Pyrus caucasica Fed. Ancestor of Georgian Pear Landraces

Maia Akhalkatsi and Zazva Asanidze
Institute of Botany, Ilia State University, Tbilisi, Georgia

Abstract: Georgia (South Caucasus) has wild Caucasian pear (Pyrus caucasica) representing as relict and endemic species of the Caucasus. It is determined by molecular analysis as the ancestor of 15 pear landraces of Georgia. We used in situ and ex situ methods for conservation of P. caucasica, as crop wild progenitor and relative for pear varieties breeder. Wild Caucasian pear was determined as a crop wild relative species according to the results of the field works carried out in Georgia and this species received high conservation value. According to scoring system to establish scores of crop wild relative pear species revealed the following data: The threats of P. caucasica have been determined only as near threatened with score 2; The rarity of this species was calculated as frequency of 10×10 km and the number of individuals reaches till 20 with score 4; Endemism of this species is not only in Georgia but on the Caucasus ecoregion and score is 5; Gene pool and taxon group identification was related with score 10 according to molecular study of pear species. The analyses have revealed the tendency of P. caucasica to be have high score (21) and in the last criteria of this species has showing closely relatedness to famous 15 traditionally Georgian pear landraces.

Key words: CWRs, domestication, georgia, pear, Pyrus caucasica

INTRODUCTION

Georgia is located in the South Caucasus and officially covers a territory of 69,700 square kilometers and its population is almost 4.6 million. The name of the country is “Sakartvelo” in the Georgian language but it’s common name “Georgia” is semantically linked to Greek (γεωργία, transliterated geōrgia) and Latin (georgicus) roots meaning “Agriculture” (Javakhishvili, 1930). The primary domestication in the fourth centre of crop origin and diversity named as the Near East included the South Caucasus, Asia Minor, Iran and the Fertile Crescent (Vavilov, 1992). Many local varieties and endemic species of Georgia are known in this domesticated centre.

Otherwise, Colchis forest is refugium in the Western Georgia of Tertiary geologic period from 66-2.588 million years ago (Nakhutsrishvili, 2013). Locations of the relict tree species are modelling in forest vegetation by GIS program, which potentially existed in six regions of western Asia: Colchis forest of Georgia, western Anatolia, western Taurus, the upper reaches of the Tigris River, Levant and the southern Caspian basin (Tarkhnishvili et al., 2012). Now a days, the real existence of relict species is in the Colchis forest and in the southern Caspian basin.

Wild Caucasian pear Pyrus caucasica Fed. (Rosaceae) is determined as relict tree and ancestor of fruit pear landraces of Georgia (Akhalkatsi et al., 2012). Domestication of P. caucasica was confirmed by morphometric and systematic molecular methods by genetic relationships between wild populations and local cultivars of pear containing only few mutations (Asanidze et al., 2014).

Therefore, in total, eleven species of wild pear occur in Georgia, but P. caucasica is endemic species of the Caucasus and most widespread among the wild pears of Georgia and it is considered as main progenitor species of local pear cultivars (Khomizurashvili, 1973). Further, P. caucasica and P. pyraster (L.) Burgsd. are regarded as the main wild progenitors, from which the cultivated European pear (P. communis L.) has probably evolved (Volk et al., 2006). The local Georgian names of the cultivated pear Mskhali and wild Caucasian pear Panta exists in all Georgian dialects; they do not have analogues in any other languages (Javakhishvili, 1930).

In this work, it was necessary to determine P. caucasica species threats and conservation levels in local populations of Georgia for determination of responsibility to the nature protection of this Crop Wild Relative (CWR). Thus, scoring system indexes was determined threats of wild pear species and it will be necessary to evaluate CWR priority for conservation.

METHODOLOGY

Pyrus caucasica involves the comparison of ‘total’ natural CWR pear diversity as already actively conserved either in situ or ex situ. This is the basis for gap analysis, which can be divided into four consecutive steps (Maxted et al., 2008):
Step 1: Circumscription of target taxon and target area: First, the taxonomic (e.g. genus, section or species) and geographical (e.g. global, regional, country or province) breadth of the analysis must be established.

Step 2: Assessment of natural diversity: The level of diversity occurring within the target taxon must be defined at the taxonomic, genetic or ecogeographical levels, i.e. how many taxa occur in the circumscribed taxon, but also the inherent genetic diversity within those taxa.

Step 3: Assessment of current conservation strategies: The diversity occurring in situ can be compared to the diversity currently conserved in order to assess the efficiency of both in situ and ex situ conservation techniques.

Step 4: Reformulation of conservation strategy: Assessment of the effectiveness of current conservation coverage in relation to natural in situ diversity identifies the element of diversity that is under conserved, i.e. the ‘gaps’ in the existing conservation strategy and helps refocus the strategy to conserve the maximum diversity and fill these gaps. The revised priorities are likely to require complementary in situ and ex situ conservation actions to ensure the comprehensive conservation of the target taxon’s gene pool.

According to this concept three Gene Pools are distinguished as follows: Primary Gene Pool (GP-1) within which GP-1A are the cultivated forms and GP-1B are the wild or weedy forms of the crop; Secondary Gene Pool (GP-2), which includes less closely related species from which gene transfer to the crop is possible but difficult using conventional breeding techniques; Tertiary Gene Pool (GP-3), which includes the species from which gene transfer to the crop is impossible, or if possible requires sophisticated techniques, such as embryo rescue, somatic fusion or genetic engineering.

The taxon group concept is used to establish the degree of CWR relatedness of a taxon. Application of the taxon group concept assumes that taxonomic distance is positively related to genetic distance. The CWR rank of taxon groups is defined as follows: Taxon Group 1a—crop; Taxon Group 1b—same species as crop; Taxon Group 2—same series or section as crop; Taxon Group 3—same subgenus as crop; Taxon Group 4—same genus; Taxon Group 5—same tribe but different genus to crop.

Thus, combined use of the gene pool and taxon group concept proposed above provide the best pragmatic means available to determine whether a species is a CWR and how closely related a CWR is to its crop.

### Table 1: Scoring system for CWRs priority

<table>
<thead>
<tr>
<th>Legends and status</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat (IUCN)</td>
<td></td>
</tr>
<tr>
<td>Critically endangered</td>
<td>10</td>
</tr>
<tr>
<td>Endangered</td>
<td>7</td>
</tr>
<tr>
<td>Vulnerable</td>
<td>4</td>
</tr>
<tr>
<td>Near threatened</td>
<td>2</td>
</tr>
<tr>
<td>Least concern</td>
<td>0</td>
</tr>
<tr>
<td>Rarity</td>
<td></td>
</tr>
<tr>
<td>Present in one 10×10 km</td>
<td>10</td>
</tr>
<tr>
<td>Present in 2-5 10×10 km</td>
<td>7</td>
</tr>
<tr>
<td>Present in 6-20 10×10 km</td>
<td>4</td>
</tr>
<tr>
<td>Present in 21-50 10×10 km</td>
<td>2</td>
</tr>
<tr>
<td>Present in &gt;50 10×10 km</td>
<td>0</td>
</tr>
<tr>
<td>Endemicity</td>
<td></td>
</tr>
<tr>
<td>Only in georgia</td>
<td>10</td>
</tr>
<tr>
<td>Only in the caucasus</td>
<td>5</td>
</tr>
<tr>
<td>Only in South-east europe</td>
<td>2</td>
</tr>
<tr>
<td>Throughout europe</td>
<td>0</td>
</tr>
<tr>
<td>GP/TG</td>
<td></td>
</tr>
<tr>
<td>Gene pool 1b/Taxon group 1b</td>
<td>10</td>
</tr>
<tr>
<td>Gene pool 2/Taxon group 2</td>
<td>6</td>
</tr>
<tr>
<td>Taxon group 3</td>
<td>4</td>
</tr>
<tr>
<td>Taxon group 4</td>
<td>2</td>
</tr>
<tr>
<td>Gene pool 3/Taxon group 5</td>
<td>0</td>
</tr>
</tbody>
</table>

This scoring system (Table 1) was studied in this work and this method was applied to wild Caucasian pear species distributed on the territory of Georgia and the evaluation was used for field survey. The criteria to be scored are threat level determined according to IUCN categories; Rarity of species calculated as frequency of 10×10 km grid squares where the species occurs; Endemicity was determined according to Key of Georgian Flora (Ketskhoveli, 1959), the herbarium data and preliminary investigation on fields. Gene pool and taxon group identification was related to molecular study of pear species (Asanidze et al., 2014).

### RESULTS AND DISCUSSION

*Pyrus caucasica* grows in the Caucasus. It is relict and endemic species to the Caucasus. This species is a tree, 20-25 (30) m tall, with a broadly pyramidal or oval crown having numerous prickles when young. The bark on the stem and older branches has deep longitudinal cracks; sometimes the bark peels in large strips or flakes. Young offshoots are greenish or dark brown with a few small, light lenticels. Leaves are 3-5 cm long and 2.5-4.5 cm wide, orbicularovate, ovate or oval, with a short sharp tip and a broadly cuneate, rounded or slightly cordate base. The leaves on young plants are sharply serrated on all edges and non-pubescent; those on adult plants are smooth-edged and pubescent only near the edges. Flowers are 2.5-3.5 cm in diameter, assembled in inflorescence of 5-8 flowers. Petals are white or pinkish. Fruits are 1.5-3 cm in diameter, for the most part round or
sometimes pyriform, yellow or green-yellow, non-rusty, with residual sepals. Pulp is white or greenish-white, 
sour-sweet, astringent and bitter, with a large number of 
seeds, darkening at maturity, edible after seasoning. This 
species is entomophilous. It is zoochore. Blossoms in 
April-May; fruits ripen in late July-September. Chromosome number: 2n = 34.

This species is a mesophyte. It occurs everywhere in 
the woodlands of the Caucasus, in mountainous and flat 
areas with sufficient moisture, often along river valleys. 
Caucasian pear grows up to elevations of 1,500-1,600 
(1,900) m above sea level. The plant prefers light (sandy), 
medium (loamy) and heavy (clay) soils, requires 
well-drained soil and can grow in heavy clay soil. It can 
grow in semi-shade (light woodland) or no shade. Dislikes 
very exposed positions. Established plants are drought 
tolerant. A very hardy plant tolerates to temperatures 
down to below -15°C. Plants often sucker and can form 
dense thickets. There are many varieties of cultivated 
pears and they are widely cultivated in the temperate zone 
for their edible fruits. By selection of varieties fresh fruits 
can be obtained from late July-April or May of the 
following year. Seed - best sown in a cold frame as soon 
can be obtained from late July-April or May of the 
year as possible. Temperatures over 15-20°C induce 
cold stratification at 1°C and should be sown as early in 
in mid to late winter. Stored seed requires 8-10 weeks 
for their first year. Plant them out in late 
and grow them on in light shade in a cold frame or 
into individual pots when they are large enough to handle 
a secondary dormancy in the seed. Prick out the seedlings 
the year as possible. Temperatures over 15-20°C induce 
seeds, darkening at maturity, edible after seasoning. This 
species will be effective to collect

Table 2: Scoring system of P. caucasica

<table>
<thead>
<tr>
<th>Legends and status</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat (IUCN)</td>
<td></td>
</tr>
<tr>
<td>Near threatened</td>
<td>2</td>
</tr>
<tr>
<td>Rarity</td>
<td></td>
</tr>
<tr>
<td>Present in 6-20 10×10 km</td>
<td>4</td>
</tr>
<tr>
<td>Endemicity</td>
<td></td>
</tr>
<tr>
<td>Only in the caucasus</td>
<td>5</td>
</tr>
<tr>
<td>GP1+2</td>
<td>10</td>
</tr>
<tr>
<td>Gene pool 1b/Taxon group 1b</td>
<td>21</td>
</tr>
</tbody>
</table>

| Sum                                 | 107   |

seeds and keep in seed banks. The local population and 
governmental bodies responsible for the nature protection 
should be informed about high conservation value of this 
species. Monitoring of the number of individuals in 
populations should be undertaken.

Thus, the results of this study have shown that some 
Georgian pear landraces are direct domesticated from the 
native wild pear species P. caucasica. The other local 
cultivars might be obtained due to selective works by 
breeding of local landraces with introduced cultivars from 
different countries in historically different periods. The 
molecular study of these taxa has clear in more details 
origin of these cultivars (Asanidze et al., 2014). The 
results confirm the hypothesis that some local pear 
cultivars of Georgia are directly domesticated from the 
endemic and relict wild Caucasian pear species 
P. caucasica.

REFERENCES


Asanidze, Z., M. Akhalkatsi, A.D. Henk, C.M. Richards 
and G.M. Volk, 2014. Genetic relationships between 
local cultivar pear (Pyrus L.) species and local 
cultivars native to Georgia, South Caucasus. 
Flora-Morphol. Distrib. Funct. Ecol. Plants, 
209: 504-512.

Javakhishvili, I., 1930. Economic History of Georgia. 
Kartuli Tsigni, Tbilisi, (In Georgian).

Ketskhovelii, N., 1959. Vegetation of Georgia. Academy 
Science Georgia, Tbilisi, (In Georgian).

Metsniereba, Tbilisi, (In Georgian).

Maxted, N., E. Dulloo, B.V. Ford-Lloyd, J.M. Iriondo and 
A. Jarvis, 2008. Gap analysis: A tool for 
complementary genetic conservation assessment. 
Diversity Distribut., 14: 1018-1030.