**Ex situ conservation of endangered geophytes of the Hirkan National Park (Azerbaijan) in the Central Botanical Garden (Azerbaijan)**

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**Abstract**

The Hirkan National Park (HNP) which includes the mountainous Talish region is a unique natural complex. The HNP was established to preserve the nature of this area, to protect relict and endemic plants of the Tertiary period and characteristic flora and fauna types, which were not affected by the Pliocene and Pleistocene glaciations (included in ‘The Red Book of Azerbaijan’) [1] and for monitoring the environment, public awareness and the creation of favourable conditions for research, tourism and recreation. The HNP is a forest with a rich floristic composition, including 150 endemic species out of a total of 435 species of trees and bushes. In the research area, more than 15 geophyte species are endemic plants of the Caucasus or Azerbaijan. Some geophyte species are *Allium lenkoranicum* Miscz. ex Grossh., *A. talyschense* Miscz. ex Grossh., *Bellevalia fominii* Woronow, *Ornithogalum hyrcanum* Grossh., *Fritillaria grandiflora* Grossh., *Crocus caspius* Fisch. & C.A. Mey., *Iris helena* (C. Koch) C. Koch, *Himantoglossum formosum* (Stev.) C. Koch, *Ophrys oestrifera* Bieb. The 92 geophyte species identified and registered in the HNP belong to 21 families and 46 genera, including 33 rare and endangered species, of which 11 species are included in ‘The Red Book of Azerbaijan’. The organization of reserves encounters significant, frequently insuperable difficulties in the present period. Even working reserves experience extreme influences of natural factors and anthropogenic impacts. This necessitates the preservation of plants, including endemic and relict, rare and endangered geophyte species of the Talish region *ex situ* in collections. Multilateral research activities frequently demand the presence of sufficient and easily accessible material that can only be provided with its preservation in collections. The aims of the Central Botanical Garden of Azerbaijan are: conservation of rare and endangered species, climate adaptation of plants, enrichment of plant resources, and selection of plants for use in gardens in Baku city.

**Background**

The richness of the Talish flora is distinguished not only in Azerbaijan, but also in botanical and geographical regions of the Caucasus. The Talish region is located in the extreme south-eastern part of Azerbaijan. In the West, the Talish Mountains are
bordered by the Republic of Iran, and in the East by the Caspian Sea. The flora of the region and its genetic resources has incorporated the remnants of the flora of various geological eras, especially the Tertiary Period and has emerged as a result of long historical development. The isolation of the geographical position of Talish, with vegetation differing in a variety of life forms, allows geophytes to be considered as a group of independent bioecological value. Therefore, this study was carried out to determine the geophyte flora of the Talish region in Azerbaijan, and to observe the conditions of the endemic and/or rare geophyte populations.

During the last decade man’s impact on natural ecosystems has increased significantly and poses a serious threat to the natural equilibrium of ecosystems. When the habitats of a rare and/or endemic species are damaged and/or fragmented by mis-management and various other human activities (such as, intensive urbanization, over exploitation of natural resources, development of tourism), distribution ranges, population sizes, and genetic variability of the species will be reduced and its members will become vulnerable to extinction at a faster rate than others. Due to this, special attention should be given to the investigation of threatened taxa.

It was necessary to consider the best ways of preserving plant genetic resources in situ and this led to the organization of the Hirkan natural reserve in Azerbaijan. The Hirkan National Park was established in 2004 based on the Hirkan State Reserve which it superseded, with an area of 29,760 hectares (297.6 km$^2$). It was enlarged in 2008 to 42,797 hectares (427.97 km$^2$) (Figure 1). The main purposes for the establishment of the National Park are: preservation of the nature of this area; protection of relict and endemic plants of the Tertiary Period and characteristic flora and fauna types which were not affected by Pliocene and Pleistocene glaciations, and their inclusion in the Red Book of the Azerbaijan Republic [1]; monitoring of the environment; public awareness; and also the creation of favourable conditions for research, tourism and recreation.

The ecosystem of the Hirkan National Park belongs to the Caspian Hyrcanian (Hirkan) mixed forests ecoregion, an area of lush deciduous broadleaved lowland and mountain forests (subtropical and temperate rainforests) that completely cover the Talish Mountains and partially cover the Lenkoran Lowland. One of the main characteristics of the subtropical forests of the Lenkoran zone (where the Hirkan National Park is located) are the well-preserved Hirkan type forests and the abundance of many endemic, rare trees, bushes and herbs [2]. Botanical expeditions over the last 50 years have given a general description of the region’s vegetation with numerous herbarium specimens having been collected by world botanists during the 19-20th century and cited in the literature especially of books such as the "Flora of Azerbaijan" in 8 volumes [3] and the "Conspectus of Caucasian geophytes" [4] and other publications [5, 6], (Table 1).

**Materials and Methods**

Field investigation began in 2004 with reference to research by Haciyev et al. [2] and Ibadli [7]. The nomenclature of taxa was according to Karyagin [3], Ibadli [4, 7] and Czerepanov [8]. The identification of specimens was also checked against specimens in the herbaria of the Botanical Institute of Baku (BAK). Specimens were deposited in
the Botanical Institute, Herbarium Fund. The list of taxa was arranged according to "The Flora of Azerbaijan" [3] and Ibadli [4, 7], with the species name, locality, habitat, properties, and altitude. On the basis of this information and the corresponding literature [3, 4] and the results of research, the geophyte plants were grouped on the basis of the type of underground storage organ: bulb, tuber, root, rhizome and corm. The endemic species were determined according to Ahundov [9] and Musayev [10]. Each species was categorized for threat according to IUCN Red List Categories [11]. The following category abbreviations are used in the text: BAK (Herbarium Fund of the Botanical Institute of Azerbaijan National Academy of Sciences, Baku, Azerbaijan), IUCN (International Union for Conservation of Nature – Red List Categories and Criteria), CR (critically endangered), EN (endangered), VU (vulnerable), CBG (Central Botanical Garden).

Results and Discussion

Herbarium specimens and also seeds of the geophyte species from different families, which were identified in the Hirkan National Park were collected basically in the spring and the autumn during the period of 2004-2007, photographs were taken and areas of distribution are specified [12, 13].

As a result of the field studies, 92 species of geophytes were identified in the Hirkan National Park, with representatives of 21 families and 46 genera [13], including 33 rare and endangered species, of which 11 species are listed in the "Red Data Book of Azerbaijan" (Figures 2, 3) [11]. The distribution of species according to families in the study area was categorized and listed. The families which include the largest number of species are as follows: Orchidaceae (26 spp.), Hyacinthaceae (11 spp.), Alliaceae (9 spp.), Iridaceae (8 spp.) and Asparagaceae (5 spp.). Families which possess less than 5 species constitute 64.13% of the floristic fund of the Hirkan National Park [13].

More than 15 geophyte species are endemic plants of the Caucasus or Azerbaijan. Some of them are: Allium lenkoranicum Miscz. ex Grossh., Allium talyschense Miscz. ex Grossh., Belvalia fominii Woronow, Ornithogalum hyrcanum Grossh., Fritillaria grandiflora Grossh., Crocus caspius Fisch. & C. A. Mey., Iris helena (C. Koch) C. Koč., Himantoglossum formosum (Stev.) C. Koch, Ophrys oestrifera M. Bieb. among many others.

Nineteen rare geophyte species in the flora of the Hirkan National Park represents 3.3% of the floristic fund of the named area. The following classification according to IUCN categories was ascribed [11]:

- **Vulnerable** (VU): 11 species: Belvalia fominii Woronow, Allium paradoxum (M. Bieb.) G. Don fil., Galanthus caspius (Rupr.) Grossh., Sternbergia fischeriana (Herb.) M. Roem., Puschkinia scilloides Adams, Scilla caucasica

*In situ* conservation refers to the conservation of biodiversity in populations growing in their place of origin. However, the organization of reserves is connected with significant, frequently insuperable difficulties in the present period. Even operating reserves are subject to the extreme influences of natural factors and anthropogenic impacts. As a result of this, there is a necessity for the preservation of plants, including endemic and relict, rare and endangered geophyte species of the Talish region in *ex situ* collections. In addition, multilateral research activities frequently demand easily accessible plant material and in sufficient quantities that can only be provided by preservation in living collections. *Ex situ* conservation is the method predominately used in agriculture. Arboreta and botanical gardens are also *ex situ* collections, but generally have too few individuals to be useful for conserving rare and/or endemic plants.

The selection of prospective species of plants, their introduction and study, for use as garden plants in Baku city is one of the main objectives of the Central Botanical Garden of Azerbaijan. This is also a way of conserving rare and endangered species, studying the introduction and climate adaptation of ornamental, medicinal, aromatic and other plants, in order to enrich the raw-material bases of plant resources. Among these groups geophytes play an important role [14, 15]. Research data shows that geophytes represent 4.25% of the flora of Azerbaijan. So, Talish floristic exposition is of great importance in CBG [12] and about 30 endemic and relict plants, especially trees, bushes and geophytes species have been planted there. The development of methods and techniques of reproduction of protected geophytes in culture, a comprehensive study of morphological, ecological and biological characteristics, will help address the issue of the rational use and conservation of rare and endangered species as *in situ* and *ex situ* collections.

**Conclusions**

- For the first time, 92 geophyte species were identified and registered in the Hirkan National Park with representatives from 21 families and 46 genera.
- Thirty-three (33) of the geophyte species are rare and endangered species, eleven (11) of which are listed in the "*Red Data Book of Azerbaijan*”.
- In the surveyed area, the Hirkan National Park, more than 15 geophyte species are endemic to the Caucasus or Azerbaijan floras.
- Based on our research, actions for protection and restoration were determined, and practical recommendations are offered.

**References**

Table 1. The plant composition of Hirkan National Park (Azerbaijan)

<table>
<thead>
<tr>
<th>Plant groups</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryophyta and Pteridophyta</td>
<td>15</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Pinophyta (Gymnospermae)</td>
<td>4</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Magnoliophyta (Angiospermae)</td>
<td>113</td>
<td>536</td>
<td>1169</td>
</tr>
<tr>
<td>including Magnolietae (dicots)</td>
<td>89</td>
<td>429</td>
<td>951</td>
</tr>
<tr>
<td>Liliatae (monocots)</td>
<td>24</td>
<td>107</td>
<td>218</td>
</tr>
<tr>
<td>Geophytes</td>
<td>21</td>
<td>46</td>
<td>92</td>
</tr>
</tbody>
</table>

Figure 1. Map of the Talish region (Azerbaijan). The Hirkan National Park borders are indicated by the red line.

Figure 2. Exposition of *Galanthus caspius* (Rupr.) Grossh. in situ (A) and the CBG (B)
Figure 3. Exposition of *Limodorum abortivum* (L.) Sw. *in situ* (A) and the CBG (B)

Figure 4. Exposition of tulips in the CBG.