Collection and Characterisation of Populations of Spelt and Emmer in Asturias (Spain)

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Abstract: Asturian *escanda* is a generic term used to refer to both emmer (*Triticum turgidum* ssp. *dicoccum*) and spelt (*T. aestivum* ssp. *spelta*). In the past, these species were widely cultivated in Spain; but are now only grown in a few localities of Asturias (Northern Spain), where they grow in small orchards that in many cases do not surpass 400 m^2. Because the maintenance of these genetic resources is in danger, a collecting mission was carried out in this Spanish region. The expedition travelled from 43°2′27′′ to 43°28′49′′ Latitude North and 5°26′25′′ to 6°14′22′′ Longitude West. The altitude range was 45–1001 ms. Thirty-one populations of spelt were located, together with four of emmer, which showed a high diversity. The objectives of the collecting mission were to collect hulled wheat in the places of this region where they are still cultivated, conserve of their genetic variability, and characterize them use as genetic source for modern crops.

Keywords: *Triticum aestivum* ssp. *spelta*; *T. turgidum* ssp. *dicoccum*; genetic resources

The change from traditional farms to modern cultivation systems has been important for the progress of agriculture. This process has led to the replacement of traditional varieties and landraces by new improved cultivars, better adapted to intensive agriculture. This substitution process has resulted in a narrowing of crop genetic variability; which has, in turn, promoted the search of new sources of variation that can be used in plant improvement programmes. For wheat, both landraces and wild relatives have been identified as a useful tool in the wheat breeding (Brown *et al.* 1989). Between these species, the domestic wheats, ancestors to the modern wheats, such as einkorn ($2n = 2x = 14$, AA; *Triticum monococcum* ssp. *monococcum* A. & D. Löve), emmer ($2n = 2x = 28$, AABB; *T. turgidum* ssp. *dicoccum* L. em Thell.) and spelt ($2n = 2x = 48$, AABBDD; *T. aestivum* ssp. *spelta* L. em Thell), could be good candidates. These wheats are named hulled wheats because the glumes remain on the grain after threshing.

These wheats were grown in Spain during the nineteenth century, at which time they were surveyed by the Spanish botanists Lagasca and Clemente, who indicated in their "Ceres Hispanica" herbarium, the existence of at least ten botanical varieties of emmer and seven botanical varieties of spelt (Tellez-Molina & Alonso-Peña 1952). During the first half of the twentieth century, these hulled wheats were widely cultivated but their cultivation decreased towards the late 1960s when agricultural mechanisation began in many areas of Spain. In the case of spelt and emmer, both species survives in marginal farming areas of Asturias (North of Spain), where are they are called *escanda* and are endangered (Peña-Chocarro & Zapata-Peña 1998).

Genetic resources

Nowadays, the interest for the hulled wheats has increased, due to interest in ecologically grown

foods that can be grown without pesticides in harsh ecological conditions and in marginal areas of cultivation where they would provide additional profit to farmers while contributing to agricultural diversification. Although a high variability has been found in these crops, their genetic diversity is very small because their neglect over several decades has resulted in many seeds used having a common origin, producing a genetic drift effect and irreversible lost of biodiversity in many cases. For these reasons, a complete and accurate evaluation of the intraspecific variability of these species was needed. The first step in this process was development of a good germplasm collection.

We conducted an expedition in Asturias (North of Spain) with the objective of collecting spelt and emmer populations in all sites of this region where the species are still cultivated. Before this collecting mission, we analysed the variability and genetic diversity for endosperm storage proteins of the two old collections preserved in Germplasm Banks, detecting a great variability in the composition of these proteins among the accessions. However, the high frequency of a few alleles, together with the low frequency of most alleles, suggested that some genetic drift effects had begun even before to the collecting of these accessions (Caballero *et al.* 2001, 2004; Pflüger *et al.* 2001). This confirmed the necessity of conserving and safeguarding these genetic resources because the likelihood of finding the same alleles in other species is very low.

One of these old collections was carried out by the personnel of the Swiss Federal Research Station for Agroecology and Agriculture in Asturias (North of Spain) during the 1930s. The approximate route followed in this expedition was obtained by the translation of the passport information send from the Swiss Institution (Weilenmann, person. commun.) and a road map Asturias. Their route was the base of our collecting mission. This was carried out between July and August 2004 in Asturias (North of Spain), after maturation and before harvesting of the plants by the framer. The possible sites were previously located in a preliminary survey at flowering time conducted in May 2004. The explored zone extended from 43°2′26.6′′ to 43°32′49.3′′ Latitude North and from 5°26′25.3′′ to 6°14′22′′ Longitude West and had an altitude range from 26 meters in Quinzanas (Pravia) to 1001 meters in La Bustiera (Pola de Somiedo).

Thirty-two and four spelt and emmer autochthon populations, respectively, were found, together with one einkorn population of unknown origin and two Swiss spelt populations. A total number of 25–30 individual spikes were collected from each population, based on morphologic traits such

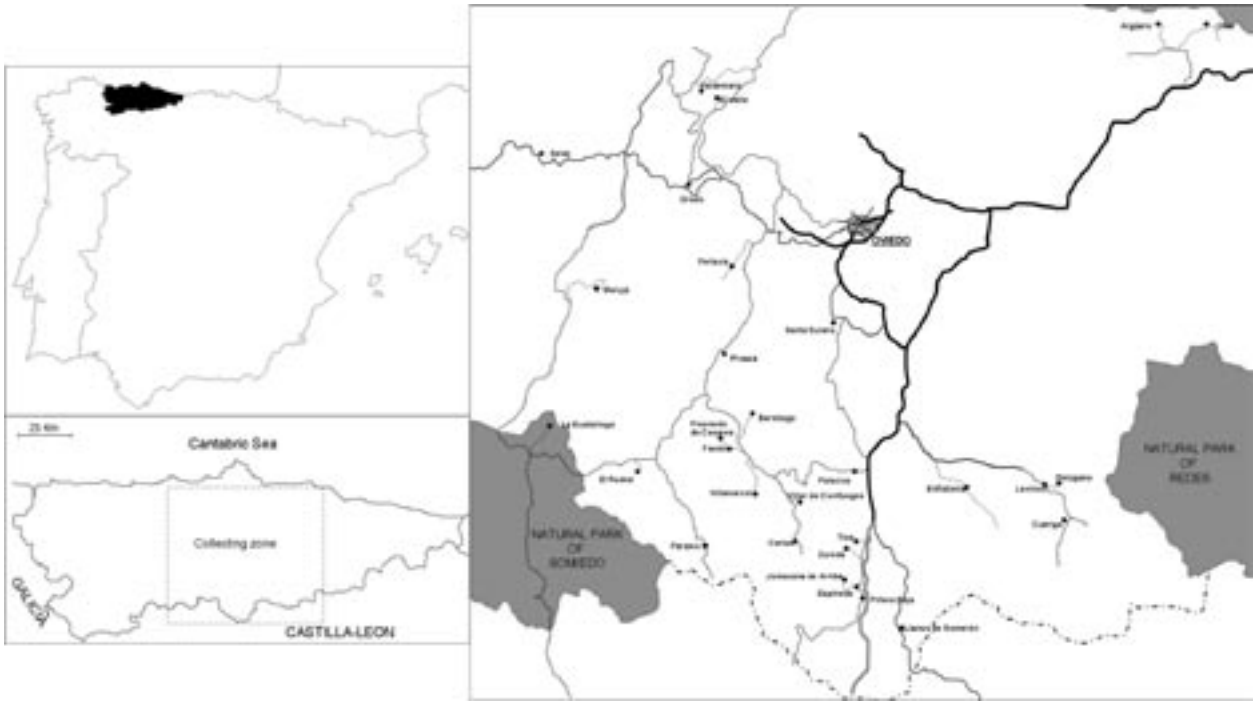

Figure 1. Map with the localization of the escanda populations collected during the summer of 2004

as size of plants, size of spikes and colour of the spike, trying to obtain the major level of diversity. In general, it was not possible to increase the number of spikes because of the small number of plants in some populations. Spikes were numbered and kept individually in paper bags that permit an optimal drying. This permits identification of seeds from a single plant, an essential prerequisite for population biological studies such as out-crossing rates and genetic structure. Each site, where the populations were collected, was marked on a map (Figure 1).

We observed the great reduction of the cultivation zones of *escanda* compared with the historical reord of Alvargonzalez (1908). This author mentioned that the escanda was cultivated in 37 out of the 78 "concejos" (local administrative unit) into which Asturias is divided. We only found it in 35 localities distributed in 14 "concejos". This information had to be obtained by direct observation in the field because of there is no official register o of this crop; farmers maintain it for their own use. Most of parcels appears in small orchards, accompanied generally by maize and beans, with field areas that not surpass the 400 m^2. Another concern is the great age of the farmers involved. They are the only person their farms and follow traditional agriculture patterns and, in some cases, very archaic practices.

The material collected in Asturias in this colleting mission present higher homogeneity than the historical collection. For example, the presence of material without awns or of relatively small size was not detected in autochthon populations, although it is present in the foreign accessions from Germany and Switzerland that have been introduced into Asturias without too control. The homogeneity has been significantly increased by the exchange of material between the farmers of different localities. The crop was abandoned years ago in many localities where now it is now grown using seeds from other localities. One good example of this is Villaviciosa locality where the *escanda* had not been cultivated for years but which is now one of the main areas of its cultivation, using seed that originated in the Aller and Pravia "concejos".

Preliminary characterization

Lagasca and Clemente in their work "Ceres Hispanica" describe seven botanical varieties for spelt (*albo-velutinum, album, arduini, coeruleum, duhamelianum, rubro-velutinum,* and *vulpinum*) and ten for emmer (*atratum, farrum, inerme, lagascae, macratherum, majus, pseudo-macratherum, pycnurum, rufum* and *tricoccum*) based in spikes with and without awns, smooth or hairy glumes and colour of the glumes (Tellez-Molina & Alonso-Peña 1952).

In a first evaluation of the material collected in Asturias in summer 2004, the morphological traits were measured so as to assign the collections according to the classification of Lagasca and Clemente (Tellez-Molina & Alonso-Peña 1952). None of the collections had spikes without awns, as was found in five of seven botanical varieties described by Lagasca and Clemente for spelt (*arduini*, *vulpinum*, *albo-velutinum*, *rubro-velutinum* and *coeruleum*) and two of ten botanical varieties for emmer (*farrum* and *rufum*) (Figure 2). Most of the collected populations included a mixture of the varieties described by Lagasca and Clemente, being only a few being homogeneous for one variety. On

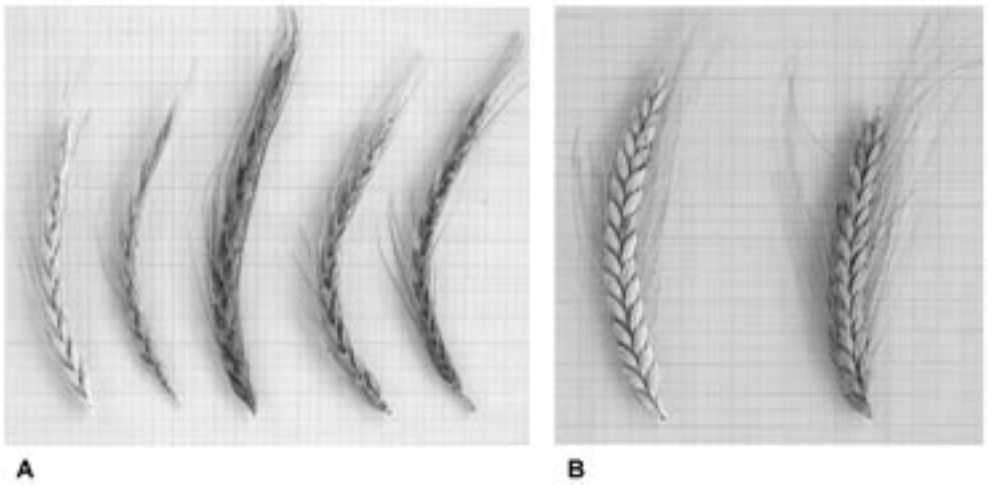

Figure 2. Some of the escanda types found during the collecting mission. A, variation for spelt, and B, variation for emmer

the other hand, these classical authors did not mention in their classification spelt with yellow spikes (smooth and hairy glumes); although, in the new collected material, these spikes appear with high frequency. The same is true for blue spikes that show different colour gradations and tones, from bright to dark and black. These spikes can have white awns, black awns or both. Unfortunately, it was not possible to determine with confidence the real colour of varieties included in one herbarium with specimens more than hundred years old because their colour may have changed with age. In the case of emmer, all the materials collected in 2004 correspond with the botanical variety of *farrum*, described by Lagasca and Clemente.

CONCLUSIONS

The first results showed an alarming lose of the variability for the morphologic characters evaluated, particularly in the case of the emmer, where eight of the botanical varieties of Lagasca and Clemente were not rediscovered. Furthermore, it was found in only four populations in all Asturian region sampled. In the case of spelt wheat, although the cultivated area is very much higher than that for emmer wheat, the amount grown has diminished in the last century. The loss in diversity is reflected in our failure to find any awnless material. This contrasts with the discovery of spikes of colours not mentioned by Lagasca and Clemente. These authors may have overlooked such spikes, or they may reflect recent introduction of foreign material to Asturias.

The variability detected in these collection for the morphological characters and the seed storage proteins, which are being analysed, could be recovered by the establishment of a core collection of each one of these crops (spelt and emmer), which could serve for increasing the diversity of the actual Asturian *escanda* and could be used for the obtaining of new products. These genetic resources could be also used for increasing the genetic background of the actual durum and bread wheats.

Acknowledgements. This research was supported by grants AGL2001-2419-C02-02 and AGL2004-03361-C02-01 from the Spanish Ministry of Education and Science and the European Regional Development Fund (FEDER) from the European Union. JBA is grateful to the 'Ramón y Cajal' Programme (Conv. 2001) from the Spanish Ministry of Education and Science for financial support.

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