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Ethnobotany of millet cultivation in the north of the Iberian Peninsula

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Abstract Having found *Setaria italica* (foxtail millet) and *Panicum miliaceum* (broomcorn millet) still being cultivated traditionally in the north of the Iberian Peninsula, we carried out ethnographic interviews with farmers to help us document an agricultural process on the verge of extinction. Crop processing of *S. italica* and *P. miliaceum* varies depending on the use of either plant. In Asturias, *Setaria italica* is harvested while green and used as fodder. In Galicia and in the north of Portugal, *P. miliaceum* grain is used mainly for human consumption. This distribution of millet in the north of the Iberian Peninsula appears to have been the case in prehistory too, although this will need to be confirmed by future research.

Keywords Ethnobotany · Millet · *Panicum miliaceum* · *Setaria italica* · Iberian Peninsula · Crop processing

Introduction

Ethnobotany is a fundamental tool for recording farming practices on the verge of extinction and for establishing the patterns that enable us interpret the archaeobotanical record. In this respect, ethnobotanical studies that document traditional millet crops have multiplied in the last two decades. *Millet–Hirse–Millet,* edited by Hörandner (1995) and based on a variety of studies in Europe and Asia, provides valuable information on consumption and on the different stages of millet crop processing. Reddy (1997) used his ethnoarchaeological work in India to define the first interpretative models on millet crops and complemented Hillman's (1984) and Jones' proposals (1984) in relation to wheat and barley crops in Turkey and Greece. The first ethnobotanical studies on millet processing in East Africa were carried out by Young (1999) in Uganda and D'Andrea et al. (1999) in Ethiopia. The article by Lundström-Baudais et al. (2002) on *Panicum miliaceum* L. processing in Nepal and France describes the operational chain in each location and deals with such interesting subjects as heat treatment and milling in relation to cereal dehusking. Manithottam and Francis (2007) report *Eleusine coracana* (finger millet) as a crop cultivated by the *Muthuvan* tribes in Kerala, southwest India. Among other aspects, they list the criteria and techniques used for selecting and preparing the soil for sowing. The latest ethnobotanical works on millet focus on specific aspects which could help throw light on the archaeobotanical assemblage as well as on the archaeological record. By way of example, (Song et al. 2013) underline the importance of immature grains when characterising the crop processing, whereas Hamon and Le Gall (2013) focus on the social role of the mills used in processing millet.

Two millet species have traditionally been cultivated in the Iberian Peninsula, *Setaria italica* L. (foxtail millet) and *Panicum miliaceum* L. (broomcorn millet). The traditional *P. miliaceum* crop in Galicia had already been described (Vázquez Varela 1993/94, 1994), but the lack of ethnobotanical studies on the cultivation of *S. italica* in Asturias

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and the need for a better understanding of the role of the different kinds of millet during prehistory impelled us to go more deeply into the subject. With the aim of documenting traditional crops possibly still surviving, we made several field trips between 2009 and 2013 to areas in which the crop was thought to have been quite common, at least until the 1960s or 1970s. Locating both *S. italica* and *P. miliaceum* meant that we had the information to record the different stages of the agricultural process and were able to identify the resulting products and by-products which could have survived in the archaeological record.

From the start we recognised a particular spatial distribution in relation to millet types in the north of the Iberian Peninsula. In Asturias, *S. italica* or mixed crops of *Setaria* and *Panicum* predominate and in the region comprising Galicia and the north of Portugal we found *P. miliaceum*. We are currently unable to find sources speaking of or actually recognising *S. italica* in Galicia and Portugal. Only *P. miliaceum* is mentioned. In Asturias, though both plants are known and sown in combination, *P. miliaceum* is considered a companion crop to *S. italica*. This may be a consequence of modern activity, and may be due to the different uses for which the crops have survived. In Galicia, the fundamental use of the grain is as food for humans or animals and in Asturias the plant is used for fodder.

Millet cultivation: archaeological and historical background

Panicum miliaceum and *S. italica* are not among the first domesticated cereals which were grown in the Near East (Zohary et al. 2012). To date, the earliest finds of *P. miliaceum* and *S. italica* are from the Cishan site in northeastern China, where phytolith and DNA analyses have helped place *P. miliaceum* in the middle of the 9th millennium cal BC and *S. italica* in the middle of the 7th millennium cal BC (Lu et al. 2009).

In Europe, the first finds of *P. miliaceum* have been dated to the 7th–6th millennia cal BC in eastern Europe (Kotova 2003; Amirkhanov 1987; Marinova 2001) and to the 6th–5th millennia cal BC in central Europe (Kreuz et al. 2005). However, direct AMS dating of several grains of *P. miliaceum* from Neolithic contexts has called into question this early presence of millets in Europe (Motuzaite-Matuzeviciute et al. 2013). Recent archaeobotanical studies seem to indicate that *P. miliaceum* became widespread in eastern and central Europe around the 4th–3rd millennia BC (Motuzaite-Matuzeviciute et al. 2013; Valamoti 2013). This could likewise be the case with the first dates for *S. italica* in Europe. Though its presence has been detected back to the 5th–4th millennia BC (Hunt et al. 2008), direct dating of these finds could bring this date forward. As far as western Europe is concerned, millets first appeared during the 3rd–2nd millennia cal BC, although it was not until the 1st millennium cal BC that their cultivation became widespread (Buxó and Piqué 2008).

The fact that *P. miliaceum* and *S. italica* did not appear in central Asia until the 2nd millennium BC has given rise to an interesting debate on the process of domestication and dispersion of these types of millet. As Hunt et al. (2008) pointed out, further light on this question would provide some insight into the interaction between the first farming societies in Eurasia.

The consumption of millet, by humans and animals alike, has been dated in Mongolia to the 6th millennium BC (Liu et al. 2012), whereas it has so far not been identified in Europe until the 2nd millennium BC (Tafuri et al. 2009). Liu et al. (2012) established that millet was a staple crop in Mongolia, and at first in the initial Neolithic, it was even more important in the human diet than for animals.

Millets in the Iberian Peninsula

In the Iberian Peninsula, the earliest evidence for *P. miliaceum* is from the Portuguese site of Castro de Palheiros (Figueiral 2008) which is dated to the 3rd millennium BC. The first evidence for *S. italica* is from the Kobaederra cave (País Vasco), corresponding to a level dated to 3310–2900 cal BC (Zapata 2002). Nevertheless, the first significant assemblages of *S. italica* were found in the sites of Cova de Punta Farisa and Masada de Ratón (Huesca), dated to the middle of the 2nd millennium cal BC (Alonso 2000). Millets also appear during the Bronze Age in the southeast of the Iberian Peninsula, in sites related to the Argaric Culture (Buxó and Piqué 2008).

In the northwest of the Iberian Peninsula, *P. miliaceum* likewise appears at the Portuguese site of Sola, at the Sola IIb level, dated to 1690–1520 cal BC (Bettencourt 2003; Bettencourt et al. 2007). However, the cultivation of *P. miliaceum* only developed fully in this area during the first Iron Age, as reflected in the large number of finds recovered in Galician sites such as As Laias/O Castelo (Tereso et al. 2013b) and in the hillfort of Penalba (Aira Rodríguez et al. 1990). *Setaria italica* was found here at 3rd/4th century AD levels at Monte Mozinho (Tereso et al. 2013c) and 4th/5th century AD levels at São Lourenço (Tereso et al. 2013a) and Teronha de Pinhovelo (Tereso 2009). The only direct (unpublished) date for *S. italica* corresponds to that discovered in the Galician hillfort of Navás (176–41 cal BC, CNA-1080, 2080 ± 25 BP, calibrated with OxCal v4.2 .4., Bronk Ramsey and Lee 2013, using IntCal13, Reimer et al. 2013).

Millet would have been introduced into the Iberian Peninsula through the Pyrenees, either on the western side through Navarre or Gipuzkoa, or on the eastern side, through the Quercy or Midi regions of France (Hopf 1991).

Its arrival can be seen as part of a prehistoric globalization process of food, in which millet, a short-cycle cereal, adapted well to the climate conditions and could be combined with other crops (Jones et al. 2011).

The current spatial distribution of millet coincides with that of its archaeobotanical remains from prehistoric sites in the north of the peninsula (Moreno-Larrazabal 2010; Dopazo Martínez et al. 1996; Teira Brión 2010; Tereso et al. 2013a): *P. miliaceum* is more ubiquitous in the northwest and *S. italica* is more so in the central northern area. This distribution will need to be confirmed by future research. There are several possible reasons for this distribution: (a) ecological characteristics, such as the needs of the different plants or the climate or soils; (b) economic factors, related to productivity; (c) aspects related to processing and the properties of each plant; (d) cultural preferences or (e) the purpose for which it is grown.

The diet detected from the isotopic analyses from various cemeteries of the Roman and medieval period in Galicia was a mixture of terrestrial and marine resources, with a presence of C_4 plants (López Costas 2012). This indicates not only the great importance of millet in this geographical region but also the fact that it was integrated into the diet. According to Austin (2006), the choice of one or other crop may also be related to the interests of the ruling class, which would dictate the market's direction. Portela's study (Portela Silva 1976) on ecclesiastical documentation of the archbishopric of Tui (Pontevedra, Galicia) indicates the number of times the different crops used as payment for land lease were mentioned in the period from AD 1100 to 1400. Most of the references are to grapes (n = 812) and cereals (n = 257) in general, whereas the number of references to leguminous crops (65), fruit (45) and vegetables (17) is notably less. The cereal taxa mentioned are *Triticum* sp. (wheat, n = 93), *P. miliaceum* (n = 80), *Hordeum vulgare* (barley, n = 61) and *Secale cereale* (rye, n = 33). *Setaria italica* is not mentioned. The products most appreciated by the church were grapes, as wine was a marketable product, and in the case of cereals, *Triticum*, because a smaller amount was needed to pay the rent (Portela Silva 1976).

During the early modern period, with the introduction of *Zea mays* (maize) at the beginning of the 17th century, millet was gradually relegated to a secondary role. Maize came into direct competition with millet, although both are short-cycle spring crops, because maize gives a greater yield and profitability (Álvarez Blanco 2002). Thus, on the A Mariña coast of the Bay of Biscay and the Atlantic coast of the Rías Baixas, all references to millet disappeared between the middle and end of the 18th century, two centuries after the arrival of maize. These were regions where it had once accounted for between 10 and 40 % of cereal production (Álvarez Blanco 2002).

In the mid 19th century, numerous mentions of *S. italica* and *P. miliaceum* were recorded in the northwest and can be found in the *Diccionario geográfico-estadístico-histórico de España y sus posesiones de ultramar* (Madoz 1846/50). It lists the various crops and their production in Spain. In Galicia and Asturias there are abundant references to the cultivation of *P. miliaceum* and *S. italica*, with *P. miliaceum* more prevalent in both regions, particularly in Galicia. There are some exceptions, either because very little importance was given to the crop in southwest Galicia and in the neighbouring regions of Castile and León, or the data available in the various legal entries used in the drafting of the dictionary are unequally distributed. For example, no data are offered for areas where millet crops have survived until recently.

Currently the cultivation of millet in the northwest of the Iberian Peninsula is negligible in comparison to what it had been until the first half of the 20th century. A variety of factors such as globalization, the crisis in the agricultural and fishing sectors or the introduction of new crops almost led to its disappearance. Another cultural factor may be worth considering. Austin (2006) suggests that some crops could have lost their appeal because they were linked to extinct habits or customs, or indeed poverty. Millet was a legacy from a traditional agricultural system in the process of disappearing, and had no place in the new market farming model, where financial yield is essential.

Methods

The area studied comprises the northwest of Spain (Asturias and Galicia) and the north of Portugal (the Minho-Lima sub-region), within the hilly and montane areas of the Euro-Siberian biogeographical region, at altitudes between 200 and 1,000 m and with a temperate Atlantic bioclimate (Fig. 1). In Asturias, the work was carried out in the southern part, in the municipalities of Cangas del Narcea, Allande and Degaña. A large part of the work was done in Villategil, located in Cangas del Narcea, and in Rebollar in Degaña. In Galicia, several villages in the provinces of A Coruña, Lugo and Pontevedra were studied. The municipalities of Rois (localities in Busto and A Senra) and Negreira (in Camiño Real), in the province of A Coruña and Xermade (in Cabreiros) in the province of Lugo were of vital importance. In Portugal, the parish of Cunha (Paredes de Coura, Minho-Lima) was chosen for the study.

Two information sources were used to document traditional millet crops: the observation of current crops of *P. miliaceum* and *S. italica* being grown (Fig. 2), and ethnographical interviews carried out on farmers who had grown it traditionally until a few decades previously.

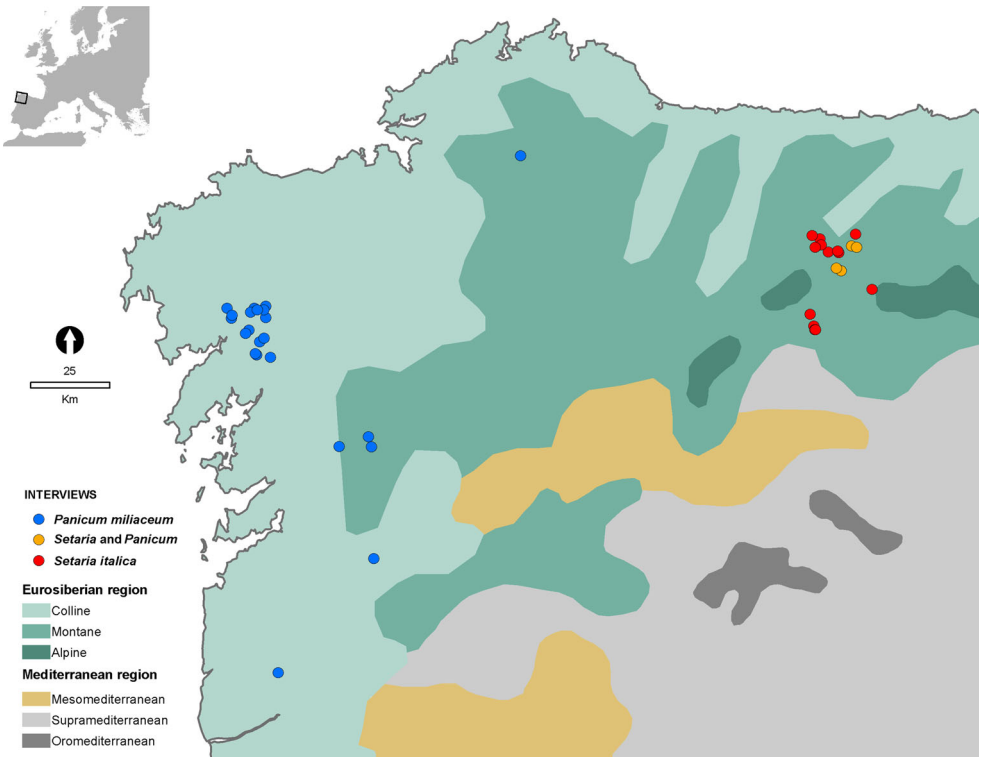

Fig. 1 Map of area studied and the localities whose inhabitants were interviewed

Fig. 2 *Setaria italica* **a** seeds; **b** ear; **c** plot; *Panicum miliaceum* **d** seeds; **e** ear; **f** plot

Field work was carried out between 2009 and 2013. In this period, 57 people from 39 different villages were interviewed (Table 1). The average age of those interviewed was 65, although some were considerably older, one of them being 95. Existing crops were identified; one of *S. italica* in Rebollar (Asturias), a mixed crop of *S. italica* and *P. miliaceum* in Villategil (Asturias) and four crops of *P. miliaceum* in Galicia (two in Rois and two in Negreira, Galicia).

A *non-structured* interview model was used, which had a qualitative approach (Bernard 2006), and avoided direct pre-set questions. Though we felt that it was necessary to provide a series of common answers, the subject and different elements of the interview could be broadened and

Table 1 Data corresponding to the interviews carried out in Asturias and Galicia (Spain)

Crops				Interviews			Places		
Setaria italica	*Panicum miliaceum*	Current crop	Last crop	No. of people interviewed	Age of those interviewed	Last interview	Villages	Council	Administrative division
•			1992	1	40	2012	Adralés	Cangas del Narcea	Asturias
•			2002	1		2012	Almoño	Allande	Asturias
•				1	65	2012	Borracán	Cangas del Narcea	Asturias
•	•			1	93	2012	Castro de Sierra	Cangas del Narcea	Asturias
•			1988	1		2012	Fonduveiga	Degaña	Asturias
•				1		2009	Genestoso	Cangas del Narcea	Asturias
•			2000	1	50	2012	Iboyo	Allande	Asturias
•			1983	1		2012	Larón	Cangas del Narcea	Asturias
•	•		1975	1	70-80	2012	Piñera	Cangas del Narcea	Asturias
•	•		1950	1	65	2012	Porley	Cangas del Narcea	Asturias
•		•	2013	2	~55, 85	2013	Rebollar	Degaña	Asturias
•			1990	1	65	2012	Robledo de San Cristóbal	Cangas del Narcea	Asturias
•			1988	1	35-40	2012	Trones	Allande	Asturias
•				1		2009	Villadestre	Cangas del Narcea	Asturias
•	•	•	2013	2	60, 63	2013	Villategil	Cangas del Narcea	Asturias
•			2002	3		2012	Zreicéu	Cangas del Narcea	Asturias
	•		1940	1	~75	2012	A Graña	Brión	Galicia
	•	•	2010	1	~40	2012	A Senra	Rois	Galicia
	•		1970	1	~50	2012	Agrafoxo	Rois	Galicia
	•	•	2012	1	65	2012	Aro	Negreira	Galicia
	•	•	2013	2	95, 75	2013	Busto	Rois	Galicia
	•		1970	1	~60	2012	Busto de Frades	Brión	Galicia
	•		1970	10	85, 60-80	2012	Cabreiros	Xermade	Galicia
	•	•	2013	1	63	2013	Camiño Real	Negreira	Galicia
	•		1960	1	77	2012	Campolongo	Negreira	Galicia
	•		1960	1		2012	Carrais	Rois	Galicia
	•		1940	1	~65	2012	Ceilán	Negreira	Galicia
	•		1950	1	~70	2013	Cimadevila	Campolameiro	Galicia
	•		1970	1		2012	Deán	Cerdedo	Galicia
	•		1970	1	50-65	2012	Ons	Brión	Galicia
	•		1930	1	90	2012	Oroso	A Cañiza	Galicia
	•		1990	1	~40	2012	Outeiro	Negreira	Galicia
	•		1940	1	~60	2012	Sanguñedo	Forcarei	Galicia
	•		1960	1		2012	Soutelo de Montes	Forcarei	Galicia
	•		1960	1	~60	2012	Urdilde	Rois	Galicia
	•		2012	1	62	2012	Vilachán	Negreira	Galicia
	•		1980	2	45-65	2012	Xallas de Abaixo	Negreira	Galicia
	•		1940	1	75	2012	Zas	Negreira	Galicia
	•		1990	4	60-75	2013	Cunha	Paredes de Coura	Minho-Lima*

* Portugal

was in no way to be conditioned by the interviewer. This was motivated by the desire give interviewees a certain amount of liberty to speak of their experience from their own points of view and to use any expressions they wished or talk about what they considered important.

The questions which were asked aimed at defining each stage of the farming process, from the initial stages such as sowing, fertilising and weeding, to the final stages such as harvesting, threshing, sieving, winnowing, dehusking, milling and consumption. Samples were taken of the product and by-product from each operation and then analysed.

Results

Crop processing is similar in the case of both crops. It differs mainly in activities related to the end use. The main aim of this work is to describe the stages involved in the processing (Fig. 3), and define the products and by-products resulting from them (Fig. 4). We shall then combine what was observed in existing plots with the information gleaned from the interviews.

Tillage/ploughing

In Villategil and Rebollar (Asturias), *S. italica* is currently grown alongside pumpkins, legumes and potatoes. It seems that formerly it was sown once the barley or oats were harvested. Potatoes were sown after *S. italica*. In Galicia, Vázquez Varela (1994) describes five possible rotations for *P. miliaceum*: wheat–millet–grass; wheat–millet–fallow; rye–millet–grass; rye–millet–fallow and rye–millet–turnips–potatoes. Although in recent times millet was often rotated with other plants like potatoes or grass, Vázquez Varela favours its association with rye.

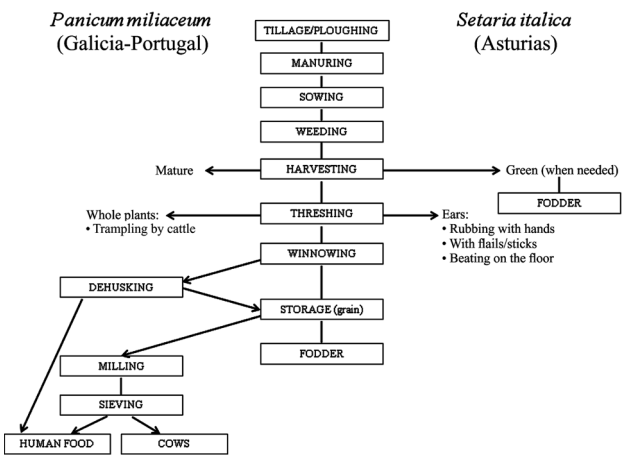

Fig. 3 Processing stages of *Panicum miliaceum* and *Setaria italica*

In Asturias and Galicia, the soil was prepared with the aid of a wooden plough drawn by cattle or donkeys up until the 1960s. Nowadays a tractor is used.

Today, the soil is not fertilized before sowing millet. In the past, this was very common. Some of the people interviewed in the region of Rois (Galicia) mentioned that soil for growing rye was heavily fertilized, as this had to be done for 2 years and it was also done for *P. miliaceum* crops. In Asturias, manure was used, but only when required by the soil.

Sowing

Both *S. italica* and *P. miliaceum* are short-cycle cereals, which is why they are sown late. The sowing date can vary depending on the weather on the preceding days and on the moisture in the soil. In Asturias, *S. italica* is sown between the end of May and the end of June. There are two clearly differentiated areas in Galicia depending on the type of crop rotations associated with *P. miliaceum*. In the hinterland of Lugo, in the municipality of Xermade, it used to be sown in the first half of June. In the west of Galicia and in Portugal, *P. miliaceum* was sown at the end of June, coinciding with the feast of St. John (24th June), and it was closely linked to the harvesting of rye as already mentioned.

Seeds are sown broadcast and a harrow is then used to flatten the soil. Both *S. italica* and *P. miliaceum* require a dry soil for sowing, although not too dry as some moisture is needed to favour germination. Conditions are optimum if it has not rained in the 2 or 3 days before sowing, but some rain after a week is beneficial. The crop is not irrigated, so climate plays a decisive role in the plant's development. As we have been able to appreciate in Rebollar (Asturias) during the course of the study, dry, hot summers reduce the size of *S. italica* considerably. On the other hand, wetter and cooler summers favour optimum growth. Something similar occurs with *P. miliaceum*. Some of those interviewed mentioned that following very dry summers, the crop is scarcely enough to provide grain for sowing the following year.

Weeding

Nowadays *S. italica* and *P. miliaceum* crops are not weeded. Indeed, some farmers indicated that weeds not only do not affect the crops but are actually beneficial when they are used as green pasture. With persistent rain, the weeds invade the unharvested crop and it is then used as pasture. The predominant weeds in this type of crop are *Convolvulus arvensis* and *Chenopodium album*. Vázquez Varela (1994) points out that the fact that *P. miliaceum* crops are not weeded, fertilized or are used in rare rotations

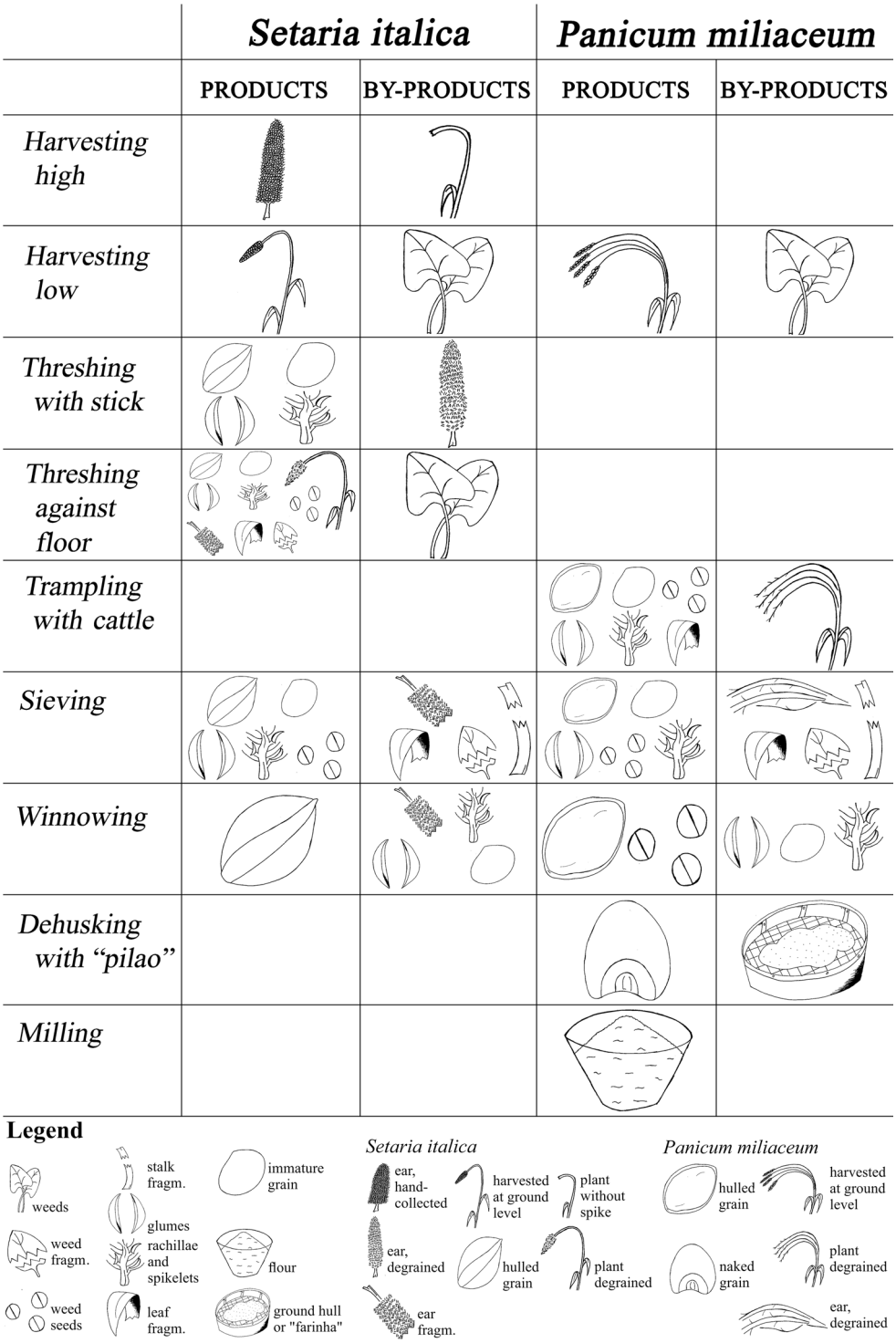

Fig. 4 Products and by-products generated in the processing of *Setaria italica* and *Panicum miliaceum*

may reflect their decline. In the case of *S. italica*, this makes sense, as it has survived only as a fodder crop.

Harvesting

In Asturias, *S. italica* is harvested between mid-August and mid-September. Most of the crop is harvested green, to be used as fodder. Harvesting is done with a sickle or scythe. Both women and men are involved when harvesting is done using a sickle, whereas the scythe is normally used only by men. This type of ground level harvesting can be linked to Type II proposed by Reddy (1997), in which weeds are also gathered as the cutting process involves no selection. The rest of the crop is left to ripen with the aim

Fig. 5 Agricultural processing of *Setaria italica* and *Panicum miliaceum* and tools; **a** harvesting of *S. italica* at ground level with a sickle; **b** plucking *S. italica* ears by hand; **c** threshing *S. italica* with a stick; **d** different tools used in harvesting *P. miliaceum* in Galicia (from *left to right*) "*mallo*" (flail), "*peneira*" (sieve), sharpening utensils (anvil, hammer and file), scythe, sickles and forks; **e** trampling *P. miliaceum* with cattle or "*calco do millo miúdo*"; **f** beating *S. italica* on a piece of wood on the ground; **g** winnowing *S. italica* with a sieve

of obtaining grain for sowing in the following year. There are two options once *S. italica* has ripened: harvesting the plant at ground level (Fig. 5a) or plucking the ears by hand (Fig. 5b), leaving the plant and weeds in the ground. These are subsequently cut using a scythe and are used as fodder. The ears collected for use as grain for sowing are chosen for their ripeness and quality. These criteria are also applied by the Muthuvan tribes in Kerala, India, when selecting the ears of *Eleusine coracana* (Manithottam and Francis 2007).

In Galicia, *P. miliaceum* is harvested between mid-September and the beginning of October, when the plants are still green but the grain is ripe. *P. miliaceum* is harvested "*a mancheas*" in Galicia. This technique consists of

directly cutting the plant with the *fouciño* or sickle (Fig. 5d) and gathering it with the free hand. It does not involve the circular movement typical of the scythe. As a result, although a smaller amount is cut, all the ears are cut and weeds can be rejected. The most common form of harvesting of *P. miliaceum* in Europe is at a higher level, unlike the kind documented in Galicia (Lundström-Baudais et al. 2002; Gunda 1983; Brandstetter 1917; Maurizio 1932). The reason could be that, in Galicia, although the main product obtained from growing *P. miliaceum* is the grain, the straw is also used as forage for stabled cattle.

Threshing

When the millet has been harvested, the plants are dried outdoors before threshing. In Asturias and eastern Galicia, the plants are left to dry in the sun for about 5–6 days, or 20 days in the shade, depending on the location. *"Matuquinos"* or sheaves are made and tied using the plant itself and are left to dry around the *"hórreos"* or raised granaries. In western Galicia, the plants are left in the cart with the ears turned inwards for 2–3 days, to start fermentation. During this process the plant "burns" and gives off white smoke (Vázquez Varela 1994). Starting fermentation makes it easier to separate the grain from the ear.

A variety of threshing processes have been found. Normally, the method chosen is the one that optimizes the number of grains recovered, the time required and the type of crop (Reddy 1997). In Asturias, only a small part of the *S. italica* harvest is threshed, as the aim is only to obtain grain for sowing the following year. Nevertheless, there are three options: (a) beating the plucked ears with a *"mallo"* or stick (Fig. 5c); (b) beating the sheaves against a piece of wood on the ground (Fig. 5f), or (c) rubbing the plucked ears between the hands. A similar process was documented by Hongrois (1995) in France, but in this case for *P. miliaceum*. The products resulting from A and C are unbroken grain, immature *S. italica* grain and glumes and rachis which may have broken off as a result of the beating or rubbing. Products resulting from B are the same, in addition to the de-grained plant which is used as forage, ear fragments, leaves and weeds and their seeds (Fig. 4). At this stage, the by-product from A and C is made up of de-grained ears which are thrown away. The by-product from B is weeds.

In Galicia, the entire harvest of *P. miliaceum* is threshed. In this region too, several processes have been recorded: (d) trampling by cattle or *"calco do millo miúdo"*: the *P. miliaceum* plants are placed on a floor of compacted earth, a smooth, dry layer of cattle excrement or a stone threshing floor or "*eira*". They are placed in circles, so that the ears lie on the stems of the previous circle and face upwards. The trampling is done by one, two or three pairs of cattle, which go round in one direction several times. On completion of the first circuit, the straw is raked or aerated to help release grain and to promote trampling on the ears still holding it. The animals are then led in the opposite direction (Fig. 5e). The change in direction is important to ensure that the animals do not get dizzy. The cattle are normally followed by someone with a bucket to gather the droppings and keep the grain clean. Vázquez Varela (1994) points out that the cows wore a muzzle, *"buceira"* to stop them from eating the grain. Some of those interviewed in Galicia said that people would also be involved in trampling if the quantity was small (e), a circumstance also documented in France and Nepal (Lundström-Baudais et al. 2002). Likewise on record is the threshing process with the "*manlle"*, flail (f) and beating with a fork (g), or beating the plants on a stone (Vázquez 1994). In both cases, the whole plants arranged in circles and not only the ears are beaten. The products and by-product resulting from processes D, E, F and G are identical (Fig. 4). The products comprise the unbroken grain of *P. miliaceum*, unripe grains, glumes, and rachis and leaf fragments. The by-product consists of the de-grained plant which is used as fodder. Nowadays a tractor is used to carry out this process. The products and by-product are identical, but the proportion of grain released from the ears is considerably greater, due to the weight of the tractor used in rolling.

Reddy (1997) points out that in Gujarat, India, *P. miliare* (syn. *P. sumatrense*) is not trampled on because the grain could be damaged, which would lead to considerable losses. Cattle trampling is used there for crops like *Sorghum bicolor* or *Pennisetum typhoides*, which produce larger grains. In Galicia, there is a cultural preference for trampling *P. miliaceum* with animals. This procedure is usual in the western coastal region, whereas in the town of Xermade, in the hinterland of the province of Lugo, the threshing of *P. miliaceum* and all other cereals was done using a *manlle,* or flail.

Sieving

After threshing, the plants are moved away by hand or with the aid of a rake. The seeds from *P. miliaceum* are gathered with a "*rodo*", a sort of wooden leveller traditionally used for levelling the field and spreading the grain (Vázquez 1994). The grain must be winnowed to remove some of the unwanted products accompanying it. Currently both *S. italica* and *P. miliaceum* are winnowed using a metal mesh. The sieve size is usually 1 mm. In France, a spiral-type sieve made of intertwined grain stalks was used in the past (Lundström-Baudais et al. 2002).

In Asturias, only plant material obtained by beating the *S. italica* plant against the ground was sieved. The products and by-products from the sieving and those recovered from

P. miliaceum in Galicia after trampling by cattle are similar (Fig. 4). The products consist of the unbroken grain, unripe grains, glumes, rachis and weed seeds. The by-products comprise the fragments of the de-grained ears, plant stalks, leaves and weeds.

Winnowing

Following sieving, the grain was left to dry in the sun for a few days. Once dry, it was winnowed. For winnowing, the wind must be gentle or moderate, enough for the heaviest grains to fall nearby or into some sort of container and for other remains to be blown away. Otherwise, the grains could be blown away with the chaff if the wind is too strong, or grain and chaff could fall together if it is not strong enough. Women are usually in charge of winnowing, which involves letting the grain fall from the sieve (Fig. 5g) or another container. Celia, from Rois (A Coruña, Galicia), mentioned the *"peneira"*, a leather sieve used for this task. These types of wind winnowing, formerly used for large quantities of grain, result in greater losses than winnowing by shaking, which is done for smaller quantities of grain (Song et al. 2013).

The product resulting from the winnowing of *S. italica* in Asturias is hulled grain, whereas the by-products consist of glumes, rachis, unripe grains and fragments of ears (Fig. 4). In Galicia, the products resulting from the winnowing of *P. miliaceum* is made up of hulled cereal seeds and the seeds of weeds. The by-products are glumes, immature grains and rachis. Song et al. (2013) point out that the by-product gathered is basically made up of spikelets, and the grains they contain are usually unripe.

Dehusking

Both *P. miliaceum* and *S. italica* are hulled cereals, requiring the husks covering the grain to be removed for human consumption.

We have observed the various processes in Galicia. In the regions of Rois and Negreira, the grain of *P. miliaceum* is not dehusked but milled with the husk in hydraulic mills. Peña-Chocarro (1999) recorded a similar process with *Triticum spelta* (spelt) in Asturias. This may be a recent adaptation of the processing as the whole area still keeps a large number of "*pías*", or mortars, in Galician, with a variety of uses, but which may originally have been used for dehusking *P. miliaceum*. The flour contains hulls which are separated by fine sieving. However, although the hulls are larger than the sieve mesh, some tend to slip through into the flour, giving it a rough and sandy texture.

On the other hand, in Xermade (Galicia) and in Cunha (Portugal), the grain of *P. miliaceum* is dehusked. "*Pías/pilos*" (Galician/Portuguese) mortars are used in which the millet is beaten with a "*pisón/pilão*" (Galician/Portuguese) pestle. Though similar, there are certain morphological differences. The *pisón* is shaped like a mallet with a double head, whereas the *pilão* is an elongated rod with broader ends. The hole of the *pía* in Galicia is narrower and lower down, and has a larger granite base. In Cunha, the hole of the *pilo* is larger and the granite base is closer in size.

Fortunately, we were able to observe the entire process in Cunha (Paredes de Coura, Portugal). The grain of *Panicum* must be warm to help remove the hulls. It can be left in the sun for a period of time or in the oven at a low temperature, approximately 40–50 °C. Heat treatment of the grain before its dehusking was recorded by Lundström-Baudais et al. (2002) in Nepal and France, and by other authors in Europe (Auriault 1976; Barboff 1995; Gamerith 1995; Gautier and Gauvrit 1980; Hongrois 1995; Le Cabec and Chalavoux 1995; Maurizio 1932). We have not found the hydrothermal treatment, a process likewise common to Nepal (Lundström-Baudais et al. 2002), Mali (Hamon and Le Gall 2013) and Austria (Gamerith 1995).

For dehusking the grain, a *"pilo"*, or stone mortar is used, along with a *"pilão"*, or wooden hand, or pestle (Fig. 6a). It appears that these two tools have been linked to millets since antiquity (Lundström-Baudais et al. 2002). The granite mortar has a small rim on the inside to prevent the grain from spilling out when beaten. The one used in Cunha had a diameter of approximately 42 cm and was 57 cm high on the outside (Fig. 6d). The hole or inner tray has a diameter of 42 cm. In Xermade (Galicia), according to the people interviewed, a straw *"fachuzo"* or rag was attached to the *pisón* to keep the grain inside. In France, a rag was placed on the rim of the mortar (Lundström-Baudais 2002). The hand is a long hard rod (96 cm) made of *Ilex aquifolium* (holly), thicker at the ends (6 cm in diameter) than in the middle (3.5 cm). A right-angle grid cut into the ends (Fig. 6b) helps break the grain. As regards the hand's typology, we have been unable to find the use of metal sheets on its ends, or the existence of a central hatch to allow the by-product to pass through, as occurs in France and Nepal (Lundström-Baudais et al. 2002).

The process of dehusking 1 kg of *P. miliaceum* in Cunha lasted approximately 40 min. About 0.5 kg of grain was put in the *pilo* each time. Four women of around 60 years of age took part in the process. Although men can also take part, this type of gender division of labour is frequent. The grain is placed in the mortar and beaten with the *pilão*. The movement consists in raising the *pilão* with one's hands up to one's head and then lowering it forcefully against the grain. When one of the beaters became tired, another person took their place. Every 10–12 min the contents of the mortar were removed and sieved to check whether the grain was clean. The by-product from this process is the "*farinha*", which is none other than the ground hull

Fig. 6 Dehusking scenes from Cunha (Paredes de Coura, Portugal); **a** dehusking *Panicum miliaceum* with a "*pilão*" in the "*pilo*"; **b** grid cut into the *pilão* from the Museo Regional de Paredes de Coura; **c** ground hull or "*farinha*" falling from the sieve; **d** drawing of the *pilo* and of the *pilão* used in dehusking *P. miliaceum* in Cunha (Paredes de Coura, Portugal)

(Fig. 6c). The product was winnowed, to ensure that the grain was as clean as possible (Fig. 4). If it was not sufficiently dehusked, it was once again placed in the mortar and beaten. The entire operation was repeated until the grain was dehusked completely and came out clean.

Barboff (1995) found another two ways of dehusking in Portugal: (a) with mortar and *pilão* worked by the feet, in the north and (b) with the aid of a rotary quern, in the south. The former comprises a swinging plate, driven by the feet. It was placed inside dwellings, the walls of which held a grip to steady the person who was dehusking the grain. The *"zangarelha"* or manual rotary mill is used for dehusking *P. miliaceum* and *Zea mays*. The dehusked cereal passes through the slot in the stationary stone or *"assinho"* and it is not milled.

Uses

Nowadays in Asturias, the *S. italica* plant is used exclusively as fodder which is cut when needed to feed the cattle. The grain is kept for sowing in the following year. Only a small part of the processed grain is given to chicks. Most of those interviewed agreed that *S. italica* is excellent fodder. In summer, when green pasture is scarce, it is ideal for fattening cattle.

In Galicia and in the north of Portugal, besides feed (grain) or fodder (plant), *P. miliaceum* is used for human consumption, typically as *"papas"*, a kind of porridge. These are basically prepared as follows: a little water is boiled with salt and the whole grain or millet flour is added little by little. Once cooked, some milk can also be added. Some of the people who were interviewed pointed out that "*papas*" cooked in water were a sign of poverty, which is why they cooked them in milk. The preparation of this kind of porridge is a well-documented process all over the world (Barboff 1995; Hamon and Le Gall 2013; Manithottam and Francis 2007; Young 1999).

Currently, *papas* are prepared in Cunha as a pudding. The grains are split in a little boiling water and the milk is added little by little, stirring continuously until cooked. Egg yolks are added to the *papas*, as well as some sugar to sweeten them and then they are seasoned with spices like cinnamon or lemon peel. Those interviewed said that five parts liquid to one part grain is the proper recipe.

Another product formerly prepared in Galicia is *P. miliaceum* bread. Vázquez Varela (1994) described how it is made: the millet flour is cooked in boiling water and then mixed with wheat or rye flour and rolled into balls, which are baked in the oven. In Cunha (Paredes de Coura, Portugal), we were given a description of a stew made from

pork and blood accompanied by millet, which today has been replaced by rice. In her *"Le millet au Portugal"* Barboff (1995), described numerous products made from *P. miliaceum*: stews such as "*sarrabulho*" or puddings such as *"arroz doce da terra"* were made from the grain, which could also just be boiled and served as an accompaniment (*"milho esparralhado"*). Flour was used to make A Serra da Barroso meatballs, carnival fritters from Tras-os-Montes or the "*papas dos fieis*" from Alentejo, which were cooked on the 2nd of November in honour of the dead.

P. miliaceum is likewise valued as feed and fodder. Commonly, the grain has been used to feed chickens and chicks. In Negreira and Rois (Galicia), a drink made from millet flour and warm water was given to the cows, and especially when they were pregnant. The straw resulting from the trampling was given to cattle, and when the crop was abundant, it was stored.

Conclusions

The continued cultivation of *S. italica* and *P. miliaceum* as crops in northern Spain has provided us with the opportunity to make ethnobotanical observations with the help of the farmers, which may shed light on the processing and use of these crops during prehistory and the Middle Ages, when they were widely used in the region.

Although the cultivation of *S. italica* in Asturias and *P. miliaceum* in Galicia is similar, the processing of each plant varies significantly depending on its intended use.

S. italica in Asturias is *harvested* in two stages: the first is done at ground level in order to gather the entire plant which is then fed to cattle, and the second, at a higher level, to gather the grain for sowing the following year. In Galicia, the harvest of *P. miliaceum* is carried out all at once, using the "*a mancheas*" technique. *Threshing* of both plants can be carried out by beating (with a *mallo*, a flail, or against a board), trampling (by cattle, people or by crushing with a tractor) or rubbing (with one's hands). Following this process, the grains of *S. italica* and *P. miliaceum* are sifted, dried and winnowed, before being stored. Some seeds are used as feed. *Dehusking* is only carried out in Galicia and in the north of Portugal in the case of *P. miliaceum* when it is used for human consumption. In both regions, *P. miliaceum* is beaten repeatedly in a large stone mortar (*pía*) using a wooden *pisón*. To help remove the hull, *P. miliaceum* is first heated in an oven. As regards human *consumption*, *P. miliaceum* is used in the northwest of the Iberian Peninsula to make porridge, stews, puddings and bread.

Current distribution of *P. miliaceum* and *S. italica* crops in the north of the Iberian Peninsula could reflect a pattern already known in prehistoric times. However, the absence of this pattern during the historical period makes further research necessary. In any case, this work shows that significant ethnographical and ethnobotanical observations can still be made in the Iberian Peninsula, even if these crops are on the verge of extinction.

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