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# Classification and Ecobotanical Study of Crop Wild Relatives: A Case-Study in Azerbaijan

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**For the first time crop wild relatives (CWR) have been classified according to international classification in Azerbaijan. It has been established that there are 965 ancestor species belonging to the 122 genera and 34 families, related to 5 gene groups. As a whole, there are 124 principal crop wild relatives which belong to I and II groups. Others are also important as a genetic resources and have various valuable properties.**

***Keywords:*** *Crop wild relatives, gene groups, ecobotany, taxonomy, Azerbaijan*

## INTRODUCTION

One of the important directions of the research of plant genetic resources is to study wild ancestors (progenitor) of cultivated plants with food and agricultural importance, their effective use and protection (Heywood et al, 2007). Food, fodder, technical, medicines, vitamins and other important plant species have begun to be cultivated since ancient times for their use by people. The term wild relatives of cultivated plants (WRCP) or crop wild relaives (CWR) are not a precise one and have been variously defined and debated (Heywood et al, 2008). Species (subspecies, variety, etc.) considered CWR are close to that cultural plant species in evolutional and genetic terms and they are plants widespread in natural flora and suitable for passing into the culture or obtaining new species including the same species. The following issues always make specialists creating new plant specifies to think about them: species should be resistant to stress factors; it should be resistant to diseases and pests and give higher quality products. In this field, main success of breeders depends on the use of more in situ materials. Therefore, at present, it is very important to study, keep of CWR and detect new ones. In recent years, increase in the role of global warming, technologic processes and other anthropogenic factors negatively affects biota, as well as, CWR; minimizes their aerials and leads to their destruction. Anthropogenic changes are undoubtedly increasing the rates of specific and genetic extinction (Maxted, 2003). Accelerating rates of species extinctions were identified at that time as threats to the genetic base of world agriculture and effort and resources were expended during the following decades to collect CWR and maintain them in ex situ conservation programs (Meilleur and Hodgkin, 2004). Although more than half of the world's flora of higher plants is useful for food and agriculture, only 2.8 % of them were passed into the state of cultural planting (Zhukovsky, 1964). Only 5 % of 4961 higher plant species in 1117 genera existing in natural flora is observed in the cultural form in Azerbaijan (Asgarov, 2016). It is clear from these examples that although our natural flora comprises rich gene pool of important agricultural plants, this richness is still weakly used. In other words, wild relatives of cultural plants have been studied in situ. For example, though 156 species of *Astragalus* species are widespread in Azerbaijan's flora, examples of seed belonging to only 5 species have been collected till now (Asgarov, 1991). Intraspecific diversity and populations of many species widespread in Azerbaijan's flora are poorly studied. Study of cultural plants with a scientific basis, and determination of the sources of their formation is related to the name of the Russian scientist, N.Vavilov (Vavilov, 1967). Later, since 1935, his multivolume "Cultural Flora of the USSR" works began to be published in Moscow and St. Petersburg. "Cultivated plants and their relatives" by P. Zhukovski (Zhukovsky, 1964), "Wild relatives of cultivated plants of flora of the USSR" by D. Brezhnev and others (Brezhnev et al.,1980), as well as, multivolume "Flora of Azerbaijan" and 3 volumes "Higher plants of Azerbaijan", "Review of the flora of Azerbaijan", "The world of plants of Azerbaijan", by Asgarov have been used (Asgarov, 2005, 2006, 2011, 2016). "Summary of theflora of Caucasus" of which 4 volumes are printed yet is of great importance in the investigation of habitats of CWR and taxonomy issues (Taktajan, 2012). There are valuable research works of I.D.Mustafayev, J.A.Aliyev, K.Abdullayev, A.Rajabli on CWR in Azerbaijan. At present, these works are conducted at the Institute of Genetic Resources of Azerbaijan National Academy of Sciences (ANAS) in a systematic manner.

The main aim of the studies was to implement valid inventarisation of CWR in Azerbaijan, develop their modern classification, identify effective ways of use of them and organize the protection of genomes.

## MATERIALS AND METHODS

The habitat of species, their planting conditions is specified by expeditions organized on different routes; herbarium and seed materials on them are collected, information about their planting conditions, as well as, GPS information is recorded. Special attention is paid to the documentation of plant seeds on descriptors. Special rules and procedures are followed during the collection of herbarium and seed materials on rare, endangered, and relic species. Seed and germplasm materials are collected for the purposes of their reintroduction.

Various methods are used on the study of wild relatives of cultural plants: comparative morphological, taxonomic, floristic, geobotanical, bioecological, hybridological and others. Improvement of study methods of CWRis considered to be one of the main duties. Especially, among these, there are compiling the electronic maps of habitats of CWR, study of useful features, molecular-genetic nature of ontogenesis etc.

International Treaty on Plant Genetic Resources adopted by the UN Food and Agriculture Organization (FAO) (2017), the Harlan and de Wet inventory (Holly et. al., 2013), information of Central Database of Genetic Resources Institute has been used in the identification of priority species of wild relatives of cultural plants. At that time, first and second centers were determined. Usually, more ancient and primitive forms are gathered in the first center, and young forms with intense diversity are concentrated in the second center.

Another method is systematic method. The essence of this method lays in the fact that progenitor, as a rule, is located in the same semi-species, section or series with the closes wild species in phylogenetic terms in systematic hierarchy.

## RESULTS AND DISCUSSION

965 species of CWR belonging to 122 genera on 34 families were found in the flora of Azerbaijan (except decorative plants) have been identified and it has determined that they belong to 5 groups of gene pool (Table 1). Azerbaijan can be considered one of the richest regions in Transcaucasian group of formation source of cultural plants in Southwest Asia. Here, among very valuable ancestor species, there are cereal grains (wheat, barley, oats, wheatgrass, rye, etc.), grain legumes (heath pea, peas, etc.), fruits (apples, almonds, grapes, medlar, walnuts, etc.), wild vegetables (onions, beets, carrots, strawberries, etc.), among feed plants: legumes fodder plants (trigonella, shamrock clover, alfalfa, melilot, sainfoin etc.), forage grasses (couch-grass, poatrivialis etc.) numerous oil, spice, herbal, vitamin plants can be mentioned. There are 124 principal crop wild relatives in Azerbaijan which were included gene pool 1 and 2 (Table 2). Some CWR were included in the list which crops were not cultivated in Azerbaijan such as *Eleusine coracana* and *Chenopodium quinoa*. Azerbaijan was considered formation centers of many of these plants. For example, among some important wild relatives of plant all over the world, wheat types (*Triticum boeoticum*, *T.spontaneum*, *T.urartu*, *T.araraticum* and others), their diversity of species more than a hundred, barley varieties (*Hordeum bulbosum*, *H.geniculatum*, *H.violaceum* and other) types of wheat grass (*Aegilops kotschyi*, *A.tauschii*, *A.umbellulata* and others), rye types (*Secale vavilovii*, *S.anatolicum*, *S.segetale* and others), in addition, many feed (*Medicago*, *Onobrychis*, *Vicia*, *Picum* and others), fruit, vegetables and melons etc. can be shown.

**Table 1.** Prioritization concepts used in the creation of the Azerbaijan crop wild relative (CWR) list.

| Prioritization concept | Sublevel description | Number of taxa in Azerbaijan |
|---|---|---|
| GP1 | Wild species being in culture and represented by breeding varieties. | 42 |
| GP2 | Prospective species for using in agriculture being phylogenetically close to the type of species passed into culture (including in the same semi-species, same selection and series). | 82 |
| GP3 | Species used as a source of gene or being useful as grafting means in hybridization activities. | 175 |
| GP4 | Species used in breeding and having useful properties (there is no any official breeding species and has not been passed into culture). | 243 |
| GP5 | All other types of species having the type represented with breeding species and being in culture: species whose useful features and usage in the economy is less studied, as well as, being rare and endangered, advent and not fully naturalized, but degenerating and growing wild. | 419 |

**Table 2.** List of global priority crop wild relatives of Azerbaijan

| Crop name | Species name | Crop name | Species name |
|---|---|---|---|
| **Cereals** | | | *P.syriaca* Boiss. |
| Wheats | *Triticumtimopheevii* (Zhuk.) Zhuk. | Sweet cherry | *Prunus avium* (L.) L. |
| | *T.urartu* Thum. ex Gandil. | | *P.cerasus* L. |
| | *Aegilops biuncialis* Vis. | Apricot | *P.* × *dasycarpa* Ehrh. |
| | *A.columnaris* Zhuk. | | *P.armeniaca* L. |
| | *A.crassa* Boiss | Myrobalan plum | *P.cerasifera* Ehrh. |
| | *A.cylindrica* Host | Plum | *P.domestica* L. |
| | *A.geniculata* Roth | | *P.spinosa* L. |
| | *A.kotschyi* Boiss. | Sour cherry | *P.mahaleb* L. |
| | *A.neglecta* Reg. ex Bertol | | *P.padus* L. |
| | *A.tauschii subsp. tauschii* Coss. | Peach | *P.persica* (L.) Batsch |
| | *A.triuncialis* L. | Strawberry | *Fragaria*×*ananassa* (Duchesne ex Weston) Duchesne ex Rozier |
| | *A.umbellata*Zhuk. | Fig | *Ficus carica* L. |
| Crest. wheatgrass | *Agropyroncristatum*(L.) Gaertn. | Blackcurrant | *Ribes petraeum* Wulfen |
| | *A.desertorum* (Fisch. ex Link) Schult. | | *R.uva-crispa* L. |
| | *A.fragile* (Roth) P.Candargy | Almond | *Prunus dulcis* (Mill.) D.A.Webb |
| Oat | *Avena barbata* Pott ex Link | | *P.fenzliana* Fritsch |
| | *A.eriantha* Durieu. | **Legumes** | |
| | *A.fatua* L. | Sweetpea | *Lathyrus annuus* L. |
| | *A.sterilis* L. | | *L.chloranthus* Boiss. |
| | *A.ventricosa* Balansa | | *L.cicera* L. |
| Finger millet | *Eleusine indica* (L.) Gaertn. | | *L.hirsutus* L. |
| | *E.tristachya* (Lam.) Lam. | | *L.sylvestris* L. |
| Int.wheatgrass | *Elymus elongates* (Host) Runemark | | *L.tuberosus* L. |
| | *E.hispidus* (Opiz) Melderis | Lentil | *Lens culinaris subsp. orientalis* (Boiss.) Ponert |
| Barley | *Hordeum brevisubulatum* (Trin.) Link | | *L.ervoides*(Brign.) Grande |
| | *H.bulbosum* L. | Alfalfa | *Medicago littoralis* Loisel. |
| | *H.spontaneum* K.Koch | | *M.papillosa* Boiss. |
| Broom millet | *Panicum miliaceum*L. | | *M.rigidula* (L) All. |
| Pearl millet | *Pennisetum orientale* Rich. | | *M.sativa subsp. varia* (Martyn) Arcang. |
| Rye | *Secale segetale*(Zhuk.) Roshev. | | *M.truncatula* Gaertn. |
| | *S.sylvestre* Host. | Pea | *Pisum sativum subsp. elatius* (M.Bieb.) Asch. & Graebn. |
| | *S.vavilovii* Grossh. | Vetch | *Vicia ciliatula* Lipsky |
| Foxtail millet | *Setaria italica* (L.) P.Beauv. | | *V.ervilia*(L.) Willd. |
| | *S.verticillata* (L.) P.Beauv. | | *V.grandiflora* Scop. |
| | *S.viridis* (L.) P.Beauv. | | *V.hybrida* L. |
| Sorghum | *Sorghum halepense* (L.) Pers. | | *V.hyrcanica* Fisch. &C.A.Mey. |
| **Fruit crops** | | | *V.johannis* Tamamsch. |
| Apple | *Malus orientalis* Uglitzk. ex Juz. | | *V.lutea* L. |
| Pear | *Cydonia oblonga* Mill. | | *V.narbonensis* L. |
| | *Pyrus boissieriana* Buhse | | *V.pannonica* Crantz |
| | *P.caucasica* Fed. | | *V.sativa subsp. amphicarpa* (Dorthes) Asch. |
| | *P.pyrifolia* (Burm.f.) Nakai | | *V.sativa subsp. nigra* (L.) Ehrh. |
| | *P.salicifolia* Pall. | | *V.serratifolia* Jacq. |
| Garlic | *Allium ampeloprasum* L. | | *C.murale* L. |
| | *A.atroviolaceum* Boiss. | | *C.opulifolium* Schrad. ex W.D.J.Koch & Ziz |
| | *A.saxatile*M.Bieb. | | *C.polyspermum* L. |
| | *A.scabriscapum* Boiss. | | *C.strictum* Roth |
| | *A.schoenoprasum* L. | | *C.urbicum* L. |
| Sugarbeet | *Beta lomatogona* Fisch. & C.A.Mey. | | *C.vulvaria* L. |
| | *B.macrorhiza* Steven | Spinach | *Spinacia tetrandra* Steven ex M.Bieb. |
| | *B.vulgaris subsp. maritima* | Safflower | *Carthamus glaucus* M.Bieb. |
| Carrot | *Daucuscarota* L. | | *C.gypsicola* Iljin |
| Asparagus | *Asparagus officinalis* L. | | *C.lanatus* L. |
| | *A.verticillatus* L. | | *C.oxyacantha* M.Bieb. |
| Lettuce | *Lactuca azerbaijanica* Rech.f. | Aubergine | *Solanum sisymbriifolium*Lam. |
| | *L.georgica* Grossh. | **Nut crops** | |
| | *L.saligna* L. | Hazelnut | *C.avellana* L. |
| | *L.serriola* L. | | *C.colurna* L. |

*Table 2 continued*

| Crop name | Species name | Crop name | Species name |
|---|---|---|---|
| **Vegetables** | | Quinoa | *Chenopodium album*L. |
| Rape | *Brassica elongata* Ehrh. | Walnut | *Juglans regia* L. |
| | *B.nigra*(L.) K.Koch | Pistachio | *Pistacia atlantica* Desf. |
| | *B.oleracea* L. | | |
| | *B.rapa* L. | | |
| | *B.tournefortii* Gouan | | |
| Radish | *Raphanus raphanistrum* L. | | |

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## Azərbaycanda Mədəni Bitkilərin Yabani Əcdadlarinin Təsnifati və Ekobotaniki Tədqiqi


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Məqalədə ilk dəfə olaraq Azərbaycanda yayılan mədəni bitkilərin yabanı əcdadları (sələfləri) Beynəlxalq təsnifata uyğun olaraq təhlil edilir. Müəyyən edilmişdir ki, Azərbaycanda 34 fəsilə, 122 cinsə aid 965 növ sələf bitkiləri 5 gen qrupuna aiddir. Onlardan 124 növ bilavasitə sələf bitkisi olmaqla prioritet olan I və II qruplara aiddirlər və seleksiya işlərində geniş istifadə oluna bilərlər. Digər növlər genetic ehtiyat kimi qiymətlidirlər. Müxtəlif faydalı xüsusiyyətlərə malikdirlər.



***Açar sözlər:*** *Mədəni bikilərin yabanı əcdadları, gen qrupu, ekobotanika, əcdad, Azərbaycan*

# Классификация и Экоботанические Исследования Диких Сородичей Культурных Растений Азербайджана

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В статье приводится таксономический состав диких сородичей культурных растений Азербайджана в соответствии с Международной классификацией. Установлено, что в Азербайджане 965 видов диких сородичей, относящихся 122 родам и 34 семействам, в общей сложности относятся к 5 генетическим группам. Из них 124 вида являются приоритетными и относятся к I и II группам. Они могут быть широко использованы в селекционных работах. Другие виды также являются ценными генетическими ресурсами и обладают различными полезными свойствами.

***Ключевые слова:*** *Дикие сородичи культурных растений, генгруппы, экоботаника, вид, род, Азербайджан*