Early Neolithic Agriculture in the Iberian Peninsula

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Early Neolithic Agriculture in the Iberian Peninsula

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The spread of agriculture in the Iberian Peninsula is documented from at least ca. 5600–5500 BC, although botanical data are absent or very limited for large areas. Archaeobotanical information shows from the beginning an imported agrarian system with a great diversity of crops: hulled and naked wheats and barleys, legumes such as pea, lentil, fava bean, vetches and grass peas, flax and poppy. This diversity of plants with different requirements, processing and uses, implies that the first farmers quickly imported or acquired a wide range of agrarian knowledge. Regional and inter-site agrarian differences are discussed in relation to factors like ecology, culture, use of the cultivated plants and management of the risk of crop failure. The adoption of farming resulted in significant ecological, economic, dietary, and social changes for the Neolithic people of Iberia.

KEY WORDS: Neolithic; Iberia; agriculture; crops; farming.

INTRODUCTION

The diffusion of farming in Europe is still a poorly known subject in many regions, partly due to poorly and unevenly recovered bioarchaeological data. This paper considers the present evidence for early

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agriculture—prior to 4200–4000 BC and the building of the first megaliths—in the Iberian Peninsula in the light of recent archaeological and bioarchaeological research, and discusses the way in which these new techniques were introduced as well as some of their consequences.

Agriculture is understood here as the practice of cultivation, this is to say, the planting of seeds or other propagules in a new situation (Hather and Mason, 2002). This differs from the previous use and management of wild plants, which obviously had existed among western European hunter-gatherers (Aura *et al.*, in press; Mason, 2000; Zapata *et al.*, 2002). In spite of the importance of plant foods to Mesolithic people (Mason *et al.*, 1994; Mason and Hather, 2002; Zvelebil, 1994), we cannot speak of continuity between the Mesolithic and the Neolithic in terms of plant use since the inclusion of exotic domestic food in the human—and probably animal—diet implied a radical change in the way plants were treated and managed. Cultivation implies a whole series of practices differing greatly from the gathering of wild foods: cereals and legumes are plants whose reproduction has to be planned and cared for since, unlike wild species, they are completely dependent on human interference for survival. Returns largely depend on how agricultural practices are planned and carried out through a continuous chain of decisions—what crops to sow, where to grow them, how to prepare the field and deal with soil fertility, how to control weeds and avoid predators and so on. Furthermore, new techniques had to be adopted for processing and cooking the new foods. Of course, the presence of crops does not imply that gathering was not practised. The collection of wild plants is well documented during the Neolithic of the Iberian Peninsula (Buxó, 1997; Zapata, 2000), although the relative proportions of these resources in the human diet are very difficult to estimate.

Iberia was the last region to adopt agriculture in the Mediterranean world. The peninsula holds a tremendous diversity of landscapes and ecological conditions, including a narrow fringe in the north with a humid oceanic climate very different from the one where cereals were originally domesticated. In this paper we will focus on the following subjects: (a) the chronology of the arrival of agriculture in the Iberian peninsula in the context of Western European farming; (b) the diversity of the crops and the agrarian practices involved; (c) the historical processes behind the adoption of farming; and (d) the consequences, since, in our opinion, the taking up of agriculture, even though on a small scale, had radical ecological, economic, dietary, social and symbolic implications for the Neolithic people of Iberia.

To accomplish this task, we will assess the available archaeological information in light of the existing archaeological plant macroremains, the most direct evidence of agriculture. We will use data from the sites that, in our opinion, offer some certainty as to chronology (Table I, Figs. 1 and 2). There are some other sites with Neolithic levels where plant remains have been considered out of context and often a more recent chronology can be assumed. There are several limitations in dealing with archaeobotanical research in Spain and Portugal. Firstly, there is an almost complete lack of information for large areas like the southern Meseta, western Andalusia or Portugal. Secondly, bioarchaeological information is not homogeneous since sampling strategies have been very varied and the range of contexts sampled is extremely diverse. A third limitation is linked to chronological issues. Only in the regions of Catalonia and Valencia do we begin to have a diachronic picture of the emergence of Neolithic agriculture. For the remaining areas, data are too scattered to establish a continuum of plant husbandry. In addition, the chronological framework has been built on the basis of a series of dates run on a wide variety of materials. In this paper, we have privileged radiocarbon dates from cultivated plants (Fig. 2). Cereals are extremely useful for dating since they are short-lived. Individual AMS ^{14}C dating of key specimens overrides the risk of dealing with disturbed contexts and with intrusions from overlying levels (Bernabeu *et al.*, 1999; Harris, 1987; Rowley-Conwy, 1995; Zapata, 2001; Zilhao, 2001) and eliminates the possibility of "old wood" in the case of charcoal. Dates in this paper have been calibrated using the program Calib 4.3 (copyright 2000 M. Stuiver and P.J. Reimer) to be used in conjunction with Stuiver and Reimer (1993).

THE ARRIVAL OF AGRICULTURE IN IBERIA: THE CHRONOLOGY

The Pyrenees: Poorly Known Early Farmers

Recent research carried out in the Pyrenean region points to very early agriculture in an area that has not traditionally been considered to lead the way in the Neolithic. In the cave of Balma Margineda (Andorra), barley, naked wheats and pea have been identified in a Neolithic context dated ca. 6000–5400 BC (Marinval, 1995). There are other pre-Pyrenean sites (Chaves, Forcas II and Olvena) which have no analyses of plant macroremains. However, these sites do have domestic animals and indirect proof of agriculture such as like lithic sickle elements, silos and querns from such early dates as ca. 5700–5500 BC (Castaños, 1995; López García, 1988; Martí, 1998; Rodanés and Ramón, 1995; Utrilla, 2002) and cereal pollen is present in Chaves from at least ca. 5300–4850 BC (López García, 1992; López García and López Sáez, 2000). However, the early radiocarbon chronology is contested due

Table I. Neolithic Sites With Domestic Plant Macro-Remains Earlier Than ca. 5000 BP and Available Radiocarbon Dates. Numbers Correspond to the Map (Fig. 1)

No.	Site	Lab reference	^{14}C BP	B.C. cal. 2 σ 95.4%	Material dated
1	Balma Margineda (Andorra) (Marinval, 1995)	Ly-3289	6850 ± 160	6010–5480	Wood
		Ly-2839	6670 ± 120	5790–5370	
2	Cova 120 (Gerona) (Buxó, 1997)		Early	Neolithic	
3	Plansallosa (Gerona) (Bosch *et al.*, 1998)	Beta-74311	6180 ± 60	5300–4960	Wood
		Beta-74313	6130 ± 60	5260–4850	
		OxA-2592	5890 ± 80	4940–4550	
		Beta-74312	5870 ± 70	4900–4550	
		Beta-87965	5720 ± 70	4770–4370	
4	La Draga (Gerona) (Buxó *et al.*, 2000)	UBAR-313	6010 ± 75	5200–4720	Cereal
		Hd-15451	6060 ± 40	5190–4810	
5	Font del Ros (Barcelona) (Bordas *et al.*, 1996; Pallarés *et al.*, 1997)	AA-16502	6370 ± 57	5440–5220	Wood
		AA-16501	6307 ± 68	5430–5060	
		AA-16499	6243 ± 56	5320–5020	
		AA-16500	6058 ± 79	5210–4790	
6	Can Sadurní (Barcelona) (Blasco *et al.*, in press)	UBAR-760	6405 ± 55	5470–5300	Cereal (27 g)
7	Cova de les Cendres (Bernabeu *et al.*, 2001; Buxó, 1997)	Beta-142228	6340 ± 70	5470–5080	Cereal
8	Cova de l'Or (Hopf, 1966; López, 1980; Martí, 1978; Bronk Ramsey *et al.*, 2002)	KN-51	6510 ± 160	5720–5080	Cereal
		H-1754/1208	6265 ± 75	5460–5000	Cereal
		OxA-10191	6275 ± 70	5460–5040	Cereal
		OxA-10192	6310 ± 70	5470–5070	Cereal
9	Abric de la Falguera (Bernabeu *et al.*, 2002; Pérez Jordá, in press)	Beta-142289	6510 ± 70	5610–5320	Cereal
10	Cova de la Sarsa (López García, 1980)		Early	Neolithic	
			N. IA:		
11	Mas d'Is (Bernabeu *et al.*, 2003)	Beta-166727	6600 ± 50	5620–5480	Cereal
		Beta-162092	6600 ± 50	5620–5480	Cereal
			N. IIA:		
		Beta-171908	5590 ± 40	4500–4350	Cereal
		Beta-171907	5550 ± 40	4460–4330	Cereal
12	Cova de Sta. Maira (Badal, 1999)	Beta-75224	5640 ± 140	4800–4220	Wood
13	Cueva del Toro (Málaga) (Buxó, 1997, 1993b)	UGRA-194	6400 ± 280	5840–4710	Wood
		GaK-8060	5450 ± 120	4500–4000	
		Unavailable	5380 ± 45	4330–4050	
		GaK-8059	5320 ± 230	4600–3650	
		GrN-15437	5200 ± 60	4220–3810	

Table I. Continued

14	Cueva de Nerja (Málaga) (Hopf and Pellicer, 1971; Jordà Pardo *et al.*, 1990)	Unavailable	5065 ± 140	4230–3540	Cereal
		Ly-5218	6420 ± 60	5480–5310	Wood
15	Cueva de Los Murciélagos (Córdoba) (Hopf and Muñoz, 1974; López García, 1980; Peña-Chocarro, 1999)	I-17772	6430 ± 130	5620–5070	Wood
		GrN-6926	6295 ± 45	5370–5080	Wood
		I-17771	6190 ± 130	5460–4800	Cereal
		CSIC-55	6170 ± 130	5460–4780	Cereal
		GrN-6639	6025 ± 45	5040–4780	Cereal
		CSIC-57	5980 ± 130	5220–4540	Cereal
16	La Lámpara (Rojo *et al.*, in press)	KIA-21350	6871 ± 33	5840–5670	Bone
		KIA-6790	6144 ± 46	5250–4940	Human bone
17	La Revilla del Campo (Rojo *et al.*, in press)	KIA-21358	6365 ± 36	5420–5260	Bone
		KIA-21346	6202 ± 31	5280–5050	Bone
18	La Vaquera (Segovia) (Estremera, 2003; López García *et al.*, 2003)	GrN-22932	6120 ± 160	5460–4690	Wood
		GrN-22929	5800 ± 30	4770–4550	Wood
		GrA-9226	6440 ± 50	5480–5320	Acorn
		GrA-8241	6080 ± 70	5220–4790	Acorn
19	Los Cascajos (Navarra) (García Gazólaz and Sesma Sesma, 2001)	Ua-16024	6185 ± 75	5300–4860	Human bone
20	Lumentxa (Bizkaia) (Zapata, 2002)	Ua 12662	5180 ± 70	4220–3800	Wood
21	Kobaederra (Bizkaia) (Zapata, 2002)	UBAR-470	5630 ± 100	4720–4260	Wood
		AA-29110	5375 ± 90	4360–3990	Cereal
22	Pico Ramos (Bizkaia) (Zapata, in preparation)	Beta 181689	5370 ± 40	4330–4050	Cereal
23	El Mirón (Cantabria) (Peña-Chocarro *et al.*, in press)	GX-25854	5500 ± 90	4520–4050	Wood
		GX-25856	5790 ± 90	4840–4410	Wood

to it being based on wood charcoal samples. Therefore, this region urgently needs to study more plant macroremains and domestic elements need to be radiocarbon dated.

The Mediterranean Region: The Traditional Pioneers

Until very recently, archaeobotanical research in the Iberian Peninsula has focused on this large region along the Mediterranean coast, including the immediate inland mountain ranges. Cave sites have provided most of the archaeobotanical dataset which is currently being improved by the excavation of open air-sites such as La Draga and Mas d'Is and by the radiocarbon dating of single grains of cereals. Starting from north to south, the cave Can Sadurní has recently provided the earliest cereal dated in the northeast (5470–5300 BC) which is similar to dates from pits in Font del Ros where cereal grains were retrieved (Bordas *et al.*, 1996; Pallarés *et al.*, 1997). This is starting to fill the gap in early Neolithic agriculture in *Catalonia*, which, by its geographical position, is one of the corridors in and out

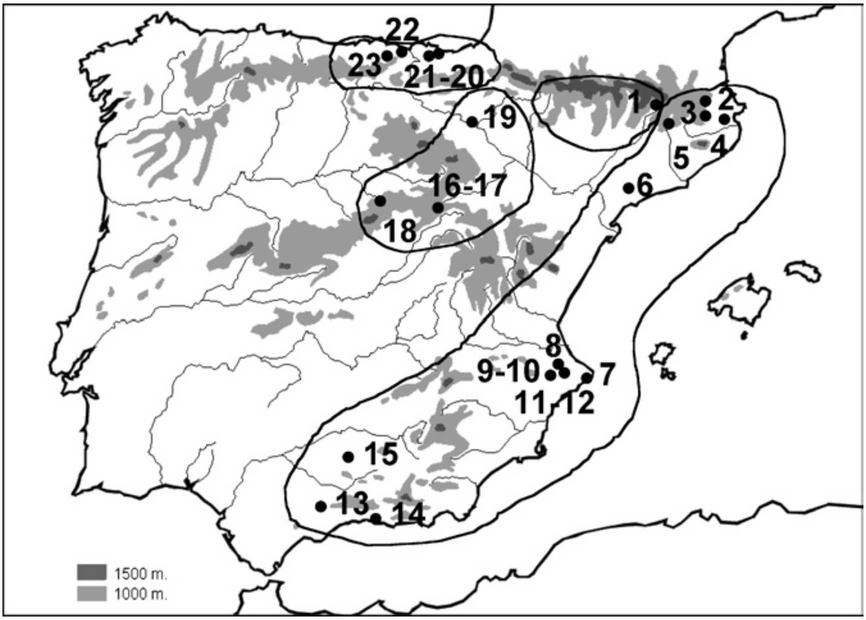

Fig. 1. Location of sites with Early Neolithic domestic plant macro-remains. Different regions are discussed in the text: The Pyrenees, the Mediterranean fringe, Inner Peninsula and Northern coast. The numbers correspond to the sites listed on Table I.

of Iberia. La Draga, although slightly later, is a waterlogged open-air site where cereal has been dated at 5200–4720 BC, and it has provided exceptionally well-preserved wooden agrarian tools. Other Neolithic sites with plant remains are Cova 120 and Plansallosa (Table II).

Neolithic agriculture in the *Valencian* region is archaeobotanically well studied with the pioneer work of Hopf (1966) in Cova de l'Or and later works in other caves like Cova de la Sarsa (López García, 1980) and Cova de les Cendres (Buxó, 1997). Recent works have widened our vision with new sites (Mas d'Is, Falguera, Cova de Sta. Maira) (Pérez Jordá, in press) offering a diachronic picture. To date, some of the oldest radiocarbon dates on cereals come from the open-air site of Mas d'Is (5620–5480 BC) (Bernabeu *et al.*, 2003) but they are closely followed by and in fact overlap with other sites (Fig. 2).

In *Andalusia*, remains of Neolithic crops are concentrated in only three cave sites from Córdoba and Málaga (Los Murciélagos, Toro and Nerja). Dates from wood charcoal indicate that, by ca. 5600–5400 BC, agriculture was already established. However, AMS dates on cereals from the Cave of

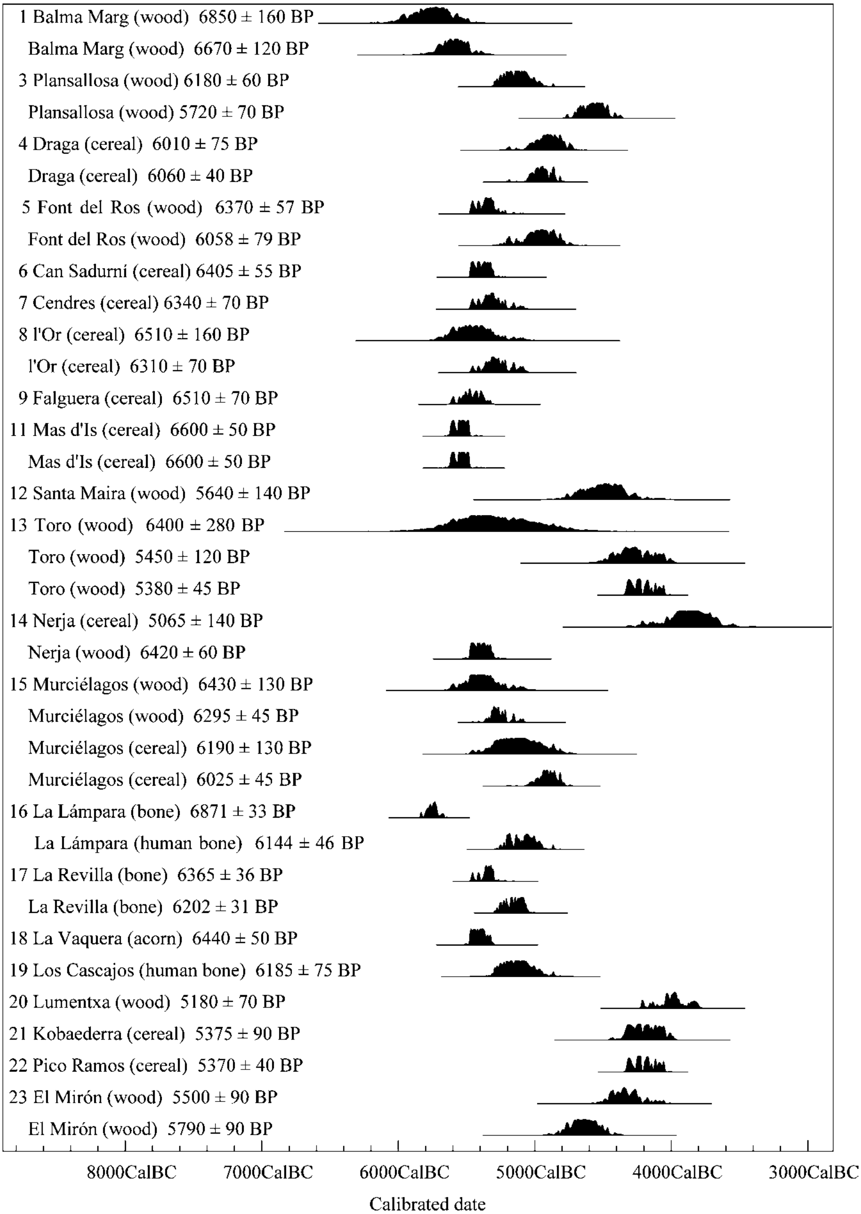

Fig. 2. Radiocarbon dates from the Neolithic sites we have mentioned. When possible, dates obtained from domestic plant remains and bone have been selected. Numbers correspond to the Map (Fig. 1). The Figure has been produced with the Program OxCal Version 3.9 (Copyright C. Bronk Ramsey, 2003) which works with data from Stuiver and Reimer (1993) (Bronk Ramsey, 1995, 2001 and Bronk Ramsey *et al.*, 2002).

Table II. Presence/Absence of Crops in Neolithic Sites With Archaeobotanical Analyses From Contexts Earlier Than ca. 4200–4000 BC

	T. monoc. Einkorn	*T. dicocc.* Emmer	*T. aestiv/durum* Bread wheat	*Hordeum naked* Naked barley	*Hordeum hulled* Hulled barley	*Hordeum indet.* Barley	*Pisum sativum* Pea	*Lens culinaris* Lentil	*Vicia faba* Faba bean	*Vicia ervilia/sativa* Bitter and common vetch	*Lathyrus* Grass pea	*Linum* Flax	*Papaver* Poppy
Pyrenees													
1 BMar		√	√	√			√						
Catalonia													
2 C120		√	√	√		√	√			√			
3 Plans			√	√		√		√		√			
4 Draga		√	√	√		√	√		√				
5 FontR	√	√	√			√							
6 CanS	√	√				√							
Valencia													
7 Cendr	√	√	√	√	√		√	√	√		√		
8 Or	√	√	√	√	√								
9 Falg	√	√	√	√	√			√					
10 Sars		√	√										
11 M Is	√		√			√							
12 SMai			√			√	√	√			√?		
Andalusia													
13 Toro		√	√	√		√	√	√	√	√	√		
14 Nerj			√	√						√?	√?		
15 Mur		√	√	√		√							√
Inland													
16 Lám	√	√											√
17 Revi	√	?				√						√	
18 Vaq	√	√	√	√	√			√		√			
19 Casc	√	√			√								
Basque-Cantabrian													
20 Lum						√							
21 Kbd		√				√							
22 Pico						√							
23 Mir	√	√	√										

Los Murciélagos start only at 5500–5000 BC (Hopf and Muñoz, 1974; Peña-Chocarro, 1999).

Inner Peninsula: The Early Newcomers

In the Upper Ebro Valley, cereal remains have been recovered in Los Cascajos, a recently excavated open-air site still under study, with various contexts such as houses, funerary and ritual deposits, storage and processing structures which have been dated within the millennium 5300–4300 BC (García Gazólaz and Sesma Sesma, 2001; Peña-Chocarro *et al.*, in press).

For the territory comprising the Northern Meseta and the mountain ranges around it, information on the Neolithic was, until recently, very limited. Megaliths were considered the first evidence of farming communities (Delibes, 1977). Little by little, older evidence was found but there was a lack of well-studied sequences, radiocarbon dates and bioarchaeological sampling. In any case, this was considered a marginal area, with a late adoption of farming from peripheral regions (Peña-Chocarro, in press). In recent years, this picture has been changing radically and three sites have afforded us an extremely interesting archaeobotanical dataset: the cave of La Vaquera in Segovia and the sites of La Lámpara and La Revilla del Campo in Soria. Although the chronology needs to be refined by the radiocarbon dating of domestic elements, the appearance of Neolithic farming seems to be extremely early. In the cave of La Vaquera, acorns, a non-domesticated, short-lived material, have provided a date of 5480–5320 BC for the context in which cereals appear (Estremera, 2003). There are older dates on wood charcoal (6000–5500 BC) for Neolithic levels but these have been dismissed by the excavator (Estremera, 2003, pp. 185–186). In the sites from Soria, there is a long series of dates which go from 5800–5700 to 5200–4900 BC in La Lámpara and from ca. 5420–5260 to 5280–5060 BC in La Revilla del Campo—if we dismiss the clearly Mesolithic dates and focus on the dates on bone. There are older dates obtained from wood charcoal (Rojo *et al.*, in press) but we think that the ongoing dating of cereals is the best approach to clarify agricultural chronology in this region (Stika, in press).

The Coast of the Bay of Biscay: The Supposed Latecomers

The northern coast of the Iberian Peninsula, with oceanic climatic conditions—mild temperatures and a very wet climate with no summer drought—has been considered a marginal area for Neolithic farming. Continuity between the Mesolithic and the Neolithic was assumed, with a long duration of hunting–gathering practices even when some Neolithic materials were available. Further, archaeologists also assumed there would be difficulty in the adoption of cereal agriculture due to the geographic conditions of the Atlantic valleys which would be more suitable for pastoralism. Ethnographic and archaeobotanical data (Iriarte *et al.*, in press; Peña-Chocarro, 1999; Peña-Chocarro and Zapata, 2003; Zapata, 2002) have only recently started to refute these assumptions. However, available data are still limited, and research is concentrated on cave sites (Zapata, in press).

The oldest evidence of agriculture for this region comes from the open-air site of Herriko Barra, a site that focussed on the procurement of wild resources, particularly deer, with no domestic animals or pottery. Cereal pollen has been identified here ca. 5200–4600 BC (Iriarte *et al.*, in press). Neolithic sites with ^{14}C dated cereal seeds—Pico Ramos, Kobaederra and El Mirón—provide later dates (ca. 4500–4000 BC).

Iberian Chronology in the Context of Western European Farming

With the exception of poppy, all the cereals and, most probably, the pulses used in the Spanish Neolithic are allochthonous crops. They could have entered the Iberian peninsula through the Pyrenees, by sea, or both (Roudil, 1990) from the central Mediterranean region and North Africa. Hopf (1966, 1987, 1991), considering the crop package, suggested an introduction from the Western Mediterranean, while Marinval (1992) suggested North Africa. However, we are faced with the lack of archaeobotanical research in some areas like Mediterranean Africa, and the scarcity of well-sampled early sites in others like France. Nevertheless, present data show that the spread of agriculture along the Mediterranean territories was a quick process: 1500 years for 3000 km from the Aegean to Portugal, spreading at a faster rate in the western half (Guilaine, 2003, p. 202).

In *Italy*, the oldest evidence of agriculture comes from the south where the sites of Coppa Nevigata and Rippa Tetta in Foggia provide cereals dated ca. 5900–5600 BC (Costantini and Stancanelli, 1994). Hulled wheats were the most important crops but free-threshing wheats, barley and pulses were also present. Through time, naked wheats became more frequent and the range of legumes increased. The diffusion of farming to the north was faster than previously thought with various cereals being present in sites like Sammardenchia (Udine) (Rottoli, 1999) and Lugo de Romagna (RA) (Rottoli, personal communication) from ca. 5500 BC (Castelletti *et al.*, 2000). The site of Arene Candide also provides radiocarbon-dated barley at ca. 5800–5640 BC (Binder and Maggi, 2001). In southern *France*, early Neolithic archaeobotanical analyses and radiocarbon dates of cereals are not common. Free-threshing wheats and hulled barley were the most important crops, but, from the Epicardial on, einkorn and emmer also appeared in small numbers. On the French Atlantic coast, naked wheats were the most abundant crop and this has been interpreted as a Mediterranean influence (Bakels, 1991; Dietsch-Sellami, 2000; Gebhardt and Marguerie, 1993; Joussaume *et al.*, 1986; Marchand, 1999).

In summary, despite all the problems we have with radiocarbon chronology and standard deviations, early radiocarbon dates of cereals from Italy and southern France seem to be ca. 200 years older than the earliest ones from the Iberian Peninsula. The spread of agriculture was indeed a quick process as some authors have already pointed out (Bernabeu, 2002; Zilhao, 2001) but, if we put it into a continental context, we can see that this is not extraordinary since agriculture spread quickly in a variety of regions—although it is true that in others it did not (Bakels, 2000; Guilaine, 2003; Price, 2000). The rapidity need not be exclusively linked to maritime colonization. Certainly, ships were not involved in the early spread of farming in the Pyrenees or in the Northern Meseta, 1000 m a.s.l. Similar cases of a remarkably fast spread of farming have also been documented in Central Europe for LBK (Bogucki, 2000, 2003, p. 212), which is the classic case of agricultural colonization (although the important role of Mesolithic groups is being readdressed [Jochim, 2000]). In southern and central Scandinavia, TRB expanded in a period of approximately 100 years through indigenous adoption (Price, 2003, p. 289), and the spread of domestic plants in inland areas of the British Islands was also very rapid (Fairbairn, 2000; Jones, 2000; Monk, 2000).

Within the Iberian Peninsula, the very limited chronological framework built on plant remains implies also a very quick process. Domestic plants are first documented on widely separated sites with radiocarbon dates which at least partly overlap (Fig. 2). In the Valencian region, crops are well documented for ca. 5600–5500 BC, in Catalonia for ca. 5500–5300 and a similar chronology is probably true for Andalusia although dates from this region have large standard deviations. Other supposedly non-pioneer areas like the Pyrenees or the periphery of the Northern Meseta have started to provide very old dates for contexts with cereals. It is true that the chronology for these regions is based on the radiocarbon dating of materials like wood and unidentified bones and will have to be re-assessed with the dating of domesticated elements, but we cannot ignore the role of Pyrenean passages and the territories inland in the diffusion of crops. Archaeological sites and materials seem to point to a relation between the southern Pyrenees and the Provence/Languedoc region through the Aude-Tet and Segre-Cinca-Esera basins (Utrilla *et al.*, 1998, p. 178). Geometric lithic materials from early Pyrenean Cardial contexts, such as the Chaves cave in Aragon, also resemble Provençal types and differ from the Mediterranean coastal ones (Cava, 2000, p. 105).

Only the northern coastal fringe of the Bay of Biscay currently reveals a different situation. Here, evidence of agriculture does not start until, at the earliest, ca. 5200–4600 BC. Although this region might be considered a frontier situation, with hunter-gatherers exploiting coastal resources and resisting farming (Arias, 1999), very little archaeological information is available for the sixth millennium BC, so this could be a result of the present state of research.

THE CROPS OF THE IBERIAN NEOLITHIC

It is not the aim of this paper to give a detailed outline of the characteristics of all the crops involved in European farming; this has already been done in the botanical and archaeobotanical literature (see particularly Zohary and Hopf, 2000). We would like only to draw attention to the fact that early Neolithic agriculture in the Iberian Peninsula is one of the most varied in the whole of the continent (Table II), and to discuss the complexity it implies for farming knowledge. In nomenclatural terms, we use the binomials and names commonly used by archaeobotanists (Hillman *et al.*, 1996). (For full scientific names and further light on synonyms, we suggest Zohary and Hopf (2000)).

Crops

Throughout the Western Mediterranean region, a wide variety of crops were cultivated during the Neolithic with some probable regional peculiarities, as for example, a greater focus on hulled wheats in Italy and free-threshing wheats in France. Mediterranean Africa is still a big question mark. The crops that have been documented in Iberia and some of their main features are outlined below.

Cereals

Wheats and barleys domesticated in the Fertile Crescent of the Near East were the traditional staple crops in the Neolithic of Western Europe. Their nutritional values are high in starch and protein, they can be stored for long periods, and yields are relatively high providing soil fertility and fixed nitrogen are adequate.

1. Hulled wheats: einkorn (*Triticum monococcum*) and emmer (*T. dicoccum*). Wheats with persistently enclosing hulls. When the spikes

are threshed, they break into their constituent spikelets which must be dehusked, usually by pounding, in order to liberate the grain from the chaff (Hillman, 1984; Peña-Chocarro and Zapata, 2003). The tough glumes of hulled wheats give excellent protection to the crop in the field and in storage. These wheats are also resistant to poor soil conditions and a range of fungal diseases (Nesbitt and Samuel, 1996). This may, at least partly, explain their survival today in Iberia, as completely relict crops (Fig. 3). Their kernels are consumed by both humans (emmer) and animals (einkorn). Einkorn straw provides an excellent raw material for crafts and thatching, while emmer straw is mainly used for animal bedding (Peña-Chocarro, 1999).

2. Free-threshing wheats: macaroni wheat (*Triticum durum*) and bread wheat (*T. aestivum*). These two species are very different genetically (one is tetraploid and the other hexaploid), but overlap considerably in their grain-shape, so identifications in this paper are presented as *T. aestivum/T. durum*. When these naked species are threshed, the glumes and chaff break and the grains are immediately released (Hillman, 1985).
3. Barleys (*Hordeum vulgare*): They are usually regarded as an inferior staple to wheats but they withstand some salinity, drier conditions and poorer soils than most wheats. The main cultivated barleys represent races of a single species (*Hordeum vulgare* L.) but hulled and naked forms have been identified in the archaeobotanical record. When hulled, the pales are fused with the kernels and cover them after threshing; in naked forms, the grain is released by threshing. There are also two-row and six-row forms.

Pulses

Pulses accompanied cereals in the first agriculture of the Iberian Peninsula (Buxó, 1997). They are very rich in proteins whereas cereals are rich in starch, so they complement each other very efficiently in the human diet. In addition, they are able to fix atmospheric nitrogen and to maintain higher levels of soil fertility (Zohary and Hopf, 2000). The following pulses have been documented in the Iberian Peninsula before 4000 BC (Zohary and Hopf, 2000):

1. Pea (*Pisum sativum*): This crop is well adapted to Mediterranean but also to cooler temperate conditions. It is a valued human food as an important source of protein.

Fig. 3. Einkorn (*Triticum monococcum*), nowadays a relict crop in Andalusia and Mediterranean Morocco, has been present in Iberia from the Neolithic.

2. Lentil (*Lens culinaris*): Also a very nutritious pulse for humans although yields may be relatively low. Traditionally, they have substituted for meat in present-day farming communities.
3. Fava bean (*Vicia faba*): It grows well under both Mediterranean and oceanic conditions and it also constitutes an important source of protein in human diet. It is also a valued domestic animal food.
4. Bitter vetch (*Vicia ervilia*) and common vetch (*Vicia sativa*): Both vetches are minor crops in traditional Mediterranean agriculture, cultivated for hay and for seed usually for animal food, and only eaten by humans in times of famine. *Vicia ervilia* is toxic to some animals and to humans although the poison can be minimized by soaking in water.
5. Grass peas (*Lathyrus sativus* and *Lathyrus cicera*): they are very resistant to drought and poor soils and have been widely used as animal feed. However, in different parts of the world and also in times of famine, they are eaten by humans. The seeds of *Lathyrus* are toxic and cause lathyrism, a crippling neurological disorder, although various processing treatments, such as boiling in water, might limit the effects. *Lathyrus cicera* has traditionally been cultivated in central Spain in mixed-cropping systems (*comuña*), providing an excellent animal food made of barley, bitter vetch, common vetch and *L. cicera*, the proportions and components being variable (Peña-Chocarro and Zapata, 1999)

Oil, Fiber and Drug Crops

Plants that produce oil, fiber and drugs were also cultivated in Western Europe from the early Neolithic. Their history is very badly known because in some cases, like the *Papaver* genus, the seeds are so small that they can be recovered only by extremely thorough archaeobotanical sampling. Flax has, for the moment, been identified in only one Neolithic site while poppy is present in two sites:

1. Flax (*Linum usitatissimum*): this crop is an important source of oil and fiber and evidence from the living plants clearly supports a Near Eastern domestication (Zohary and Hopf, 2000).
2. Poppy (*Papaver somiferum*) is today used as a source of opium, a powerful medicinal and narcotic substance, and it is also cultivated for its seeds which are rich in oil. We are inclined to think that during the Neolithic the main use of the plant would be for its oily seeds. However, its use as a narcotic substance cannot be ruled out.

The wild plant was known to early Western Mediterranean farmers and familiarity with its narcotic properties may be presumed (Sherratt, 1991). Opium compounds have been identified in human bones and dental calculus among late Neolithic miners (male) in Gavá (Barcelona) (Juan-Tresserras and Villalba, 1999). Also, opium–poppy capsules were found in the Cueva de los Murciélagos (Albuñol, Granada) in a Neolithic burial context inside esparto grass containers (Neuweiler, 1935 in Alfaro, 1980), so it may have had a symbolic significance within funerary practices. Its presence as temper in a small Neolithic pot from Belgium also seems to point to a ritual use (Bakels, 2000). The crop is closely related to wild and weedy forms, which grow mainly in coastal areas in the Western Mediterranean. This fact, along with archaeobotanical data, points to a Western Mediterranean domestication (Fig. 4). Thus, this is the first crop that was added to the original plant assemblage outside the Near East (Peña-Chocarro, 1999; Zohary and Hopf, 2000). From the Western Mediterranean, it quickly spread to central, northern (Bakels, 2000; Jacomet and Kreuz, 1999) and eastern Mediterranean (Kroll, 1991).

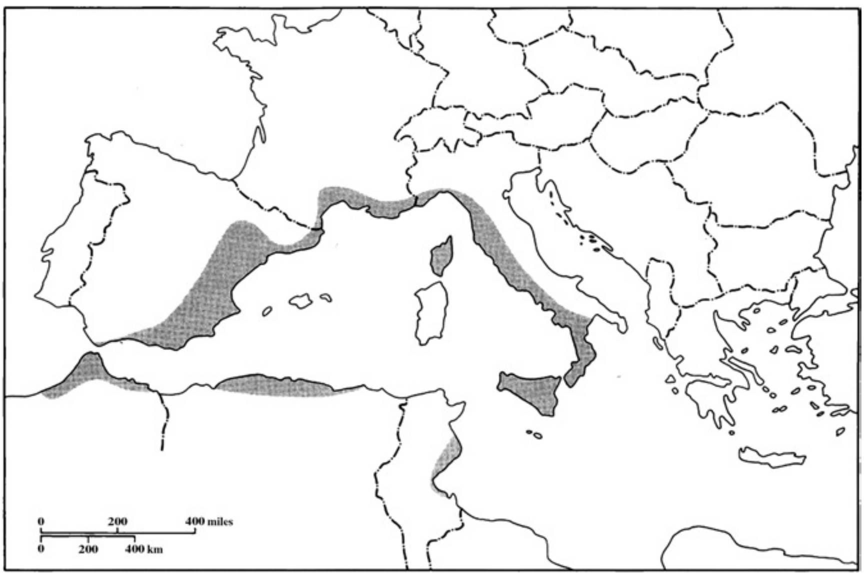

Fig. 4. Wild *Papaver somniferum* ssp. *setigerum* distribution in the Mediterranean (Jacomet and Kreuz, 1999 based on Zohary and Hopf, 2000).

Regional Crop Patterns and Possible Explanations

There are serious limitations in the quantity and quality of archaeobotanical data, but some regional patterns are starting to appear (Table II). The earliest sites from *Catalonia* and *Valencia* showed a large diversity of crops: hulled wheats (*T. dicoccum* and the less common *T. monococcum*), free-threshing wheats (*T. aestivum/durum*), hulled and naked barleys, and legumes such as fava beans, lentils, peas, common vetch and grass peas (*Lathyrus sativus/cicera*). Free-threshing wheats were the best represented although in sites like Cendres and Cova de l'Or, emmer wheat was also important. This diversity continued throughout the middle Neolithic but in the late Neolithic there was a preference for barleys and naked wheats (Buxó *et al.*, 1997). In Andorra, in the *Pyrenees*, the site of Balma Margineda also produced hulled and naked cereals and one legume, the pea. In *Andalusia*, the situation is similar, but einkorn wheat is absent so far. The Cueva del Toro is exceptional for the varied assemblage of legumes, while the finds of opium poppy (*Papaver somniferum/setigerum*) from the Cueva de Los Murciélagos are also remarkable. Even the supposedly marginal and poorly known *Cantabrian-Basque* region had an important variety of crops before 4000 BC, four cereals having been identified: einkorn, emmer, free-threshing wheats and barley; pulses are absent so far.

In *Central Iberia*, the few sites that have been studied are starting to give very interesting and divergent data. Like the variety we see on the Mediterranean coast and nearby inland territories, in the cave of La Vaquera both free-threshing and hulled cereals have been identified, free-threshing wheats being the most abundant, as well as lentil and common vetch. However, the inland sites of Los Cascajos, La Lámpara and La Revilla had the most unusual crop assemblages in the Spanish Neolithic in that they lacked free-threshing wheats. In the Upper Ebro Valley, in the site of Los Cascajos, emmer chaff (basically glume bases and spikelet forks) mixed with fragments of indeterminate cereals were the most common finds and einkorn was also been identified in very low numbers. Barley appears to occur in specific contexts like burials and ritual deposits; however, the scarcity of data on Neolithic funerary contexts argues for caution in interpretation. The sites of La Lámpara and La Revilla del Campo in Soria also provided samples dominated by hulled wheats (*T. monococcum* and *T. dicoccum*), but a few remains of barley were also identified. Hulled wheat chaff was used as pottery temper and in adobe making. Besides cereals, another two important crops were flax and poppy. Legumes are absent so far.

Thus, a rapid survey of archaeobotanical findings shows regions or sites where free-threshing wheats predominate (Mediterranean coast), sites where they are absent (in the central area), regions where legumes are absent (Cantabrian-Basque region) and others where they are very abundant and varied (Andalusia). Some of this may be explained by taking into consideration the conservation and taphonomic problems that affect plant preservation and the low number of sites that have had proper sampling and analyses. For example, legumes are traditionally poorly represented in archaeobotanical records for reasons which may range from a real lack of importance in human diet during prehistory to taphonomic problems related to processing away from fire. In the case of the Cantabrian-Basque Neolithic, plant remains are so few in the cave sites that we have studied that it is not surprising that legumes are not represented. They will probably appear with future excavations. However, other situations, like the absence of free-threshing wheats in some regions and sites, may reflect real regional or site patterns which may be related to a variety of factors. Ecology, culture and function are the most obvious ones.

Starting with the *ecological factors*, the crops that we have documented in the Iberian peninsula before 4000 BC have different growing requirements and tolerances, but we know nothing about the several prehistoric varieties that are no longer extant. In addition, we cannot identify varieties with our current techniques which are based on grain and chaff morphology. Hulled wheats are resistant to poor soil conditions and fungal diseases (Nesbitt and Samuel, 1996). Barleys also tolerate drier conditions and poorer soils than most other cereals. Thus, it is possible that the occupants of La Lámpara and La Revilla, located 1000 m a.s.l. with harsh climatic conditions and probably poor soils (especially at La Lámpara, as the accompanying weeds indicate) might have selected einkorn and emmer as their main crops as well as barley. Something similar might have happened on the coast of the Bay of Biscay. This narrow coastal fringe belongs to the Euro-Siberian biogeographic region. It is a mountainous area with an oceanic climate, mild and very wet (ca. 1000–1700 mm/year) with no summer drought. It is the only region of Iberia where *T. dicoccum* is still kept under traditional cultivation due to its good yields under these conditions (Peña-Chocarro, 1999; Peña-Chocarro and Zapata, 1998) (Fig. 5). Barley and emmer wheat were probably the most common crops here during the Neolithic and we have suggested peculiar features for agriculture in this ecological setting (Zapata and Peña-Chocarro, in press). However, the recent identification of naked wheats in El Mirón (Peña-Chocarro, work in progress) enlarges the range of crops available to the local Neolithic populations. More research is needed and we should also consider the fact that the known carpological finds from the northern coast are not strictly contemporaneous with the oldest finds from other areas (Fig. 2).

Crop use may also determine the array of crops used and may, in turn, be guided by *cultural decisions*. Thatching with straw could result in the

Fig. 5. Small field of hulled wheats (*Triticum dicoccum* and *T. spelta*) under traditional cultivation in the Northern territory of Asturias. These relict crops might have survived as a result of good adaptation to wet and mountain conditions.

planting of small plots of einkorn wheat specifically for this purpose, even if the grain was not greatly valued (Peña-Chocarro *et al.*, 2000). Moreover, the cultivation of particular crops is sometimes justified simply by their being socially highly appreciated and valued foods, even if returns are not good or if they are very labor intensive—as is the case of emmer in Spain (Peña-Chocarro, 1999) and Ethiopia (d'Andrea, 2003)—or for symbolic reasons (Hayden, 1996, 2003).

Reasons for Neolithic Crop Diversity

The first farmers in southern Europe had in their favor a Mediterranean ecological setting that differed little from the one where the crops were first taken into domestication. This is in contrast to central and northern Europe, where early agriculture focussed on fewer crops—mainly emmer wheat. However, a large diversity of crops soon extended also to central and northern Europe, so we should not push ecological determinism too far in order to explain Mediterranean diversity. The strikingly wide range of crops for the period prior to 4000 BC in the Iberian Peninsula may have occurred for several reasons.

(1) Even with the co-occurrence of different crops in the same site and sample, in most cases we cannot tell whether we are dealing with maslins (different crops grown together in the field) or monocrops that became mixed during refuse disposal or after deposition. The sowing of mixed crops of cereals or legumes in the same field is a common practice in order to reduce the risks of crop failure (Jones and Halstead, 1995). Although it is possible that maslins existed during the Neolithic, the concentration of cereals in some archaeobotanical samples shows that monocropping was practised during the Neolithic (Buxó *et al.*, 2000; Pallarés *et al.*, 1997; Pérez Jordá, in press). Similarly, hulled and naked wheats must have been grown separately because they require different processing techniques.
(2) The diversity could have been related to the very structure of the earliest farming which, for other Mediterranean regions, has been described as intensive, diversified horticulture based on small plots (Halstead, 2002). It might also have resulted from trials wherein the first farmers of a particular region experimented with all available crops and assessed the results of farming practices in a new ecological setting.
(3) The cultivation of small plots with a wide range of different crops may have been the result of a conscious strategy designed to minimize risk. As Halstead has pointed out in reference to Greece, farmers can protect themselves against failure by growing a diversity of crops with different growth requirements and tolerances (Halstead, 1996). In the Valencia region in the Late Neolithic (fourth millennium BC), agriculture started to focus on a smaller selection of crops, a strategy that might also have been linked to technological changes and to the cultivation of bigger fields (Pérez Jordá, in press).
(4) The different uses of the crops could have determined their selection and growth. The first farmers, either aware of different uses or perhaps exploring different uses, decided to grow a wide range of crops. For example, the flour and dough properties of the different wheats vary. Straw is also an extremely valuable by-product with different uses depending on the species. In the case of barleys, present-day farming communities favor naked barleys for the preparation of food, whereas hulled forms are preferred for animal food and for brewing beer (Zohary and Hopf, 2000).

In summary, diversity implies that, from the beginning, Neolithic farmers were aware of, and/or explored, the uses and agrarian practices related to these plants. A variety of factors influenced farmers' options when choosing which crops to grow and in what proportions, giving rise to the wide array of situations we can see from our samples, reflecting the complexity of Neolithic farming communities. Among these factors, the reduction of the risk of crop failure may have been a very important one.

Another factor that needs to be explored in order to explain diversity is the interaction between agrarian production and domestic animals: which part, if any, of the production was intended for animal feed and how this modified and was integrated into the agrarian system and into human subsistence. In the Mediterranean region of Iberia, Early and Middle Neolithic animal husbandry was based on caprines, pigs and bovids (in descending order of importance); sheep predominated over goats in a 4:1 ratio. Mortality patterns indicate the selection of young and very young animals, so we may assume production was meat-oriented. The inclusion of goats in the flocks of sheep might have served to feed lambs rejected by their mothers; this is still a common practice among present-day Mediterranean shepherds (Pérez Ripoll, 1999 and personal communication). The limited data for the Atlantic region also show a predominance of caprines (Mariezkurrena, 1990) and milk from goats, sheep and cows might also have been used in human diet. We might be dealing with small flocks which fed on uncultivated areas and on stubble fields of cereals and legumes. At the same time, caves and rock-shelters were being used as corrals (Badal, 1999); the movement of animals could have been restricted, and their food brought to them. Archaeobotanical data from Abric de la Falguera, a rock-shelter used as a Neolithic corral, show that by-products of the winnowing of cereal crops (awns, spikelet bases and chaff) were transported to the site, presumably to feeding the animals.

TOOLS, AGRARIAN PRACTICES AND LABOR

Other works have already focused on Neolithic tools and agrarian practices (Buxó, 1997; Gibaja, 2001; González Urquijo *et al.*, 1994). Faunal remains do not support the use of ards and animals for ploughing during the period before 4000 BC. The site of La Draga is remarkable for being the only waterlogged Neolithic site where plant remains have been studied and for providing different types of picks for ploughing and sticks for digging. Various types of sickles were also found and some of them reveal close similarities with those from the middle Neolithic of the Alpine region (Bosch *et al.*, 2000, 2004; Buxó *et al.*, 2000; Gibaja and Palomo, 2004). In the Basque coastal region, lithic sickle elements were almost non-existent during the Neolithic and only began to be relatively abundant in the Chalcolithic (Cava, 1986, 1990). Experimental and ethnographic research in Spain and Morocco leads us to suggest alternative methods, slower than the sickle, for Neolithic harvesting in this northern region, such as (Ibáñez *et al.*, 2001) uprooting the whole plant, plucking the ears off by hand or with the aid of the *mesorias* (two sticks joined with a string still in use in Asturias, Northern Spain [Peña-Chocarro, 1999]) (Fig. 6). Several factors could have induced farmers to use these alternative techniques, even though they were familiar with the sickle: (a) the cultivation of hulled wheats, as the semi-fragile rachis allows the ear to be easily torn from the stalk, (b) the existence of small fields: the sickle is faster than the other systems so farmers use the slow methods only when working in small fields; (c) the use given to the straw may require a particular length of stalk, (d) a wet temperate climate means that cereals mature more slowly and progressively so time-consuming techniques other than sickles can be used, and (e) the person's skill (see Ibáñez *et al.*, 2001 for full discussion). The diversity in harvesting practices is just one example of how the first farmers went through complex decision-making processes and had some technical choices, in spite of acquiring a whole package of crops and techniques.

The information on agrarian practices is linked to the proper sampling and retrieval of weeds and chaff in our archaeobotanical samples (Hillman, 1981; Jones, 1984, 1987). However, a characteristic of archaeobotanical samples from Iberia is the scarcity of these materials, most finds being composed of clean grain. This could, at least partly, be because most samples come from caves (Fig. 7). In the Neolithic, caves were probably the locus of particular activities (Bouby, 2003) which may not always have reflected the entire *chaîne opératoire* of crop-processing. They can be used as storage places, areas for keeping the animals, hunting or ritual spaces, and so forth. Most agrarian practices would take place outdoors, close to the fields or to the open-air village-sites which existed during the Neolithic but are very poorly known in large regions of the peninsula. Other practices such as careful weeding, exclusive ear gathering during harvesting or post-harvest cleaning might also be the reason for the lack of weeds and chaff in our samples. In spite of this lack of archaeological information, traditional agriculture shows that at least 30 distinct operations are involved in the cultivation of any type of crop and in its conversion into food (Hillman, 1985, 1984). These operations are related to the physical features of the plant, to the scale of production, and to the uses to which it will be put. The dichotomy between hulled and free-threshing wheats is particularly interesting due to the very different processing needs for extracting the grain (Hillman, 1984; Peña-Chocarro, 1999) and would have has significant implications in terms of human labor (Fig. 8), all of which we shall discuss below.

Fig. 6. Harvesting of hulled wheat with *mesorias*, two sticks joined with a string, in Asturias (N. Spain). According to ethnoarchaeological modelling, similar tools might have been used in northern territories of the Iberian Peninsula during the Neolithic. In other regions the use of sickles with flint elements is well documented.

Fig. 7. Chaff imprint of a hulled wheat (*Triticum* cf. *monococcum*, einkorn) on pottery from La Lámpara (Soria). Chaff is very scarce in archaeobotanical samples from Iberia, particularly from caves. It is more common in open-air sites, where crop processing may have taken place.

THE PEOPLE, THE REASONS AND THE CONSEQUENCES

Plants and People

Diffusion is the main process involved in the introduction of crops into Western Europe (Harris, 1996, 2003), although at least in one case, opium poppy, there is evidence to support a local process of domestication in the Western Mediterranean. How plants and animals spread to the west is still open to debate: through demic diffusion (colonization, migration), through cultural diffusion with hunter-gatherers adopting the crops, or through a combination of both. We are obviously dealing with a process that varied according to region. Explanations given for the adoption of farming in the Iberian Peninsula include some of the main models that have been put forward for the adoption of farming in Europe as a whole.

Taking the Pyrenees as the natural route into the peninsula, some authors (Barandiarán and Cava, 2000, p. 312; Utrilla *et al.*, 1998) propose a trans-Pyrenean/Provençal origin for the Neolithic in the southern part of

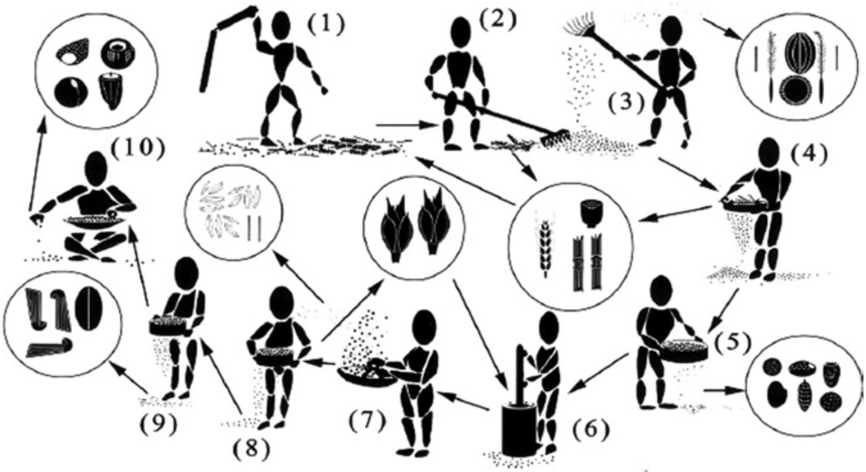

Fig. 8. Hulled wheat processing stages. (1) Threshing, (2) raking, (3) first winnowing—light weed seeds and some awns are removed, (4) coarse sieving—weed seed heads, unbroken ears, straw fragments are removed and unbroken ears are rethreshed, (5) first fine sieving—small weed seeds and awns are removed, (6) pounding, (7) second winnowing—paleas, lemmas and some awns are removed, (8) sieving with medium-coarse sieve—spikelet forks and unbroken spikelets—repounded, (9) second fine sieving – glume bases, awns, remaining small weed seeds, tail grain and awns removed, (10) hand sorting—removal of grain-sized weeds by hand (Stevens, 2003).

the central Pyrenean region, which, according to recent data, seems to be very early. In Catalonia, recent information from La Draga points to certain links with Alpine lake-sites on the basis of agrarian artifactual technology (Bosch *et al.*, 2004) and crop assemblages. One of the most well-known models to explain the Mesolithic–Neolithic transition, at least in the Valencia and Aragon regions, is the dual model. According to this, two communities would coexist: (a) fully Neolithic, allochthonous groups, represented by the classic sites with cardial ceramics and no Mesolithic industrial tradition, and (b) indigenous groups, who would continue hunting and gathering while progressively incorporating some Neolithic elements such as ceramics. The new techniques would spread firstly by direct contact between both communities (direct acculturation) and secondly through contact among indigenous groups (indirect acculturation) (among others, see Bernabeu, 1996, 2002; Fortea *et al.*, 1987; Juan-Cabanilles, 1992; Martí, 1992, 1998; Martí *et al.*, 1987; Utrilla, 2002). This model has been contested by researchers who believe that the archaeological evidence might, instead, reflect single populations carrying out different activities in different sites (Barandiarán and Cava, 1992, 2000, 2001).

For Portugal, Zilhao (2001, 2003) has suggested the maritime colonization of areas uninhabited by Mesolithic people. In the Northern Meseta and Northern Portugal, the colonization of a depopulated area has also been put forward by several authors (Carvalho, 2002; Delibes and Fernández Manzano, 2000; Kunst and Rojo, 1999) although a second model places emphasis on the existence of a local Mesolithic population (Jiménez Guijarro, 1999). It is obvious that Neolithic people navigated, since domesticates spread into the British and Mediterranean islands. However, it seems unlikely that colonization from external populations, maritime or not, was the driving factor in the spread of plants through the continent or through the Iberian Peninsula. The known coastal distribution of Late Mesolithic and Neolithic sites in Iberia (Juan-Cabanilles and Martí, 2002) is most probably the result of archaeological activity, and the huge archaeologically vacant territories might fill if research focused on new regions, as, for example, the recent discovery of new sites during surveys in the inland province of Soria (Kunst and Rojo, 1999).

In the northern coastal fringe along the Bay of Biscay, all authors support an indigenous adoption of farming (Alday, in press; Arias, 1999; Barandiarán and Cava, 2001; López Quintana, in press; Zilhao, 2000). Similarly, in the Upper Ebro Valley where more sequences are available, continuity can be seen from the Mesolithic to the Neolithic in the settlements and in other aspects, such as lithic industry (Alday, 1999, 2000, in press; Barandiarán and Cava, 2001). The number of early Neolithic sites was not very high in comparison with Mesolithic ones (Barandiarán and Cava, 2001: 525), and there is no evidence of immigration. However, this picture of continuity might be challenged by the finding of open-air sites like Los Cascajos in the Upper Ebro Valley.

Another line of evidence used to study human migrations in the past is molecular biology. The contemporary Basque population is probably the best studied in Iberia since it is a genetic outlier for several loci as well as the Rh-negative allele (although mitochondrial studies do not identify differences between this population and the bulk of Europeans [Barbujani, 2002]). However, the available genetic data are ambiguous when trying to assess population continuity in the past, since the Basque status may be partly the result of reduced Neolithic penetration as well as genetic drift due to isolation and small population size (Richards, 2003, p. 153).

In sum, different Mesolithic cultural settings and different ecological situations conditioned the way in which cultivated plants became integrated into human subsistence. The adoption of farming was not a homogeneous process throughout the territory and present data show that we are dealing with an extremely dynamic scenario with some scholars supporting episodes of maritime colonization and others placing emphasis on processes of acculturation.

Thoughts on Causality

"No hunter-gatherer occupying a locality with a range of wild foods able to provide for all seasons is likely to have started cultivating their caloric staples willingly. Energy investment per unit of energy return would have been too high. However, cultivation offered one major advantage: it allowed more calories to be extracted per unit area of land, albeit at the expense of much hard work and ecological damage" (Hillman, 2000, p. 393).

Could this quote from Hillman, referring to Near Eastern hunter-gatherers, be applied to the Mesolithic populations of the western end of the Mediterranean? Are we facing the same causality throughout Eurasia? The reasons behind the adoption of farming in the Old World are a recurrent focus of archaeological research, and a controversial issue since this is a topic embedded in theoretical traditions and backgrounds. For a long time, environmental change with a decline in wild food and/or demographical stress were supposedly the triggers. However, environment and demographical changes, even if they may explain the origin of cultivation in the Near East (Hillman *et al.*, 2001; Hillman, 2000), do not shed light upon the spread of farming through Europe: a phenomenon which happened at different times in different regions and, therefore, under different climatic and demographic situations. Even if we accept the arrival of external populations into the Iberian peninsula bringing agrarian practices with them, agriculture was also eventually adopted by the local hunter-gatherers. Why the success of farming and, in particular, why the success of cereals?

Firstly, the process of sowing and obtaining a harvest must have given the first farmers a clear sense of control over nature unlike any form of management of wild plants. The advantages of extracting more product in a very limited area and at a given time are obvious, although it would be at the expense of a lot more work and the risk of crop failure. Wild plants available in Mesolithic Iberia did not offer such potential. Crops can be easily stored *per se* or by feeding them to domestic animals although we do not know how much of the crop was devoted to animal forage and, thus, to increasing the growth and reproduction rates of domestic animals.

In Iberia, in terms of nutrition, acorns were probably the best potential energy staple of pre-farming societies. They were bulk carbohydrate providers, were very similar, in nutritional terms, to cereals (Mason, 1995) and were extremely abundant in the Holocene forests. It is very likely that they were systematically consumed by Mesolithic people (Mason, 2000; Zapata, 2000) although they would have had to be processed in order to remove the astringent tannins (Mason, 1992). Within an otherwise relatively monotonous and limited spectrum of protein and starch-rich plants, it is difficult to understand what the impact of becoming familiar with cereals and domestic legumes must have been for Western Europeans. The cereals had new tastes; they could be cooked in diverse ways; they could be brewed to produce alcohol (this was probably an early by-product); they could be produced in controlled quantities; and, at least in the case of cereals, did not need to be detoxified before consumption. Also, the exorphines present in cereals seem to activate reward centers in the brain and create a sense of well-being when they are consumed in quantity (Wadley and Martin, 1993, cited in Hillman *et al.*, 2001), something that may reinforce their regular consumption. Hayden (2003, p. 462) attributes the good taste of cereals to the balance of lipids to protein and starch, which naturally appeals to people's palates. Not surprisingly, "bread" is often a synonym for food. Cereals are extremely valuable in certain periods of people's lives, in the weaning of children, for example, and in animals' lives: present-day farmers consider some cereals to be first-class animal fodder and to be suitable for animals which have just given birth. Cereals provide high-quality raw material for a diversity of crafts and the straw of hulled-wheats specifically is highly rated for thatching in Mediterranean regions (Fig. 9).

Some scholars have long suggested (for example, Bender, 1978) a relationship between initial domestication and social relations. The prestigious use of foods related to competitive feasting has recently been re-evaluated by Hayden (1996, 2003), and attention is now being paid to luxury foods in the past (van der Veen, 2003). Luxury foods are foods that are not necessary for survival and that are usually rare, expensive, or exotic. They tend to be consumed on certain occasions and are often imported (Bakels and Jacomet, 2003). It may be that cultivated foods were such luxury elements in Neolithic Western Europe, at least for some time. People tasted cereals and legumes before they actually grew them and, in all probability, they became desirable foods. It is likely that, in this context of high prestige value during the early Neolithic (while there were still hunter-gatherers and farmers' crop-production was limited), cereals and other crops could be easily exchanged for other commodities as Hayden (2003, p. 463) suggests for rice in southeastern Asia. Alliances among groups usually involve material flows which take advantage of existing networks, and cereals may well have spread rapidly in this way. We agree with Price (2003) that the adoption in Europe of such a global phenomenon as farming had little to do with environment and demography, but was related to internal factors of human

Fig. 9. House thatched with einkorn (*Triticum monococcum*) straw in Mediterranean Morocco, the main reason for growing this cereal in the Rif.

society and the decisions that human groups made with regard to their ways of life.

Some Clear and Not-So-Clear Consequences of Farming

As pointed out by Hillman (2000, 2003) and Hillman *et al.* (2001) for the Near East, and as is applicable to other parts of Eurasia, the adoption of agriculture, even if it was on a small scale, had radical implications for ecology, habitat, labor, human diet, social and economic organization, political power, ideology and probably gender relationships. Some of this impact is particularly visible after 4200–4000 BC when the first megaliths were being built, but most of these changes had begun at least 1000 years earlier in Iberia and were closely linked to the new farming activities.

Agriculture usually implies significant *modifications to the landscape* through human intervention in plant cover. The balance with the environment in some areas of Iberia was so delicate that farming and demographic growth had a serious impact on soils (Martínez Cortizas and Moares, 1995) and vegetation-cover throughout the territory, although there may also have been some human disturbances during the Mesolithic (Ramil, 1993). Anthropogenic impact, which was a combination of deforestation processes, transformation of plant communities, expansion of secondary woodland formations, as well as pioneer, pyrophilous, ruderal, and nitrophilous taxa, is visible in the pollen and wood–charcoal records [See, for example, Ramil (1993)] for the mountain areas of Galicia; Iriarte (2002) and Zapata (2002) for the Basque Country; Riera *et al.* (2004) and Badal (2002) for Mediterranean Spain].

Crop husbandry reinforces restrictions in mobility and stable settlement as crops require periodic attention and grain stores are not easily moved (Jones, 2000). Farming means that much greater quantities of food can be raised, facilitating both sedentariness and demographic growth. The data on Neolithic *settlement patterns* in Iberia are extremely biased by the fact that most of the sites we know are caves or rock-shelters (see distribution of sites and dates in Juan-Cabanilles and Martí, 2002). These may have had very specific uses during the Neolithic, such as corrals (Alday *et al.*, 2003; Badal, 1999). In many areas (northern coast, Andalusia and so forth), very few or no open-air settlements are known for the period before 4000 BC. However, the recent excavation of sites like La Draga (Bosch *et al.*, 2000), Mas d'Is (Bernabeu *et al.*, 2003), Los Cascajos (García Gazólaz and Sesma, 2001), Plansallosa (Bosch *et al.*, 1998), Font del Ros (Bordas *et al.*, 1996) or the Ambrona complex (Kunst and Rojo, 1999), offers a completely different picture. Postholes defined various types of houses associated with other structures such as hearths, silos, ritual deposits and areas for the extraction of building materials. The presence of large ditches at some sites implies that, at least 1000 years before megaliths were built, considerable *communal energy input* was devoted to the construction of monumental earthworks—a deliberate and perdurable modification of the landscape. Although interpetation of ditched enclosures is problematic [in Iberia, interpretation starts to be better defined only in the third millennium BC (Díaz del Río, 2004)], they do not appear to have been defensive structures, nor did they delimit habitation areas. They have been tentatively interpreted as aggregation centers intended for specific functions (funerary, ceremonial?) (Bernabeu *et al.*, 2003). The creation of new collective social spaces reflects significant changes in social organization and political power within early Neolithic societies. New leadership and social regulations could have been needed because of new types of conflict deriving from prolonged sedentariness (Bender, 1978) or from more restricted access to land.

Agriculture is hard work. The first cultivation of cereals in new regions was probably costly and high-risk, particularly in environments like oceanic northern Iberia. Considering how many different crops were being grown in the early Neolithic, *labor strategies* at the family- or group-level would soon have had to be adapted to the new seasonal tasks, leading to significant changes in the arrangement and planning of activities. To take one of the clearest examples, hulled wheats are extremely labor-intensive, and they have probably become relict because of this. After threshing, they are often stored as spikelets which must be dehusked and cleaned to obtain the grain. Dehusking can be done on a daily or small-scale basis in a variety of ways, such as pounding in wooden mortars, in holes in the ground, or in querns, or rubbing in baskets with a soft material like cork (d'Andrea, 2003; Hillman, 1984; Peña-Chocarro and Zapata, 2003) (Fig. 10). Afterwards, the grain from both hulled and free-threshing cereals must be cleaned through winnowing, sieving and hand sorting, and is eventually ground into flour or easily digested fragments.

There is no evidence for such time-consuming domestic activities in western Europe during the Mesolithic. Whittle (2003, p. 43) points out that research has focused on how crops were tended but little attention has been paid to the socialities involved. Although it is dangerous to assume that gender roles are immutable through time, a division of labor related to gender has been found in all cultures (Kottak, 1997, p. 316). D'Andrea (2003) observes that cross-cultural ethnographic studies support a link between plant–food processing in its final stages and women. Agriculture, and in particular the processing of time-consuming crops such as einkorn and emmer wheats, which are very well documented in Neolithic Iberia, inevitably had a serious impact on people's workloads and we should consider that it may have affected women in particular.

Because of this need for labor, the practice of agriculture tends to limit the time available for foraging and gathering wild foods from remote areas (Hillman, 2000). Although information on this issue is extremely limited because very few Mesolithic sites have been properly sampled for plant macroremains (Mason and Hather, 2002), we can suggest an increasing dependence on a narrow range of domestic species during the Neolithic. This would lead to a *collapse of dietary diversity*, and knowledge of the ecology and methods for wild plant gathering and processing would also tend to be forgotten. This issue should be re-addressed in future archaeobotanical research.

Ethical and *spiritual perceptions* concerning humans' relationships with the world necessarily went through significant changes. In Iberia, this can be perceived through the manifestations of art, the assessment of which goes beyond the scope of this paper (see, for example, Bernabeu, 2002; Fairén, 2004; Sanchidrián, 2001; Utrilla, 2002; Utrilla and Baldellou, 2002). The energy input required for agriculture, even at a very small scale, would lead to a *proprietorial attitude* toward land (Fairbairn, 2000). Even if land were plentiful, this would very quickly generate control of access to particular resources, individualistic concepts of ownership, and the related production of symbols and territorial markers. Is this the role of rock-art or

Fig. 10. Dehusking of hulled wheat (*Triticum monococcum*, einkorn) in a mortar excavated on the floor in the Rif mountains (Morocco).

megaliths as has long (Renfrew, 1973) been suggested? In any case, in the Iberian peninsula megaliths were being built from ca. 4200–4000 BC, more than 1000 years after a very complex type of agriculture was established, so we need to see these burial structures as the product of societies that had been farming for a very long time.

CONCLUSIONS

The spread of agriculture was a *quick process* throughout the Mediterranean area and also within Iberia. Sites on the eastern Mediterranean coast of the peninsula have cereal caryopses dating from ca. 5600–5500 BC. Recent data show that areas traditionally not considered pioneer, such as the Pyrenees and the Meseta margins, may likewise have been early agrarian contexts, although their chronology needs to be confirmed with the radiocarbon dating of domestic plants or animals. Data from the northern coastal fringe along the Bay of Biscay show a delay with respect to other regions, with agriculture not starting until ca. 5200–4600 BC. This might be a product of archaeological research but we cannot completely rule out a frontier situation with hunter-gatherers exploiting wild resources and ignoring farming. We still lack plant macroremains for large areas.

The rapid spread of agriculture in Iberia need not necessarily be explained by the vector—for example, maritime colonization was obviously not involved in inland territories—but was more likely related to Mesolithic societies, human decisions and social relations. Although it is obvious that Neolithic people navigated and spread crops along European coasts and islands, crops must have also spread through existing Mesolithic networks and alliances. We suggest that there were very good reasons that cereals, legumes, and oil/fiber crops were desirable products. The case of cereals is archaeologically the most apparent. Cereals must have been greatly appreciated by the last hunter-gatherers and the first farmers because they offered malleability, palatability, the possibility of high productivity, self-storage or for feeding domestic animals, a sense of control over nature, and perhaps the fatal attraction of being a luxury and highly valued food. Work was hard but the returns in wealth and social terms were apprently worth the effort.

The presence of a *diversity of crops*, such as that documented in Neolithic Iberia, with different requirements, processing and uses, implies that the first farmers quickly imported or acquired wide range of agrarian knowledge. The absence of free-threshing wheats in some early sites may reflect real regional or site patterns which could be related to factors like ecology, culture and the use of crops. A reduction in the risk of crop failure might be another reason behind diversity. A characteristic of the archaeobotanical samples from Iberia is the scarcity of weeds and chaff and, consequently, information on agrarian practices is extremely limited.

The adoption of agriculture soon entailed significant *transformations* on ecology, habitat, human diet, social and economic organization, ideology and probably gender relations. Some regions in Iberia had a fragile balance with the environment so soils and vegetation-cover suffered important changes, which are visible in archaeobotanical samples. Settlement patterns have only recently begun to be re-assessed through the excavation of early and middle Neolithic open-air sites. The presence of ditches might indicate that heavy communal work was already practised at least 1000 years before the megaliths were built. Iberian megaliths were built only from ca. 4200–4000 BC and thus were the work of experienced farming societies.

Agriculture meant increased *labor* cost. Considerable efforts had to be made at key, seasonal periods, and some crops required very labor-intensive processing on a daily basis; we think it is likely that these new everyday tasks were women's work. How this changed people's lives in Neolithic Iberia and how labor was controlled are things that should be further explored by archaeological research.

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