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PGR Forum: serving the crop wild relative user community

Abstract

Kell, S. P., Jury, S. L., Knüpffer, H., Ford-Lloyd, B. V. & Maxted, N.: PGR Forum: serving the crop wild relative user community. — Bocconea 21: 413-421. 2007. — ISSN 1120-4060.

The Euro-Mediterranean region is an important centre for the diversity of crop wild relatives – species closely related to crops that can provide useful traits for crop improvement. The European Community funded project, PGR Forum (www.pgrforum.org) created a web-based Crop Wild Relative Information System (CWRIS) to provide access to crop wild relative data to a broad user community, including plant breeders, protected area managers, policy-makers, conservationists, taxonomists and the wider public. The system includes data on uses, geographical distribution, biology, population and habitat information, threats (including IUCN Red List assessments) and conservation actions. This information is vital for the continued sustainable utilization and conservation of crop wild relatives. Accessible via the CWRIS is a catalogue of CWR derived from two major databases: Euro+Med PlantBase and Mansfeld's World Database of Agricultural and Horticultural Crops; with the addition of data sources for forestry, ornamental, medicinal and aromatic groups. Results show that approximately 80% of the Euro-Mediterranean flora consists of crop wild relatives and other utilized species, as well as the crops themselves; in other words, at least three-quarters of the plant species in the region have a current or potential direct use to humankind. This paper presents a summary of the methodology used to create a Euro-Mediterranean catalogue of CWR, and some preliminary results from analysis of the data.

Introduction

The combined European and Mediterranean region (here referred to as Euro-Mediterranean region) is an important area for the taxonomic and genetic diversity of crop wild relatives (CWR). Major crops, such as oats *(Avena sativa* L.), sugar beet (*Beta vulgaris* L.), apple (*Malus domestica* Borkh.), annual meadow grass (*Festuca pratensis* Huds.) and white clover (*Trifolium repens* L.), have wild relatives in Europe and the Mediterranean. Many minor crops have also been developed and domesticated in the region, such as arnica *(Arnica montana* L.), asparagus *(Asparagus officinalis* L.), lettuce (*Lactuca sativa* L.), and sage (*Salvia officinalis* L.). Other groups of socio-economic importance in the region are forestry species such as *Abies alba* Mill., *Populus nigra* L. and *Quercus ilex* L., ornamentals such as species of *Dianthus*, *Euphorbia*, *Geranium* and

Primula, and medicinal and aromatic plants such as species of *Anemone*, *Campanula*, *Helianthemum*, *Orchis* and *Verbascum*.

The term 'crop wild relative', as well as specifically relating to the wild relatives of agricultural and horticultural crops, may also be applied in a more general sense to taxa related to other species of direct socio-economic importance, and thus include food, fodder and forage crops, medicinal and aromatic plants, condiments, ornamental and forestry species as well as plants used for industrial purposes, such as oils and fibers. CWR taxa provide a wealth of useful traits transferable to socio-economically important species. They are essential components of natural and semi-natural habitats, as well as of agricultural systems, and are critical for maintaining ecosystem health. Their conservation and sustainable use is also vital for improving agricultural production, increasing food security, and maintaining the environment. CWR germplasm (genetic material) has been utilized by humankind for thousands of years to improve the quality and yield of crops. Farmers have used traditional farming methods involving selection for millennia, and more recently plant breeders have utilized genes of CWR to improve crops for resistance to pests and diseases and tolerance to abiotic stresses, such as drought and salinity. Other uses can lead to increased protein and vitamin content, the improvement of medicinal plants and development of pharmaceuticals.

Threats to crop wild relatives

Major threats to CWR are habitat alteration, fragmentation and loss, changes in land management practices and genetic pollution. Many CWR have limited distributions and habitat niches. For example, in the UK, *Asparagus officinalis* subsp. *prostratus* (Dumort.) Corb. is confined to free draining sea cliffs and sand dunes, where it is threatened by changes in land use and agricultural practices, tourism and soil erosion (UK Biodiversity Steering Group 1998; T. C. G. Rich pers. comm. 2003). CWR are commonly weeds of traditional farming practices and are often associated with the cultivation of local varieties (landraces). With an increase in industrial farming and cultivation of high-yielding varieties, the taxonomic and genetic diversity of the associated CWR has decreased, resulting in genetic erosion and local extinction. A further hidden potential threat to CWR is that many of the less common species that are not immediately threatened are overlooked in conservation planning. Without active management, these taxa are also likely to be at risk.

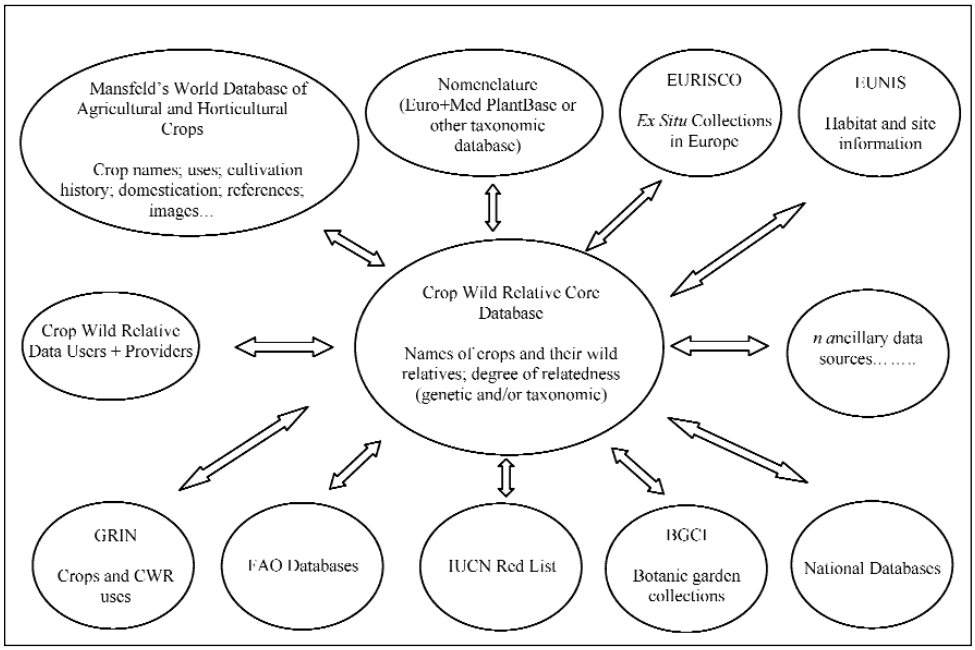
Although it is acknowledged that populations of CWR throughout the Euro-Mediterranean region are under threat from habitat alteration and loss, their conservation, both *in situ* and *ex situ* has received relatively little systematic attention (Maxted 2003). There have been a number of initiatives to inventory CWR taxa at country level (notably Schlosser & al. (1991) and Hammer & Schlosser (1995) for the former German Democratic Republic, Mitteau & Soupizet (2000) for France, and for the European part of Russia (Smekalova pers. comm. 2003)), and at regional level for Europe, (notably those proposed by Zeven & Zhukovsky (1975), Heywood & Zohary (1995) and Hammer & Spahillari (1999, 2000)). However, prior to the PGR Forum project, there had not been a coordinated effort focussing on the production of a comprehensive Euro-Mediterranean catalogue.

A gateway for crop wild relative information

PGR Forum (www.pgrforum.org) has created an online information system to make CWR data available to a broad user community, including plant breeders, protected area managers, policy-makers, conservationists, taxonomists and the wider public (Fig. 1). The web-enabled Crop Wild Relative Information System (CWRIS) (PGR Forum 2005; Kell & al. 2007) includes data on CWR taxonomy, uses, geographical distribution, biology, population and habitat information, threats (including IUCN Red List assessments) and conservation actions. This information is vital for the continued sustainable utilization and conservation of crop wild relatives.

Accessible via the CWRIS is the Catalogue of Crop Wild Relatives for Europe and the Mediterranean (Kell & al. 2005). The Catalogue was generated by firstly matching the genus names found in Mansfeld's World Database of Agricultural and Horticultural Crops, which enumerates agricultural and horticultural cultivated plant species (but with the exception of ornamental and forestry species) (Hanelt & IPK Gatersleben 2001; IPK Gatersleben 2003), with the genus names present in Euro+Med PlantBase (Euro+Med PlantBase 2005, Version September 2005). This was followed by abstracting the taxa within those matching genera from Euro+Med PlantBase, thus creating the first catalogue of crop wild relatives for Europe and the Mediterranean (Fig. 2). This list contains 23513 of

Fig. 1. Crop Wild Relative Information System (CWRIS). Accessible via the information system is the crop wild relative taxon database. This is linked to *n* external data sources. Some existing data sources are shown. The two-way arrows indicate the reciprocal nature of the system.



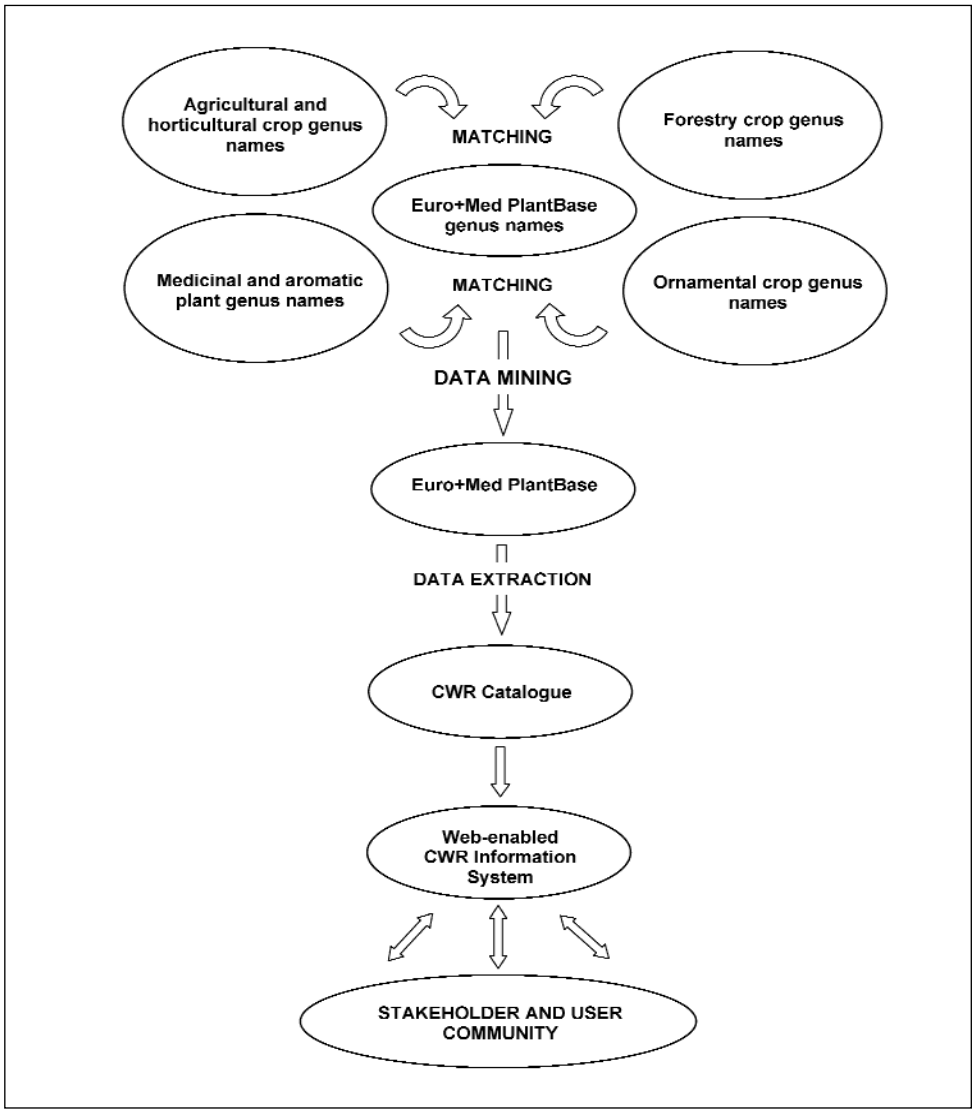


Fig. 2. Methodology for the creation of the CWR Catalogue for Europe and the Mediterranean (Kell & al. 2005). The method can be adapted for any country or region by replacing Euro+Med PlantBase with the country or regional flora.

the 30983 species recorded by Euro+Med PlantBase as present in the region; thus, around three quarters of the species can be considered crops and CWR, i.e. those species found within the same genus as an agricultural or horticultural crop.

The same procedure was followed to include forestry, ornamental, medicinal and aromatic plants in the E+M CWR Catalogue. The genus name lists for these groups were

extracted from the following sources: for forestry taxa, Schultze-Motel's (1966) 'Enumeration of cultivated forest plant species', for ornamental taxa, a list provided by the Community Plant Variety Office (see CPVO 2001) (this list contains those taxa for which the title had been granted and all active applications as of July 18 2003) (Kwakkenbos pers. comm. 2003), and for medicinal and aromatic plants, the database 'Medicinal and Aromatic Plant Resources of the World' (MAPROW) (Schippmann pers. comm. 2004) (in addition to those listed in the Mansfeld Database).

The addition of the forestry and ornamental groups to the agricultural and horticultural crop and CWR list, and the extension of the medicinal and aromatic groups, resulted in a catalogue of 25687 crop and CWR species for Europe and the Mediterranean, which is 83% of the 30983 species recorded by Euro+Med PlantBase as present in the region. This suggests that more than three-quarters of the plant species in the region have a current or potential direct use to humankind. Of these, 90% (23216 species) are considered native. The 25687 species listed in the catalogue are spread across 1239 genera; this represents 49% of crop genera worldwide.

Further analysis indicates that approximately 68% (17495) of crop and CWR species found across the Euro-Mediterranean region are found in Europe alone; 89% (15656) of these species are considered native. The country with the highest crop and CWR species richness is Turkey, with 7235 species; that is 28% of the crops and CWR of the Euro-Mediterranean region, or 41% of the crops and CWR of Europe. Of the Euro-Mediterranean crop and CWR species, 58% (14994) are endemic to the region, and 49% of European crop and CWR species (8624) are endemic to Europe.

Table 1 shows the number of species in each of the four socio-economic groups: agricultural and horticultural crops, forestry species, ornamentals and medicinal and aromatic plants. The percentage of the total number of Euro-Mediterranean crop and CWR species (25687) attributable to each group is given.

Table 2 is a matrix showing the percentage of species common to all four groups. The bottom left side of the matrix shows species shared by each group in the left column as a percentage of the species in each group given across the top row. The top right side of the matrix expresses the percentages in reverse. For example, 13% of species in the agricultural and horticultural crop and CWR list are also found in the forestry list; and conversely, 92% of forestry crop and CWR species are found in the agricultural and horticultural list.

It is interesting to note that very high percentages of crop and CWR species extracted from the genus list derived from Mansfeld's World Database of Agricultural and Horticultural Crops are common to the other three socio-economic groups; that is, 95% of the species in the forestry list, 90% in the ornamental list and 92% in the medicinal and aromatic plant list. This can be explained by the fact that many crop species have several uses, as do ornamental plants (e.g. medicinal, vegetable), and that cultivated medicinal and aromatic plants are also included in the Mansfeld Database. Moreover, there are many species within the same genera as the agricultural and horticultural crop genera that have uses classified within one of the other three socio-economic groups, and thus these groups will share many of the same CWR. Also of note are the high percentages of medicinal and aromatic plant species common to the other three groups: that is, 77% of agricultural and horticultural crops (though as noted above, the Mansfeld Database also includes cultivated medicinal and aromatic plants), 95% of forestry species and 88% of ornamental species.

Table 1. Total number of crop and CWR species in the Euro-Mediterranean region and the numbers and percentages of species in each group: 1 - agricultural and horticultural, 2 - forestry, 3 - ornamental, 4 - medicinal and aromatic.

	E+M crop and CWR species	1	2	3	4
Total nº of E+M crop and CWR species	25687	-	-	-	-
Total species per crop group	-	23513	2843	7499	19784
Species per group as % of total	-	92	11	29	77

Table 2. Matrix showing the percentage of crop and CWR species shared by each of the four groups: 1 - agricultural and horticultural, 2 - forestry, 3 - ornamental, 4 - medicinal and aromatic.

%	1	2	3	4
Agricultural and Horticultural	-	95	90	92
Forestry	11	-	17	14
Ornamental	29	45	-	33
Medicinal and Aromatic	77	95	88	-

This illustrates the extremely broad use of plants for medicinal and aromatic uses, many of which are species harvested from the wild. Perhaps not surprisingly, the group with the least percentage of species common to the other three groups is the forestry species, with 11% of species common to the agricultural and horticultural crops, 17% common to the ornamental species and 14% common to medicinal and aromatic plants.

It should be noted that Euro+Med PlantBase is currently undergoing taxonomic editing. The results presented in this paper are those based on the September 2005 version of the database. Further and more detailed analyses of the data can be found in Kell & al. (2007a).

Using the CWRIS to aid conservation planning

The aim of PGR Forum was to provide tools and techniques for the conservation and sustainable use of CWR. The CWR Catalogue, accessed via the CWRIS, provides the vital information resource that is needed for conservation planning and management. Decisions must be made, whether at national, regional or international level, as to which are the priority taxa in most need of conservation action. One of the fundamental aspects of this process is for CWR users and conservation practitioners to know which species are most closely related to the crop of interest, i.e., the species that are likely to be of greatest use in breeding for crop improvement using conventional methods.

In order to indicate the degree of relatedness of CWR to the associated crop, a method has been proposed by Maxted & al. (2006). The Gene Pool concept (Harlan & de Wet 1971) permits taxa to be grouped according to their relative closeness to the crop, into the primary (GP1A and 1B), secondary (GP2) or tertiary genepool (GP3). However, to assess whether a taxon should be placed in GP1A, GP1B, GP2 or GP3 requires detailed knowledge of genetic diversity and breeding systems. In the many cases where this information is not available, the authors have proposed a Taxon Group (TG) concept as follows: TG1 = same species, TG2 = same section or series, TG3 = same subgenus, TG4 = same genus, TG5 = same tribe, but different genus, thus permitting a 'proxy' assessment of the degree of genetic relatedness of a CWR to the crop using the existing taxonomic classification. The authors propose a formal definition of a CWR as being a taxon that occurs in GP1 and GP2, or TG1-TG4. Although the Taxon Group concept does not give as accurate an indication of genetic relatedness as the Gene Pool concept, it serves as an alternative indicator in the absence of detailed genetic information. Furthermore, the implementation of the Taxon Group ranking system is straightforward, since this information is inherent in the taxon's classification.

Information on uses, both of the crops and their wild relatives, is available via the CWRIS, drawing on major data sources such as Mansfeld's World Database of Agricultural and Horticultural Crops (Hanelt & IPK Gatersleben 2001; IPK Gatersleben 2003) and GRIN Taxonomy (USDA, ARS, National Genetic Resources Programme 2006). In cases where new information on use needs to be entered into the system, PGR Forum used and adapted existing data standards, such as those of the Taxonomic Databases Working Group (TDWG) (Cook 1995) and IUCN – The World Conservation Union (IUCN 1995-2006).

The CWRIS also aims to provide information on geographical distribution, biology, population and habitat information, threats (including IUCN Red List assessments) and conservation actions. This information can be drawn from a wide range of existing sources, many of which are actively managed, thus creating a dynamic CWRIS providing the most up-to-date information, combined with the option to link to any number of data sources in the future. An XML schema (Extensible Markup Language) acts as a means of linking the database to other data sources.

PGR Forum has created a unique system to provide access to crop and CWR information for use by a broad range of stakeholders, either at regional or national level. The CWR Catalogue, accessible via the system, provides the vital baseline upon which the detailed taxon and population level data can be built. The means of bringing together multiple data sources, both for the creation of the Euro-Mediterranean CWR Catalogue and for the CWRIS itself, illustrates how existing information resources can be harnessed and utilized to produce a dynamic system that is vital to make informed decisions about the conservation of plant genetic resources.

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