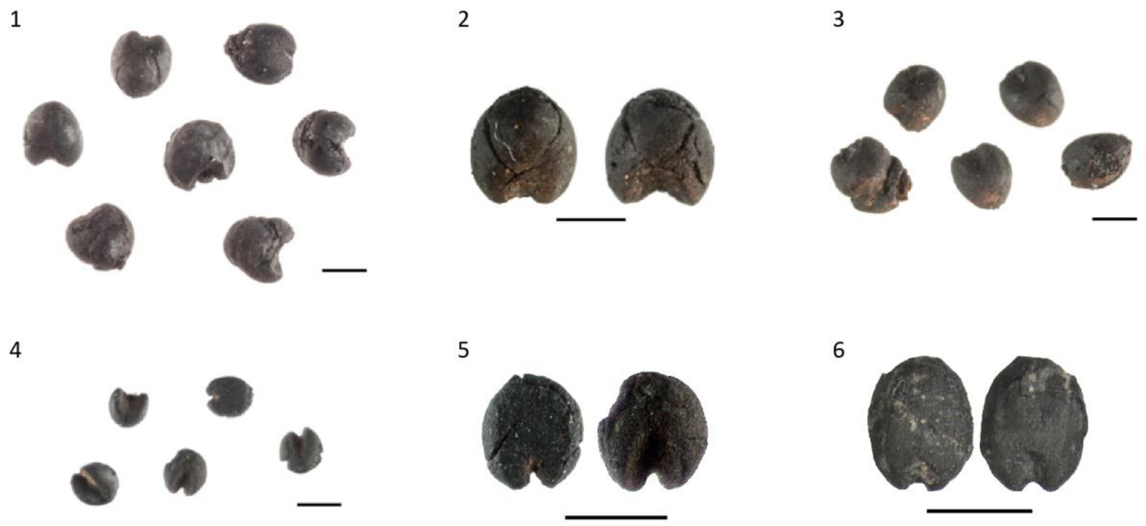

Figure 3. Millets from Cova de Punta Farisa: 1–2, *Panicum miliaceum*, 3, *Setaria italica*. Masada de Raton: 4–5, *Setaria italica*. Los Morrones: 6, *Setaria italica*.

On the other hand, in the south of the Iberian Peninsula, the first evidence of the presence of millets comes from two sites linked to the Phoenician influence in this territory: Huelva, 950 cal BC (1041-837 cal BC) and Jardín de Alá, 943 cal BC (1012-836 cal BC).

4. Did Millets Penetrate the Iberian Peninsula through Different Routes and in Different Timeframes?

The data presented above potentially suggest that the introduction of the cultivation of the two species followed two main avenues. The first is from the north and traversed the Pyrenees and the Cinca Valley as early as the 13th century BC, whereas the second, from the south and of Mediterranean origin, introduced the two millets along with other crops to settlements under Phoenician influence between the 10th and 9th centuries BC.

4.1. The Trans-Pyrenean Route Initiated in the 13th Century Cal BC

As noted, the earliest remains of the cultivation of millets are linked to Late Bronze Age contexts in the Cinca Valley in the northeast of the Iberian Peninsula. Millet finds specifically from settlements of the Segre-Cinca I-II Regional Group indicate that the origin of its cultivation in this area was presumably on the other side of the Pyrenees (Figure 4).

The data on millets in the south of France from the end of the 2nd millennium BC only concern the southeast of France as the few analyses from the southwest have yielded no traces of this crop [2]. In the Department of the Pyrénées-Orientales Department there is scant precise information prior to 1200 BC (Middle Bronze Age) regarding both broomcorn millet and foxtail millet [39]. Well-documented assemblages in Languedoc only appear in the Late Bronze IIb/IIIa (1200-900 BC) at the sites of Baume Layrou (Trèves, Gard) and La Fangade 2 (Sète, Hérault) [41]. Another millet assemblage was identified slightly farther north in the Rhône River Valley at the Cave of Fourches (Sault, Vaucluse) dating to between 1400 and 1200 BC [41].

The cultivation of broomcorn millet in Central Europe, as noted previously, began between 1490 and 1330 cal BC. In northern Italy, in turn, datings from three sites (Custoza, Santa Giulia and Lavagnone) point to an earlier timeframe between 1780-1450 cal BC [3]. In spite of scarce data, it appears that millet was not introduced into the northwestern Mediterranean arc from northern Italy, but rather along a southward route from Central Europe through the Rhône Valley. This notion is supported by finds of millets from sites in the Rhone Upper Valley such as Grotte du Gardon (Ambérie-en-Bugey, Ain) and Périphérique Nord (Lyon, Rhône) dating to the Late Bronze Age I/IIa, a period corresponding chronologically to 1400-1200 BC [41].

Figure 4. Schema illustrating the different routes serving to introduce millets cultivation by chronological phase.

Hence the finds from Valle del Cinca from this chronological standpoint are consistent with the spread of these crops across Europe along an east-west axis. It is thus necessary at this point to wait for new archaeobotanical data from northern Italy, southern France and the Pyrenees to attain a clearer view of route of penetration of the different millets.

Broomcorn millet is recorded at a later period in the south of the Ebro Valley at the site of Cabezo de la Cruz in levels from the second half of the 9th century (831 cal BC) [20]. Here it corresponds to 40% of the samples and persists into later 8th–7th century BC phases (Table 1, Figure 2).

Another example of an early presence of different millets is in the coastal area of northeastern Catalonia along to the current border with France where both broomcorn millet and foxtail millet are recorded at Sant Martí d'Empúries (Table 1) in a phase ranging from 850 to 800 BC (final stage of the Late Bronze Age IIIa) [30]. It is likely that its introduction into this area came directly from the southern France as there is evidence that Sant Martí d'Empúries maintained continuous contacts with the north throughout Protohistory (Figure 4). The north-south flow through the Pyrenees surely persisted both through the eastern extremity of this region as well as through the Segre and Cinca Valleys.

It is noteworthy that certain lines of research on the cultivation of millets have sprung up in recent years founded mainly on the detection of C4 plant signals among stable isotope analyses of human remains, as well as in human teeth and on the surfaces of querns [42–45] Panicoideae phytoliths are confirmed for 6th millennium cal BC levels at sites in the south of France [46] and North Africa [47]. However, the absence of millets in their archaeobotanical records suggests that the phytoliths could actually correspond to wild plants (*Setaria*, *Digitaria*, *Echinocloa*) that grew naturally in these environments in that timeframe.

The same scenario emerges from the study of starches, for example, on the island of Formentera from levels dating to the middle of the 2nd millennium BC [48]. There is in fact no archaeobotanical evidence of the cultivation of millet on these islands until the first half of the 1st millennium BC [22]. The results of isotope studies of human remains from

La Vital (Valencia) are interpreted as indicating the consumption of C4 plants in the 3rd millennium cal BC, potentially an intake linked to millet cultivation [49]. This nonetheless remains unconfirmed by the current archaeobotanical record [18].

A recent study of finds from the Cave of El Espinoso and from the Cave of Los Canes (Asturias) also bolsters the idea of an introduction of the cultivation of millets into the north of the Iberia between 1235 and 1099 cal BC. This is based on evidence of biomolecular C4 plants in isotopic analyses and the identification of polyhedral starch grains on human teeth [50,51].

There is thus a discrepancy between the archaeobotanical record and certain proposals based on analyses of various elements such as phytoliths, isotopes or starches that could lead to rewriting the history of the domestication and expansion processes of these plants. Although the potential of these analyses cannot be denied, it is necessary to carefully assess the degree of identification yielded by each of these lines of research. In this sense, the study of the seeds, which offers the possibility of identification at the species level as well as direct dating, does not support, at least for the moment, the notion of the introduction of millets into the Western Mediterranean in such early timeframes.

4.2. The Southern Phoenician Route Initiated in the 10th Century Cal BC

The expansion and consolidation of millets, initially into the south and later into the east of the Iberian Peninsula, appears to be closely linked to Phoenician colonization (Figure 4). These Eastern Mediterranean communities presumably introduced a series of agrarian innovations throughout all the areas they settled and simultaneously favoured the expansion of these new initiatives among the local communities under their influence.

However, the archaeobotanical record directly from Phoenician contexts is generally very scarce which could possibly explain the absence of traces of millets at sites in the Orient [52,53] in spite of citings of these crops in biblical texts [54,55]. A similar situation occurs at the settlements sampled in Tunisia. Millets are in fact only recorded in 10th–9th cal BC contexts at the Numidian site of Althiburos [56], a settlement in the interior of the country far from the coast. Nor is there currently any evidence of these crops from the few sampled Phoenician settlements in either Sicily or Sardinia. In the Western Mediterranean it is only identified at sites in the Iberian Peninsula and the Island of Ibiza. It must be noted that this is undoubtedly linked to the degree of sampling.

There is nonetheless evidence that the earliest evidence of millets in the south of the Iberian Peninsula (10th–9th c. BC) are contemporary to the introduction of different fruit trees, notably vine (*Vitis vinifera*), olive (*Olea europea*), fig (*Ficus carica*), pomegranate (*Punica granatum*) and almond (*Prunus dulcis*). New crops such as melon/cucumber (*Cucumis melo*) and chickpea (*Cicer arietinum*) likewise appeared at this time [26,57]. Furthermore, sites linked to either the colonial world such as Huelva, or to the indigenous world such as the coastal settlement of Jardín de Alá, or even the inland settlement of Guadix [11], could serve as examples of the expansion of the cultivation of millets during the outset of the 1st millennium cal BC throughout an extensive area of Andalusia.

These new crops also began to spread throughout the east of the Iberian Peninsula and to islands such as Ibiza from the 8th century BC. However there is not always proof of the association of millets with fruit trees or with other novelties such as chickpeas. Both crop associations are recorded at colonial settlements such as Fonteta [25] and *Ebusus* [22], as well as in nearby indigenous settlements such as Alt de Benimaquia and La Vital. Millets in these cases appear to be generally associated with a wide range of fruit trees: pomegranate, vine, olive, apple/pear (*Prunus malus*/*Pyrus domesticus*). However, as the distance of sites from the colonial settlements increases towards the interior and the north, the proportion of millets persists while the number of fruit trees decreases or even disappears.

For example, the only evidence of fruit cultivation associated with broomcorn millet at Kelin, a settlement located 80 km inland, is that of fig and vine that appear in levels from the 7th–6th century BC. Similarly, and farther northward, there are sites along the coastline (Vinarragell) or slightly inland (Monte Calvario, Torrelló del Boverot) with traces of millets together with a reduced set of cultivated fruits such as vine and fig. Sites farther inland

(Los Morrones), in turn, also bear evidence of millets but not fruit trees. This situation resembles that to the north of the Ebro River where certain coastal sites such as Font de la Canya and Olérdola offer traces of the cultivation of millets, vine and fig. Yet what is more common for this area is that the settlements reveal no signs of either millets and fruits.

This situation appears to bolster the notion of a double process regarding the spread of these two groups of crops. The dynamics in the south of Iberia appear to be clear as fruit trees and millets spread towards the north subsequent to the founding of the different Phoenician colonies. It is nonetheless certain that the variety of fruit trees adopted by local communities decreased during this advance. The data from the Ebro Valley, by contrast, suggest an expansion of the cultivation of millets towards the south (Figure 4). The surroundings of the Ebro Valley and the northern interior of the Valencian region saw the intersection of each current. Here certain communities only adopted the cultivation of millets while others took on both crops.

It is difficult to define with certainty the source of the influences in each case. These potentially stem from the convergence taking place here between different communities and agents generating highly dynamic circumstances. One cannot ignore that other innovations linked to the colonial world, notably wheel thrown pottery, were not necessarily adopted in an identical manner by the different groups. Communities in zones such as the interior of the Ebro Valley adopted agricultural innovations along the lines of those cited above but did not change their way of producing pottery. However the opposite can be said of the coastal communities to the east and south of Iberia. Somehow the different groups embraced the innovations that were of interest to them while simultaneously rejecting others.

It is likewise difficult to determine the origin of the cultivation of the different millets in the central area of the Catalan coast as they could derive from either a southern Phoenician influence or from a northern current (Figure 4).

4.3. The Evolution of the Cultivation of Millets during the Iberian Period (550-150 BC)

The interpretation of the evolution of millet cultivation in the timeframe subsequent to 550 BC is highly conditioned by a very uneven archaeobotanical record throughout the different territories. The presence of millets in the south is quite scarce, while in the east only broomcorn is linked to sites surrounded by humid lands and good quality soils [18]. Here in any case it represents a minority when compared to cereals clearly dominated by hulled barley and naked wheats (*Triticum aestivum/durum*).

Northeastern Iberia offers the most substantial record from a series of settlements where millets play a more prominent role, albeit always secondary to barley and wheat. Certain of these sites such as Can Xercavins and Ca n'Olivé are found along the central coast while others such as Gebut or Els Vilars are in the interior. However, the highest values of millets are systematically in northeastern Catalonia, specifically in the region of Empordà (Figure 5). Most are in the vicinity of the Greek colony of *Emporion*, in a sector characterised by high quality agricultural soils.

As noted above, the eastern and southern Iberian coastline saw the cultivation of a greater diversity of fruit trees whereas the areas to the north of the Ebro River were dominated almost exclusively by the cultivation of vine and fig. This lower diversity coincides at the same time with lower proportions of fruit trees and an agriculture focused or specialised in cereal production [40]. Another sign bolstering cereal specialisation is this territory is the vast number of silos [58,59].

The significance of the production of millets must thus be assessed in the framework of a specialization of cereals clearly oriented for commerce taking place fundamentally in the surroundings of the Greek colony of *Emporion*. The fact that millets are crops cultivated in spring, as opposed wheat and barley that are usually grown in winter, expanded the potential of exploiting a territory rich in soils suitable for cereals. These are therefore possibly the different factors that conditioned and rendered possible the cultivation of millets. On the one hand, there is no evidence as to external factors such as a demand for these crops by the commercial network stretching throughout the Mediterranean at the time. On the other hand, one must also consider its capacity to intensify production enabling new cycles of crop rotation, a factor that would favour the yields of the 'major' cereals. Finally, and to a lesser extent, millets offer a more advantageous use of storage in silos as they fill more efficiently the spaces between the grains [60,61]. These different factors thus could have facilitated wagering on a type of agrarian system in a territory that met the characteristics of soils and climate suitable for the production of millets.

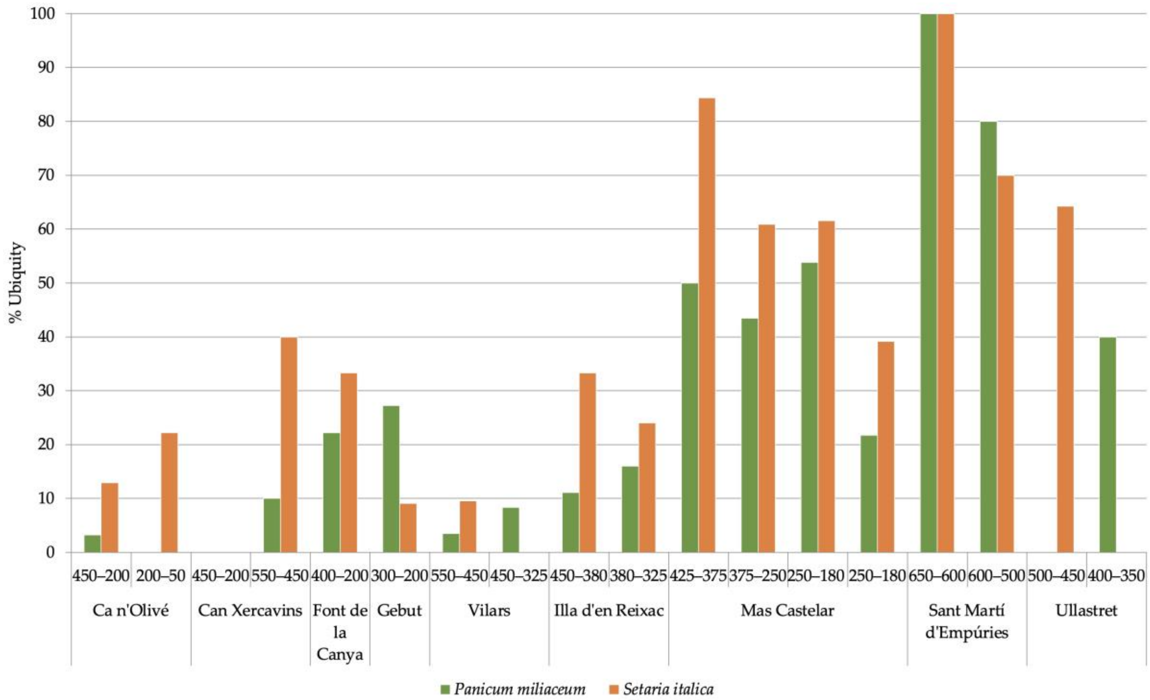

Figure 5. Comparison of the percentage of ubiquity of broomcorn millet and foxtail millet in settlements of the northeast of the Iberian Peninsula during the Iron Age.

5. Conclusions

The data as to seeds and fruits garnered by archaeobotany regarding the origin and expansion of broomcorn millet (*Panicum miliaceum*) and foxtail millet (*Setaria italica*) along the Mediterranean coast of the Iberian Peninsula clearly point to two avenues of introduction. The first and oldest, dating approximately to 1250 cal BC, saw the spread of these crops from Europe through the Pyrenees to the Lower Valley of the Cinca River and subsequently to other settlements in the Ebro Valley. This first phase of the introduction of millets requires nonetheless further research focusing, for example, on the direct dating of the ancient specimens collected from settlements in the Pyrénées-Orientales Department of France. This approach should shed light not only on additional aspects as to the routes of its introduction, but on the recurrent problematic finds of millets dating to the 2nd millennium BC in settlements of southeastern Iberia.

The second avenue of the introduction of millets dating to the 10th century cal BC onwards initially departs from the south before later spreading to the east of the Iberian Peninsula. It is linked to the Phoenician presence and the introduction of other agrarian innovations such as fruit tree (vines and others) cultivation during the 9th–7th century BC. There remains nonetheless an intermediate geographical zone between these two currents of arrival where it is difficult to determine whether the cultivation of millets resulted from a northern or southern influence.

The cultivation of millets throughout this area widely expanded from the 7th century BC onwards, specifically in areas where growing wheat or hulled barley was clearly intended for the Mediterranean commercial network, as is the case of the settlements located in the hinterland of the colony of *Emporion*. Millets in this framework could have ended up serving as a complement to the main cereals, favouring an intensification of cereal production based on new forms of crop rotation.

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