

Triticum spelta L. – Suebian crop? An ethnographic hypothesis on genetic trial

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Introduction

Spelt wheat (*Triticum spelta* L.) was an important food grain in ancient Europe from the Bronze Age to the medieval times, and currently survives as a relict crop in Central Europe where this cereal has found a new market as a health food^[1]. Until the 20th century, spelt was the traditional wheat used in the northeast of Iberian Peninsula and a recently proposed ethnographic thesis states that this cereal was a vestige and heritage of the Suebi Kingdom that established in Gallaecia between 410 and 584 AC^[2]. This thesis has been defended in ethnographic investigation, based on dialectal data (terminology of threshing) and on folklore data, as the traditional forms of crop stores, and ploughs used in this region, formerly under Suebian reign^[3,4]. As indicated in the Figure, historical investigations consigned three possible migration routes from alleged homeland regions of the Suebians to Iberian Peninsula: 1) "Donausueben" thesis^[5,6], 2) "Schwabens" thesis^[7] and 3) "Eider-Swaefns" thesis^[8].

The present study aims to verify the mentioned thesis by genetic comparison of samples of *T. spelta* L. of North-West-Iberian origin with a large number of samples from other Eurasian regions. A significant genetic similarity (identity) of the Peninsular *T. spelta* L. with samples from one of the historically thesis referred could establish the Suebians's homeland region before they moved into Gallaecia.

Material and Methods

Plant material

Spelt seeds were kindly provided by several European Germoplasm Banks and Plant Breeding organizations. The seeds from 55 accessions were planted in 2002-2003 and the typical morphological characteristics of *T. spelta* L. were confirmed. Twelve samples were withdrawn due to non-uniform morphologies, being the final population composed by 43 samples from different European and Asian countries. Seeds and leaves were collected and leaves were immediately frozen (-80°C) for further analysis.

DNA extraction and sequencing

Total genomic DNA was extracted from 2 or 3 grains or frozen leaves of each accession using commercial kits or the traditional CTAB based method. A 1-kb sequence, including a part of the promoter and the coding region, of the high-molecular-weight (HMW) glutenin B1-1 and A1-2 subunit genes was PCR amplified as previously described^[9]. PCR products were purified and sequenced (ABI PRISM 310 genetic analyser, Applied Biosystems).

Data analysis

All sequences were corrected, assembled and aligned using *Codon Code Aligner*. Phylogenetic analysis was performed using the *Bionumerics*® software (Applied Maths). Sequence data for additional accessions were retrieved from the EMBL nucleotide sequence database (<http://www.ebi.ac.uk/embl/>) and used for phylogenetic analysis.



The possible migration routes of Suebians..

Results

Genetic diversity analysis

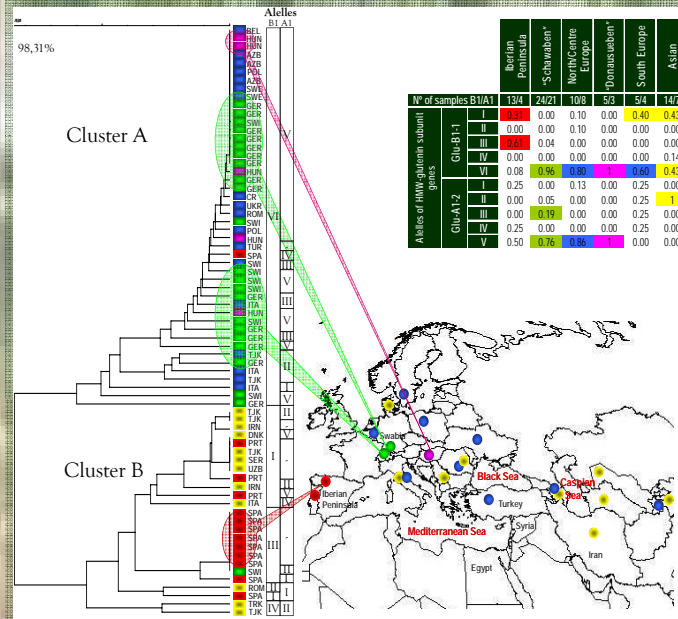
Genetic analysis was based on an approximately 1kb sequence, including part of the promoter and the coding region of the HMW Glu-B1-1 and Glu-A1-2 subunit genes. From the 43 spelt accessions, and including the sequences retrieved from EMBL, 71 Glu-B1-1 and 47 Glu-A1-2 sequences were obtained.

Five Glu-B1-1 and five Glu-A1-2 alleles were identified, based on 18 informative sites in both genes, in agreement with previous studies^[9]. Sequence of the variety 'Oberkulmer Rortkorn' was used as a reference (ref), because of the Central European occurrence of this spelt landrace that could represent the primitive spelt wheat type^[10].

Table with nucleotide sequences for Glu-B1-1 and Glu-A1-2 alleles. Part (a) shows Glu-B1-1 alleles (B1-1I to B1-1VI) and part (b) shows Glu-A1-2 alleles (A1-2I to A1-2V). Reference sequences are also provided.

Informative sites of 5 alleles of the HMW glutenin B1-1 (a) and A1-2 (b) subunit genes. Numbering of the nucleotide positions (-1) starts at the ATG start codon, and at positions with indels '+' marks the presence of an insertion and '-' marks the absence of an insertion.

Distribution of alleles related to geographical origin



Combined dendrogram of a 150bp and 678bp fragment of the Glu-B1-1 and Glu-A1-2 alleles, respectively, calculated by a multiple alignment-based similarity matrix using UPGMA clustering. The map shows the distribution of the spelt accessions: ● Iberian Peninsula, ● varieties that would support the "Suebian" thesis and ● varieties that would support the "Donausueben" thesis. The remaining samples are coloured according to their distribution in cluster A (●) and B (●). The Table presents the frequencies of Glu-A1-2 and Glu-B1-1 alleles calculated for different geographic origins.

In order to determine the genetic relationship between Iberian Peninsula spelt and "Suebian" spelt, according to the "Donausueben" and "Schwabens" thesis (we do not had accessions to evaluate the third thesis, Iberian Peninsula spelts (from Portugal and Spain), 29 "Suebian" spelts (from Germany, Switzerland and Hungary) and 29 from other Eurasian regions were used for genetic analysis.

Two main clusters (A and B) can be clearly distinguished, being the first cluster mainly composed by accessions from 'Swabian' and North/Centre Europe. These accessions share a unique B1-1 allele (B1-1V), whereas the remaining four B1-1 alleles (B1-1I, B1-1II, B1-1III and B1-1IV) were represented in cluster B and corresponded in general to Iberian Peninsula and Asian spelt varieties. Glu-A1-2 alleles were more dispersed distributed among the dendrogram. However, in general A1-2 III and A1-2 V alleles grouped mainly in the cluster A.

Although, some exceptions are observed in the distribution, i.e., Asian or Denmark accessions in cluster A and B, respectively, and this can be explained by spelt cultivation and the frequent crosses between spelt with different origins or with bread wheat, and also by the infrequent correspondence between the limits of natural regions and political borders or artificial transfer of germplasm^[11].

The alleles B1-1 VI and A1-2 V were highly frequent in 'Swabian' spelt (0.96-1 and 0.76-1), whereas B1-1 I and B1-1 III were the most frequent alleles in Iberian spelt.

Conclusions

The genetic distance between Iberian and Asian spelt is shorter than between Iberian and North/Centre European spelt varieties. This suggests, in combination with historical data, that Iberian spelt had most probably an Asiatic origin, like other wheat crops. This is in agreement with the historically documented dissemination of spelt by the Romans in the Mediterranean Region^[12], that occurred before the Suebi colonization of the North of the Iberian Peninsula. These data are supported by the remains of spelt found in the Iberian Peninsula, that date back to the Roman period^[13,14].

The northern and central European varieties are genetically more related to 'Swabian' varieties than the spelt varieties from the Iberian peninsula since they grouped in other cluster. The two proposed ethnographic thesis about Swabian spelt, according to the "Donausueben" and "Schwabens" thesis can therefore not be confirmed, and the migratory route for the Suebi tribe still needs further clarification.

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