Triticeae Biodiversity and Conservation, a "Genebanker" View

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Abstract: Wild *Triticeae* are important genetic resources for cultivated cereals. While wild and primitive wheats are well preserved, other genera are rather neglected. Most of *Triticeae* have a large area of distribution, many occupy secondary habitats, or are weedy. However, there are also species with a limited distribution and those need primary attention in conservation. Annuals can be easily stored *ex situ* as easily as cultivated cereals; perennials have their longevity shortened. For successful conservation of genetic diversity one sample of a species is not enough. It is necessary to collect samples from the whole distribution area. Geographically distant populations differ not only morphologically, but can have different spectra of genes. Even within a population there are large differences. For species scattered in distribution or restricted to a certain small area, it is reasonable to consider their *in situ* conservation. The basic requirement is to protect the locality/ies and to ensure that they are managed for sustainable reproduction of the *Triticeae*. Basically, this requires maintaining acceptable levels of use by man (grazing and disturbance), acceptable levels of plant competition from other species, and controlling allochtonous invasive species. Localities with *in situ* conservation require instant monitoring. A detailed documentation (so called passport data) is prerequisite for both *ex situ* and *in situ* conservation. The taxonomic system must be conservative, without frequent nomenclatoral changes. *Ex situ* conservation represents a static system allowing instant access to the materials. *In situ* conservation is dynamic and preserves the whole populations allowing microevolution and coexistence of target species with pathogen populations. It is desirable to maintain both systems simultaneously.

Keywords: *Triticeae*; biodiversity; conservation; *in situ*; genetic resources

The tribe *Triticeae* is one of 13 tribes of the subfamily *Pooidae*. It includes over 350 species and 500 taxa including subspecies (Löve 1984, Dewey 1984) belonging to various number of genera (up to 38 genera), the number depending on the taxonomic concept adopted. Economically, the tribe *Triticeae* includes the most important part of the plant division for human beings, the cereals. Wheat and barley are staple food components in the larger part of the world. They also belong to the earliest domesticated crops, in the Near East dated to more than 9000 years BC (domesticated emmer and eincorn in Cafer Höyük, Wilcox 1991, domesticated barley in Ain Ghazal, Rollefson *et al*. 1985). Wheat and barley were not only sources for food. Barley, was used for brewing of ancient beer. Knowledge of brewing is probably as old as its domestication; only its technology was simpler and its taste somewhat different. The first evidence for brewing is from the 4th millennium BC from south Mesopotamia, where Summerians fermented barley bread and malt. Rye and oats were originally bad weeds in wheat and barley fields that were domesticated much later than wheat and barley.

The tribe also includes many important species that are not cereals. Most species occupy vast areas and serve are important for forage and soil cover. They include perennial steppe grasses, annual, ephemeral grasses, synanthropic and weedy grasses. Such diversity in habitats has led to the evolution of a tremendous diversity of characters and genes, all of which are of potential value in breeding or direct cultivation. Some other *Triticeae* are very limited in distribution and need to be protected.

Biodiversity

The *Triticeae* species occupy very diverse ecological habitats, from very wet to very dry. Some species, such as *Elymus caninus* which grows in lowland forests along the rivers (in Alnion), can even withstand short periods of fresh water flooding. Such species are common in marsh lands. Other species grow in areas that are regularly inundated by salt water, such as *Leymus mollis* in Kamchatka and along the western North America coast. Other species of *Leymus* grow in different zones based on their ability to tolerate of high osmotic pressure (Figure 1, Holubec *et al*. 2003). Other species of *Triticeae* grow easily in the reach of salt spray from the sea. For example *Hordeum spontaneum* grows on rocky slopes facing the Mediterranean Sea in the Near East, adopting a prostrate form that hangs from the rocks. Salt crystals can be seen on its leaves. Some species can grow also in the saline basins because they are resistant to a high concentration of salts.

Triticeae are often pioneer species starting succession in extreme habitats. Not long after volcanic eruptions, a quite rare species of the Far East, *Leymus villosissimus* was observed growing on virgin lava in Kamchatka (Figure 2). Another species, *Leymus racemosus* can stabilize moving sand dunes on the northern margin of Gobi desert in Mongolia (Figure 3). In many such localities *Triticeae* are the only plant cover. Annual grasses with a high share of *Triticeae* species, especially, genera *Heteranthelium, Eremopyrum, Taeniatherum*, are often part of the semidesert vegetation of Central Asia and Near East.

Overgazed, irreversibly damaged land, pastures, and abandoned fields in areas of the Near East with low annual precipitation are usually massively invaded by annuals, mainly *Aegilops crassa.* Such secondary vegetation can last for many years, stopping or delaying succession, especially when a heavy drought period limits appearing of perennials.

Triticeae **as genetic resources**

Wild species are unique genetic resources, particularly for appropriate related cultivated species, but in general sense, even distantly related species can serve as good gene donors of target characters. Geneticists and gene bankers needed to sort their resources according to their value for breeding. The gene pool concept was adopted to characterize the closeness of species to cultivated crops on the basis of their crossability. With increasing under-

Figure 1. Zonation of *Leymus paboanus* and *L. angustus* according to their tolerance to osmotic preasure in salty basin, Bulgan, Mongolia

Figure 2. *Leymus villosissimus* is often in early succession stages on lava, Kozelski volcano, Kamchatka, General view and detail

standing of genetic background, the species were shifted from one pool to another. Gene pool 1 was reserved for cultivated material, such as land races, while gene pool 2 and 3 included ancestral species with homologic and homoeologic genomes and for other species. This concept is a bit outdated, because modern methods of genetic engineering make transfers of genes from distantly related species as easy as from close relatives.

Annual, closely related species, mainly *Aegilops* spp., and *Hordeum spontaneum* were historically widely used in cereal improvement. However, other genera and species were underutilized. One problem is their low availability. Here is the role of gene banks, to gather those species, make preliminary evaluation and include them in germplasm collections.

Conservation

There are two goals of germplasm conservation in gene banks: (1) conservation of defined (characterized and evaluated) material for ever under conditions that ensure no or minimal changes of genetic composition, prevention of genetic drift and (2) making the material available for use in breeding and research. Conserving material of rare species so as to save them from extinction is part of goal 1. For common species the second goal is more important.

Collection

Collection for gene bank conservation must ensure the widest possible genetic diversity of material. Collection should be made from a large number of localities, especially when the species has a large area of distribution. Special attention must be paid to geographically and orographically isolated niches and to isolated localities at the outer limits of a species range where genetic variation may be larger or genetic composition different because of their long isolation.

Both bulk and individual (spike/spikelet) gathering is applicable, the former for simple gene bank storage and the latter for creating of lines useful for breeding.

Regeneration and maintenance

Multiplying of material depends on the mating system involved. There are all kinds of systems within *Triticeae*: from self pollinating (*Triticum*), facultatively outcrossing (*Aegilops longissima*), to completely autoincompatible (*Amblyopyrum muticum*). Therefore, it is important to ensure isolation of plots for outcrossers, even facultative outcrossers, at least by combining of not related species. For autoincompatible species it is important to make larger plots to have enough pollen for a good seed set.

Characterization and evaluation

Gene banks always require characterization of the materials they store. Characterization in this context means recording a set of morphological and phenological traits that are speicifed in the appropriate descriptor list. Evaluation means determining, from repeated trials, the materials' average value for economic traits such as yield and resistances to pests. For wild materials a simplified

Figure 3. *Leymus racemosus*, an early stage of succession on sand dunes, north margin of Gobi desert, Mongolia

Figure 4. *In situ* conservation of *Triticum dicoccoides*, marked research plot, Amiad, Israel

set of descriptors is required so as to distinguish the material provide the background needed to evaluate its value to breeders for useful characters such as resistances.

Documentation

Each gene bank must have a documentation system. It includes internationally agreed passport data, evaluation data, and gene bank storage data. Passport data includes the identity of the material. In addition to the national accession number (unique identifier) that is permanently associated with the accession, genebank documentation includes the general characterization, donor data, collector data and locality data. For wild materials the source and locality data are very important and must be filled in detail (incl. GPS data).

Herbarium sheets and "spike" collection

Vouchering collections is very important. Vouchers are herbarium specimens made at the original locality or, if this is not feasible, from plants in the first year of regeneration. Such specimens are critically important to solving problems associated with mixing of samples, initial misidentification, and identifying phenotypic changes of materials after decades of regeneration.

In situ conservation

Ex situ conservation in gene banks is a genetically static conservation strategy. The accessions reflect the situation at the locality at the time of collection. On the other hand, *in situ* conservation involves protecting the locality, both the ecosystem and the target species. It is a genetically dynamic system, permitting change, including further evolution such as coevolution with pathogens. Its importance is getting increasing recognition. For *Triticeae* it is a useful supplementary method to the classical *ex situ* collections. It is a living gene bank, where it is possible to target collecting of samples of required characters. It is, therefore, very important to design natural reserves especially for rare and threatened species such as wild wheats. It is good if there is a chance to join efforts with botanists and design reserves that protect not only *Triticeae* but other native species. Such reserves require a continuous monitoring of target species and observation of possible threats to the site and species (Figure 4). Protecting the locality must include a reasonable maintenance regime to prevent unwanted succession. This usually involves mowing, controlled grazing, and in some cases also fire. Fire aids some target species such as *Triticum dicoccoides* and other annuals that drill their seeds deeply into the soil by bristles on awns because it decreases competition and speeds germination of seeds in the soil supply.

In situ conservation of crop wild relatives is just beginning, but it has a promising future. Presently, it is important to conserve fragments of disappearing species. In regions of higher *Triticeae* diversity it can serve as a complex natural seed bank.

References

Dewey D.R. (1984): The genomic system of classification as a guide to intergeneric hybridization with the perennial *Triticeae*. In: Gustafson P.J.: Gene Manipulation and Plant Improvement. Plenum Press, New York, 209–279.

Holubec V., Bocková R. (2003): Stress and plant adaptation in the natural environment. In: Bláha L., Bocková R., Hnilička F., Hniličková H., Holubec V., Molerová J., Štolcová J., Zieglerová J. (eds): Plant and Stress. VURV Prague, 44–56.

Löve A. (1984): Conspectus of the *Triticeae*. Feddes Report, **95**/4: 225–258.

Rollefson G., Simmons A., Donaldson M., Gillespie W., Kafafi Z., Kohler-Rollefson I., McAdam E., Ralson S., Tubb K. (1985): Excavations at the pre-potery Neolithic B villageof Ain Ghazal (Jordan) 1983. Mitteilungen des Deutschen Orient-Gesellschaft zu Berlin, **117**: 69–116.

Wilcox G. (1991): Cafer Höyük (Turquie): Les Charbons de bous néolithiques. Cahiers de l'Euphrate, **5–6**: 139–150.