

CHASING THE TRACES OF DIFFUSION OF AGRICULTURE DURING THE EARLY NEOLITHIC IN THE WESTERN MEDITERRANEAN COAST

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Abstract: The knowledge on the diffusion of agriculture during the Early Neolithic in the Western Mediterranean is still sparse. This paper reviews the available information and presents some recent results that bring out the potential of archaeobotanical materials on this topic. Crop exchange and diffusion in the western Mediterranean basin is observed but differences between the so-called Impressed ware and the Cardial ware cultures are still difficult to state. Possible exchanges between the LBK-II and Cardial ware cultures are evaluated. Agricultural practices are still hard to compare on a site-to-site basis but some regional patterns are presented.

Keywords: prehistoric agriculture, process of neolithisation, diffusion of agriculture, archaeobotany, Western Mediterranean.

Resumen: El conocimiento del proceso de difusión de la agricultura en el neolítico antiguo del Mediterráneo occidental es todavía escaso. En este trabajo se revisa la información disponible y se presentan los nuevos resultados que muestran el potencial del material arqueobotánico en este tema. El intercambio de cultivos y su difusión en el oeste del Mediterráneo es constatado pero las diferencias entre las llamadas cultura Impresa y la cultura Cardial son todavía difíciles de demostrar. Posibles intercambios entre el LBK-II y la cultura cardial son evaluados. Las prácticas agrícolas todavía son difíciles de comparar de un sitio a otro pero algunos patrones regionales son presentados.

Palabras clave: agricultura prehistórica, proceso de neolitización, difusión de la agricultura, arqueobotánica, Mediterráneo occidental.

Introduction

The western Mediterranean is a well-defined territory between the western Italian coast, the eastern coast of the Iberian Peninsula and the northern coast of Morocco, Algeria and Tunis. The diffusion of agriculture in this area was a very complex phenomenon. The first arrival of agriculture seems to be dated back to 6000 cal BC in the Italian coast, linked to the Impressed ware Culture, but further changes are detected in later periods c. 5400 cal BC, with the formation of the Cardial ware Culture (see, for instance, Guilaine and Manen 2007; García-Atiénzar 2010). In order to observe the impact of these dynamics in the diffusion of agriculture in the region, our concern for this paper will be limited to the archaeobotanical studies from those sites dating to the VIth millennium cal BC and located at around 100 km from the actual coastline.

In the last decade, the state of research in archaeobotany of the Early Neolithic of the Western Mediterranean has evolved at different rhythms in the different regions.

For instance, some areas lack of new systematic (published) investigations, such as the Gulf of Lyon, southern Italy or northern Africa. On the other hand, some new and representative data from other zones have recently appeared.

In the following lines we will present a short synthesis of the available data on this subject, with a particular focus on archaeobotanical analyses, with the aim of putting forward some general trends, proposing future topics of research and encouraging the continuity and improvement of sampling strategies at the sites.

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The available archaeobotanical data on cultivated plants

We will present the results per region. The location of the sites is shown in fig. 1 and a synthesis of all the sites and main cultivars can be found in fig. 2. The quality of the data is described in fig. 2 as “low”, “good” or “very good”. “Good” quality has been stated after considering several criteria. First of all, the materials must be fully quantified; secondly, there must be more than 400 identified items (or somewhat lower numbers but obtained through a systematic sampling strategy); thirdly, the archaeological context must be clearly stated. In order to consider the results of a site as “very good” several independent contexts must have been sampled, being most of them of “good” representativity.

The southern coast of the western Italian Peninsula and Sicily

Two sites are known for this period. One is Grotta dell’Uzzo and the other one is La Marmotta. Grotta dell’Uzzo (Sicily) is occupied in several moments during the VIth millennium. Glume wheats (*Triticum dicocum* and *T. monococcum*), as well as barley (*Hordeum vulgare*) and lentil (*Lens culinaris*), are encountered in the first Neolithic occupation (c. 6000 cal BC). Free-threshing wheats, pea (*Pisum sativum*), broad bean (*Vicia faba*) and bitter vetch (*V. ervilia*) do not appear until the second occupation (c. 5500 cal BC) (Constantini 1991). La Marmotta (Lazio province), on the other hand, was occupied during a short period around 5400 cal BC (Kromer 2009). Emmer (*T. dicocum*) is

the dominant taxon (Rottoli 1993), while presence of einkorn (*T. monococcum*), tetraploid naked wheat (*Triticum durum/turgidum* type) and two-rowed hulled barley (*Hordeum distichum*) is also documented. Lentil, pea, grass pea, vetches and opium poppy (*Papaver somniferum*) have also been identified in the site (Rottoli and Castiglioni 2009).

Ligurian coast

Arene Candide is the only site for which we have available archaeobotanical data. The results are very scarce (65 remains) but several taxa have been identified: naked wheat, emmer, einkorn, barley and lentil (Rottoli and Castiglioni 2009)

Gulf of Lyon

The accessible data for the Early Neolithic in the Gulf of Lyon are meagre. For many of the recent studies we only have information on the presence of cereal taxa and most of the studies that were carried out in the last century are unrepresentative or incompletely published. At least nine sites have been studied in the coast of the gulf. Naked wheat is the commonest taxon, followed by emmer, naked barley (*Hordeum vulgare* var. *nudum*) and einkorn. The authors consider that two distinct phases can be differentiated: glume wheats are dominant in the Impressed ware culture while naked cereals seem to take up the main role during the Cardial ware culture (Gassin *et al.* 2010).

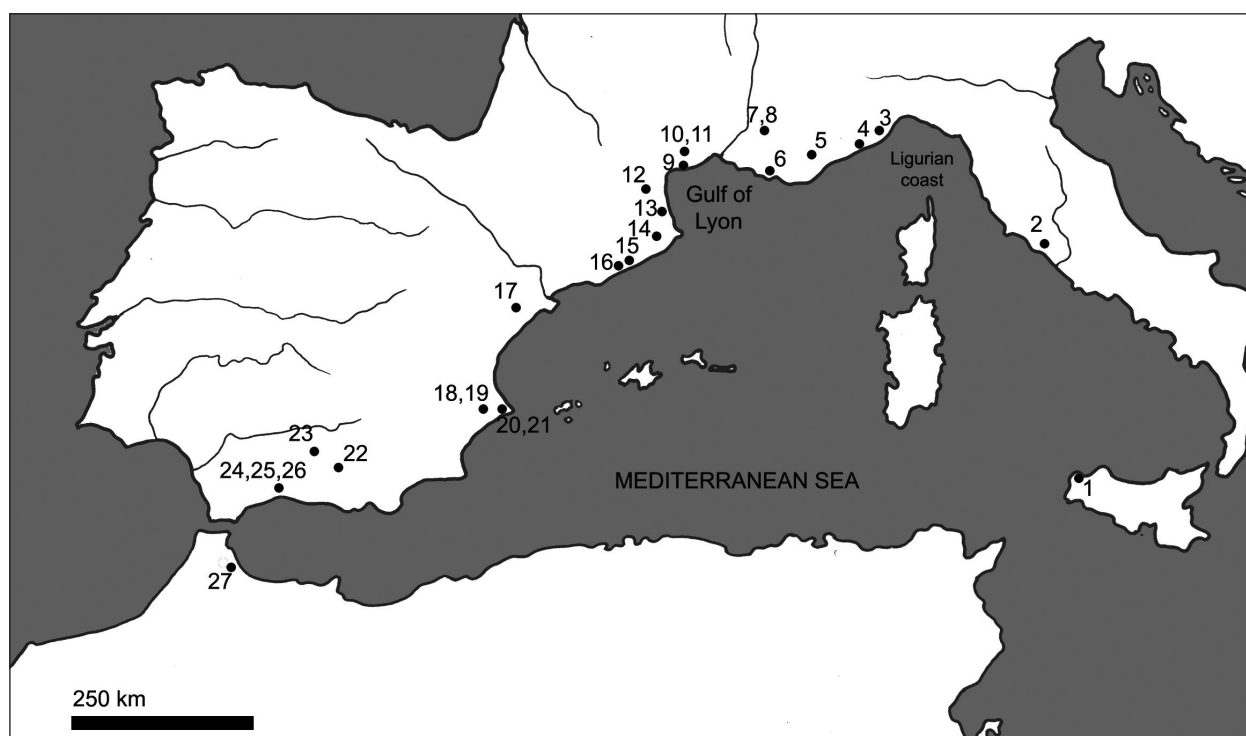


FIGURE 1. Location of the sites that are commented on the text.

Area	Site	Type	Representativity	Period	<i>Triticum</i> "nudum"	<i>Triticum</i> <i>dicoccum</i>	<i>Triticum</i> <i>monococcum</i>	<i>Hordeum</i> <i>vulgare</i> s.l.	<i>Pisum</i> <i>sativum</i>	<i>Lens</i> <i>culinaris</i>	<i>Vicia faba</i>	<i>Lathyrus</i> sp.	<i>Papaver</i> <i>somniferum</i>	Reference
SIItS	Grotta dell'Uzzo	Cave	Low	VIIIth mil		X	X	X		X		X		Constantini 1991
				2nd 1/2 VIth mil	X	X	X	X	X	X	X	X	X	
SIItS	La Marmotta	Open-air	Low	2nd 1/2 VIth mil	X	X	X	X	X	X		X	X	Rottoli 1993; Rottoli and Pessina 2007
Lig	Arene Candide	Cave	Low	VIth mil	X	X	X	X		X				Rottoli/Castiglioni 2009
GLy	Pendimoun	Rock shelter	Low	1st 1/2 VIth mil	<i>Triticum</i> sp.			X	X					Binder et al. 1993; Gassin et al. 2008
				2nd 1/2 VIth mil	X	X	X	X						
GLy	Fonbregoua	Cave	Low	2nd 1/2 VIth mil	X	X		X						Gassin et al. 2008
GLy	Peiro Signado	Open-air	?	1st 1/2 VIth mil	X	X	X							Gassin et al. 2008
GLy	Pont de Roque Haute	Open-air	?	1st 1/2 VIth mil	X	X	X							Gassin et al. 2008
GLy	Grotte de l'Aigle	Rock shelter	?	2nd 1/2 VIth mil	X	X	X		NO DATA AVAILABLE					Gassin et al. 2008
GLy	Baume d'Oullins	Rock shelter	?	2nd 1/2 VIth mil	X	X	X	X						Gassin et al. 2008
GLy	Cova de l'Esperit	Cave	?	2nd 1/2 VIth mil	X									Gassin et al. 2008
GLy	La Resclauza	?	?	2nd 1/2 VIth mil	X		X							Gassin et al. 2008
GLy	Font aux Pigeons	Rock shelter	?	2nd 1/2 VIth mil	X		X							Gassin et al. 2008
NIp	Can Sadurní	Cave	Good	2nd 1/2 VIth mil	X	X	X	X				X		Antolín and Buxó 2011
NIp	Sant Pau del Camp	Open-air	Low	2nd 1/2 VIth mil	X	X		X	X		X			Buxó and Canal 2008
NIp	La Draga	Open-air	Very good	2nd 1/2 VIth mil	X	X	X	X	X		X		X	Antolín and Buxó in press
SIp	Mas Cremat	Rock shelter	Low	2nd 1/2 VIth mil	X			X						Pérez-Jordà 2010
SIp	Mas d'Is	Open-air	Low	1st 1/2 VIth mil	X		X	X						Pérez-Jordà 2005
SIp	Falguera	Cave	Low	2nd 1/2 VIth mil	X	X	X	X		X				Pérez-Jordà 2006
SIp	Cova de les Cendres	Cave	Low	2nd 1/2 VIth mil	X	X	X	X	X	X	X			Buxó 1997
SIp	Cova de l'Or	Cave	Good	2nd 1/2 VIth mil	X	X	X	X						Hopf 1966
SIp	Los Castillejos	Open-air	Very good	2nd 1/2 VIth mil	X		X	X	X		X			Rovira 2007
SIp	Los Murciélagos	Cave	Low	2nd 1/2 VIth mil	X	X		X					X	Peña-Chocarro and Zapata 2011
SIp	Roca Chica	Rock shelter	On-going study	VIth mil?	X	X		X						Peña-Chocarro and Zapata 2011
SIp	Cueva del Hostal Guadalupe	Cave	Low	VIth mil?	<i>Triticum</i> sp.			X						Peña-Chocarro and Zapata 2011
SIp	Cueva de Bajondillo	Cave	Low	VIth mil?	X									Peña-Chocarro and Zapata 2011
NAf	Kaf Taht el-Ghar	Cave	Low	2nd 1/2 VIth mil	X	X		X			X	X		Ballouche and Marinval 2008

FIGURE 2. Synthesis of the cultivars that have been detected in the sites that are commented on the text. By *Triticum nudum* we understand any free-threshing wheat (e.g. *T. aestivum*, *T. compactum*, *T. durum*, *T. turgidum*). By *Hordeum vulgare* s.l. we understand any type of domesticated barley (*Hordeum vulgare* var. *vulgare*, *H. v. var nudum*). By *Papaver somniferum* we understand both subspecies, both the cultivated and the wild ones. Abbreviations for the different areas: SIItS (Southern Italy and Sicily), Lig (Ligurian coast), GLy (Gulf of Lyon), NIp (Northern coast of the Iberian Peninsula), SIp (Southern coast of the Iberian Peninsula), NAF (Northern Africa). Code for sites: Grotta dell'Uzzo (1), La Marmotta (2), Arene Candide (3), Abri Pendimoun (4), Baume de Fontbréoua (5), Font aux Pigeons (6), Grotte de l'Aigle (7), Baume d'Oullins (8), Peiro Signado (9), Pont de Roque Haute (10), La Resclauza (11), Grotte Gazel (12), Cova de l'Esperit (13), La Draga (14), Caserna de Sant Pau (15), Cova de Can Sadurní (16), Cingle del Mas Cremat (17), Mas d'Is (18), La Falguera (19), Cova de les Cendres (20), Cova de l'Or (21), Los Castillejos (22), Los Murciélagos (23), Roca Chica (24), Cueva del Hostal Guadalupe (25), Cueva de Bajondillo (26), Kaf That el-Ghar (27).

The northern coast of the eastern Iberian Peninsula

Three sites have been considered for this region. Two of them, La Draga and Can Sadurní cave, have yielded some of the best archaeobotanical materials of the area under study. Sant Pau del Camp did not allow obtaining representative results, although several taxa were identified. Naked wheat, emmer and hulled barley are present in all the sites, while einkorn is only documented in Can Sadurní and la Draga. Durum wheat is, by far, the main taxon in La Draga (Antolín and Buxó in press), while emmer is the best represented taxon in Can Sadurní (Antolín and Buxó 2011), where naked wheat also has a very important presence. Naked barley seems to be a minor cereal in this area. A few remains of pea and broad bean were identified in la Draga and in Sant Pau del Camp. Opium poppy has been recently identified in la Draga (Antolín and Buxó in press) and for the moment we cannot rule out the possibility that it was cultivated. The assemblage in Can Sadurní has a special interest because it was part of a funerary offering (see below).

The southern coast of the eastern Iberian Peninsula

This area is a large territory that goes from the Ebro delta to the strait of Gibraltar. Ten sites at a short distance from the coast have yielded positive results on cultivated plant remains. Only Cova de l'Or and Los Castillejos gave a suf-

ficient number of items to consider them as representative. The materials from Cova de l'Or belonged to two concentrations of charred grain associated with typical Cardial pottery vessels (Hopf 1966). Naked wheat, emmer, einkorn and hulled barley were identified. Los Castillejos had several episodes or occupations during the VIth millennium, showing all of them a clear spatial organization of the site. Naked wheat, einkorn, naked barley, pea, broad bean and opium poppy were recognized (Rovira 2007). Naked wheat and barley were identified in most of the sites, while emmer is only present in Cova de les Cendres (Buxó 1997), la Falguera (Pérez-Jordà 2006), cueva de Los Murciélagos (Hopf and Muñoz 1974) and Roca Chica (Peña-Chocarro and Zapata 2011); and einkorn in Cova de les Cendres, Mas d'Is (Pérez-Jordà 2005) and la Falguera. Pea, lentil and broad bean were identified in Cova de les Cendres. Lentil was also identified in la Falguera.

Northern Africa

Some materials have been recently analyzed in Northern Africa, more specifically in the site of Kaf That el-Ghar (Tetouan). Among the few analyzed remains it has been possible to identify emmer as the best represented taxon, but also naked wheat, naked barley, probably broad bean and grass pea (*Lathyrus sp.*) (Ballouche and Marinval 2003). New significant data are being obtained from current excavations in Ifri Oudadane, in northern Africa (Linstädter 2011; J.Morales oral com.).

Discussion

The quality of the data

As can be observed in fig. 2, the data for the area under study have a very low representativity. Many sites lack any type of archaeobotanical study while others have only been partially analyzed. In some occasions, systematic sampling has been carried out but the results have not been good. This shows that greater efforts must be put in the obtaining and processing of systematically recovered soil samples and the subsequent analysis of archaeobotanical materials. There is a need of samples from clearly independent units of analysis and sites with some spatial organization, in order to move on from the simple taxa list that has been presented in this paper. Despite some drawbacks, several statements can be put forward and new aspects can be commented after recent studies.

The cultivated taxa

In the early nineties, the taxa that were mostly considered as cultivars for the area under study were either cereals or legumes. Only recently, results from the only two lakeshore sites that have been excavated, La Marmotta and La Draga, and Los Murciélagos Cave have contributed with an extra taxon: opium poppy. Poppy is commonly stated among the cultivars from the second phase

onwards of LBK culture in the late VIth millennium cal BC (see, for instance, Kreuz 2007; Salavert 2010, 2011). Salavert (2010) considers that the domestication of poppy could have occurred in northwest Europe on the basis of the low number of sites that have documented poppy in the Mediterranean area. The author suggests that wild poppy could have reached the area as a weed and only later it could have been domesticated. We consider that the studies in the Mediterranean area are still not representative enough to discard the possibility of an early domestication in this region. Not many open-air dwelling sites (comparable to the contexts in the LBK culture) have been analyzed yet and poppy has been frequently found in those sites where preservation is good and systematic strategies have been applied.

Among the cereals, naked wheat is clearly the most common taxon in the area. Only in two sites, La Draga and La Marmotta, it has been possible to identify it as tetraploid naked wheat (*Triticum durum/turgidum* type) based on the morphology of the rachis. Naked wheat is the main taxon in all the sites with good or very good representativity (fig. 2) except Can Sadurní cave and La Marmotta, where emmer is better represented. Emmer is also present in most of the sites of the studied region

all along the VIth millennium cal BC, but it is absent in seven sites, four of them in the Gulf of Lyon.

As mentioned before, it has been proposed that hulled wheats were the main cultivars in the Ligurian coast and the Gulf of Lyon during the Impressed ware culture and that naked cereals would have replaced them in the Cardial ware culture. Supporting this hypothesis, we know that emmer is the main taxon in the two phases of Grotta dell'Uzzo and that there is no naked wheat in Pendimoun, while emmer is common in the early contexts of the sites in the region. Nonetheless, we consider that the state of research is at a too early stage to put forward any conclusions for the main cultivars of the Impressed ware culture. Furthermore, there are new results that do not completely agree with such a simplistic model. The analysis from Can Sadurní cave, for instance, shows a clear dominance of emmer in its assemblage, which is associated with typical Cardial pottery. In the earliest phases (layers XI and X) of Cova de les Cendres emmer also prevails, being a Cardial context once again. Despite these examples we do agree that it seems that hulled wheats are more common in the earliest Neolithic sites, while naked cereals reach a more important role in later periods and in certain areas, such as southern Spain and the Gulf of Lyon. This change could respond more to a cultural choice rather than to climatic reasons, especially considering that the conditions were rather cooler and wetter than nowadays (Aguilera *et al.* 2011), which would, in fact, favour the cultivation of hulled wheats. One should consider the fact that hulled wheats might be a more secure crop for the first attempts in new regions, since they require less labour input and can survive summer rains and pests better than naked cereals.

The role of the remaining taxa is much more imprecise. Einkorn is usually just sparsely documented and it is particularly absent in the sites of the second half of the VIth millennium in the Gulf of Lyon and in the southernmost sites of the Iberian Peninsula (it is only present in Los Castillejos).

Barley is well represented in most sites. The distinction between naked and hulled barley is not always free of discussion, especially when only a few grains are recovered. Nevertheless, some trends are observed. On the one hand, two-rowed hulled barley (*Hordeum distichon*) is present in La Marmotta and hulled barley is found in several other sites such as La Draga, Can Sadurní cave or Cova de l'Or. On the other hand, the origin and spread of naked barley is somewhat unclear, since it is only important in the sites from the south of the Iberian Peninsula and southern France and it seems to reach the north-west of the LBK culture at some point in the end of the VIth millennium cal BC (Salavert 2011). This fact could be showing the multiple ways in which crop exchanges could have happened from the first stages of the Early Neolithic in Europe and Northern Africa.

The role of legumes in human subsistence during the Early Neolithic is also a matter of discussion. The num-

ber of findings is usually low, although, when present, they often show a wide taxonomic diversity. Pea, lentil and broad bean are the best represented taxa. Pea, lentil and grass pea are represented from the first half of the VIth millennium cal BC, while broad bean is only found in more recent chronologies. Most of them show a wide distribution although only the regions of Southern Italy and Southern Iberian Peninsula have documented all the taxa. The Gulf of Lyon and the Ligurian coast are the poorest areas in legume findings for the moment.

Cultivation techniques

What do we know about crop husbandry practices in the Early Neolithic of the Mediterranean area? Did they cultivate permanent fields? Were the main crops spring or winter sown? Were they grown as maslins or monocrops? Was it an extensive or intensive cultivation? Our knowledge is still very limited. The scarcity of weeds in the record does not allow statistical approaches such as those applied by A. Bogaard in Central Europe (Bogaard 2004). The only attempt has been made by N. Rovira, who proposed that permanent fields would have been used in the Early Neolithic in los Castillejos site on the basis of weed assemblages. The most commonly identified weeds in the area under study are *Chenopodium album* and *Galium aparine*. Other taxa have been identified in certain sites, such as: *Portulaca oleracea*, *Sambucus ebulus*, *Verbena officinalis*, *Lolium sp.*, *Lithospermum officinale*, *P. rhoeas/dubium*, *Urtica sp.* and *Taraxacum officinale*. Most of the taxa are annual plants that grow well in humid disturbed places but there are some perennials as well, such as *Sambucus ebulus*, *Taraxacum officinale*, *Lithospermum officinale* and *Verbena officinalis*. They all would grow favourably in disturbed grasslands. Other taxa are more typical of dry lands and warmer conditions such as *Silybum marianum*. This analysis should be carried out on a sample-by-sample basis in order to reach representative results. For the moment we can only state that the most common taxa are annual plants typical of disturbed areas that could grow as arable weeds in irrigated or dry fields. This could point to permanent field cultivation practices. In most cases it seems obvious that well irrigated fields could have been available in the vicinities of the sites.

Further advances have been reached in the distinction between monocrop or maslin cultivation in certain sites. Studies that have been carried out in Can Sadurní cave and La Draga point to the possibility of monocrop cultivation practices. In Can Sadurní it has been stated that emmer, einkorn and naked wheat would have been grown separately (Antolín and Buxó 2011), while in la Draga it has recently been proposed that naked wheat would have been grown as a monocrop (Antolín and Buxó in press). The husbandry of the remaining taxa in both sites remains uncertain with the available data. Nevertheless, the existence of maslins should not be ruled out. It has been proposed for the LBK culture that

maslins of einkorn, emmer and pea could have existed on the basis of the taxa present in the few storages that have been analyzed (Kreuz 2007). Otherwise, this could be put forward as a difference in husbandry practices between both areas. If so, harsher climatic conditions in central Europe could be the most reasonable argumentation to explain such differences.

Harvesting techniques

Information on harvesting techniques has come, for the moment, mainly from use-wear analysis on lithic sickles. The best results have been achieved at the eastern coast of the Iberian Peninsula. It seems that sickles in the southern part of the Iberian Peninsula would have been obliquely inserted in the hafts, while a different pattern is observed in the sites at the north-eastern part of the peninsula and the gulf of Lyon: here longer blades would be inserted in parallel to the handle or, instead, one single long blade would be obliquely inserted (Gibaja *et al.* 2011). The results for the north-eastern part of the Iberian peninsula show two different harvesting techniques, one at a high level and one that would probably occur at the base of the straw. This data could support the hypothesis that different traditions existed in the different regions.

From an archaeobotanical point of view, some contributions to this issue have been attempted. The analysis that has recently been undertaken in one sample from a grain store in la Draga concluded that it was likely that naked wheat was harvested at a low-on-the-straw level (Antolín and Buxó in press). This was inferred by the type of processing that was detected on the grains. This will be commented further on.

Processing techniques

Little information is available on threshing, dehusking and milling techniques in the Early Neolithic in the area under study. No threshing floors have been found and dehusking areas have not been well established in any site. The presence of quern stones is relatively common and some functional analyses have been carried out.

The analysis that was carried out on the materials from the cave of Can Sadurní allowed putting forward a hypothesis for the dehusking techniques applied on the site (Antolín and Buxó 2011). Fragments of grain produced prior to charring were found among large quantities of charred grain. Such fragments could only have been produced by a mechanical activity (i.e. dehusking). For this reason, such fragments were quantified and surprising results were obtained. Einkorn presented higher percentages of fragmentation (20-45%) than emmer (5-10%) all along the excavated area in the site. This was interpreted by the authors as an evidence of independent processing of both taxa. Experiments on the dehusking process of hulled wheats have shown that different techniques can produce different degrees of fragmentation of the grains (Meurers-Balke and Lüning 1992): using a stone mill can produce between 20 and 40% of frag-

mentation, while wooden mortars produce around 5%. The presence of a stone mill with clear traces of cereal grounding (Ache 2011) next to these grain concentrations could be seen as an evidence of this process.

Other threshing techniques have been inferred in La Draga, based on similar types of observations (Antolín and Buxó in press). In this case, the presence of very small percentages of grain fragments produced prior to charring, and also the appearance of cracked grains, resembles the reference materials obtained from recent threshing activities using a threshing stone and a threshing board (Antolín in press). Although we could not state that such threshing techniques were used in la Draga, this led us to affirm that at least animal trampling was used for threshing. Such technique would only be applied if the harvest had been at a low-on-the-straw level and it was still necessary to separate the ear from the straw. Besides, cattle trampling implies a certain quantity of production, which, together with other evidences in the site, such as the existence of grain stores, led us to propose that the process could have involved considerable amounts of material that would be consumed in the subsequent weeks/months.

Both cases have one thing in common, which is that grain was totally processed before getting charred. Nevertheless, the practices in both sites are totally different and so are the contexts (a dwelling site opposed to a funerary context). Relations are, for this reason, difficult to establish.

Storing techniques

Storage practices are diverse in the Early Neolithic, even at a regional scale. It is not our aim to review all of them here. Stores have not been documented in most of the sites, yet we should not rule out the possibility that the grain was not stored in the dwelling site but in nearby caves. Precisely this hypothesis has been stated for slightly more recent periods in Cova 120. This cave could have acted as a secret storage place for the inhabitants of the nearby open-air site of Plansallosa (both in the northeast of Girona province, in Spain) (Alcalde *et al.* 1991). The presence of silos or storage pits has been documented in some sites such as Sant Pau del Camp, Roca Chica, Fontbregoua (Villa and Courtin 1983) and Pont de Roque Haute (Guilaine *et al.* 2007). Other storing techniques are documented as well. Large storage pottery vessels have been recovered in La Marmotta (Rottoli and Pessina 2007) and are likely to be present in Pont de Roque-Haute, while basketry containers could have been used in la Draga, along with specific storage buildings (Bosch *et al.* 2006).

Ways of consumption

Little is known about consumption in the Early Neolithic of this territory. Alimentary consumption is difficult to attest when lacking any food “products” such as carbonized “bread” or evidences of other processes such as bulgur or flour production. There are no available

data on potsherd residues analysis that confirm the consumption of vegetal products. On the other hand, one should consider that many of the seed and fruit remains that we have presented here were carbonized during cooking activities, thus demonstrating the consumption of most these products. As previously stated, other uses of crops and especially of processing by-products should not be discarded, i.e. animal feeding in the case of emmer wheat or use of the straw for roof thatching in the case of

einkorn wheat (Zapata *et al.* 2004). Poppy could have been cultivated for its oil content, for consumption or for its psychotropic properties (Salavert 2010).

The particular case of Can Sadurní cave might be an example of other types of consumption, such as ritual consumption. In this case, it has been proposed that potsherds full of cereal grain were offered as funerary offerings and subsequently burned in what could have been part of the funerary ritual (Antolín *et al.* 2011).

Conclusions

The diffusion of agriculture in the Western Mediterranean is a complex process that involved two different traditions or cultures: the Impressed Ware culture and the Cardial Ware culture. It seems that hulled wheats are more frequently present in the first stages of this diffusion but they could have been replaced by naked wheat (and naked barley in some regions) during the second half of the VIth millennium cal BC. Legumes are present in the record from the first stages of agriculture but the whole spectrum is found in the more recent period. Monocropping is detected in some sites of the western coast of the Iberian Peninsula and there are evidences for the cultivation of permanent fields in some cases. Different harvesting techniques are observed

among the different regions, which could respond to the existence of regional differences in the area under study (Gibaja *et al.* 2011). Contacts with the LBK-II culture are observed by the diffusion of poppy and naked barley (Salavert 2011). Finally, despite we assume that the main objective of these cultivars was alimentary consumption, other possibilities should not be ruled out. Ritual consumption is stated in the cave of Can Sadurní.

Further studies are needed in order to obtain representative and comparable data between the different areas. Systematic sampling strategies must be applied in all excavations and fully quantitative archaeobotanical studies are deeply encouraged.

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