

## Rare and endangered plants of the flora of Georgia common in the Tbilisi environs (East Georgia, Caucasus)

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### Abstract

The protection and preservation of biodiversity around big cities is an urgent problem of modern times. The present study is devoted to the protection and preservation of the wild flora of Tbilisi City. 40 rare and endangered vascular plants of flora of Georgia growing wild in the Tbilisi environs have been identified. 14 of them are trees, 6 - shrubs, 2 - semi-shrubs and undershrubs, 17 - perennial herbs and 1 - annual plant. Each of them was assessed according to IUCN categories and criteria: Critically Endangered (CR) – 6 species, Endangered (EN) – 10, Vulnerable (VU) – 12, Near Threatened (NT) – 8 and Data Deficient (DD) species – 4. They are plants of different bio-ecologies and are distributed in the different vegetation types and habitats. 19 species are endemics of the Caucasus. Two of them (*Astragalus cyri* Fomin and *Anthemis saguramica* Sosn.) are endemics of Georgia. The article provides a list of the target species with reference to key synonyms, families, habitats (within Tbilisi environs), life forms and IUCN categories and criteria (within Georgia).

**Keywords:** Species; IUCN; Life form; Habitat; Endemic

### 1. Introduction

Biodiversity protection is an urgent problem of modern time. Natural landscapes are the most important environment that creates recreational areas and a clean ecological environment in the outskirts of cities. Therefore, protection of biodiversity and preservation of natural vegetation cover is especially relevant for big cities. Along with the protection and preservation of natural landscapes, the most important emphasis should be placed on the rare and endangered species. Based on the above, the aim of our research was to identify rare and endangered species of flora of Georgia that are widely distributed in the Tbilisi environs, their regional (within Georgia) assessment according to IUCN categories and criteria [1] and to determine their habitats.

### 2. Material and method

#### 2.1. Study area

##### 2.1.1. Physical-geographical conditions

Tbilisi is the capital of Georgia. It is located in the central part of the Caucasus ecoregion (Figure 1). Tbilisi environs include basin of Mtkvari River from village Dzegvi to the section between Fonichala-Rustavi.

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Figure 1 Location of Georgia and Tbilisi City in the Caucasus ecoregion (Map by Lachashvili et al. [2])

The territory is characterized by a diversity of physic-geographical conditions. The endings of large geographical units of different origin and geological age converge here (Figure 2): 1. the eastern endings of the Lesser Caucasus, namely of the Trialeti Ridge; 2. the extreme southern branching of the Great Caucasus - Saguramo-Ialno Ridge; 3. the extreme northwestern ending of Mtkvari-Araks lowland - part of Kvemo Kartli lowland; 4. the extreme north-western and western parts of the Iori Plateau; 5. the eastern part of Kvernaki low ridge (Skhaltba low ridge). Such diversity determines the complexity and mosaic of the terrain of the Tbilisi environs. At the same time, the hypsometric amplitude of the Tbilisi area is high - it is about from 350 m a.s.l. to 1875 m a.s.l. [3-7].

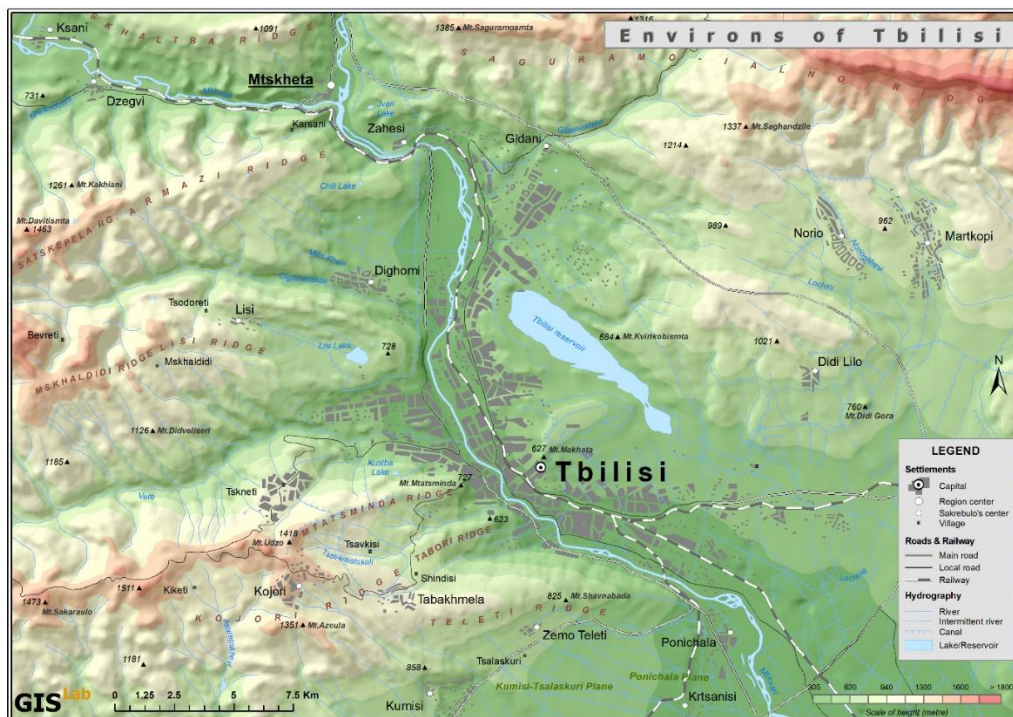


Figure 2 Physical-geographic map of Tbilisi environs [(Map by Lachashvili et al. [7])

The areas of different climatic zones are intersected in the Tbilisi environs [8, 9]:

- Transitional climate from a moderate warm steppe to a moderate humid with hot summer and two minimums of precipitation per year (BS-Cxa);
- Moderate humid climate with moderately cold winter and prolonged warm summer and two minimums of precipitation per year (Cxb);
- Moderate humid climate with moderately cold winter and hot summer and two minimums of precipitation per year (Cxa);
- Moderate humid climate with cold winter and prolonged cool summer and two minimums of precipitation per year (Dxbk').

The soil cover is also diverse. Different modifications of grey-cinnamonic, cinnamonic and brown forest soils are the main ones. Grey-cinnamonic soils on the Kvemo Kartli lowland are salinized to varying degrees and fragments of solonetz and solonchak soils are also included in their area. Alluvial soils are developed on the river terraces (especially along the Mtkvari River). There are rocky exposed bedrocks and scree-stony ecotopes and loamy and clayey-sandy badland sections [10, 11].

### 2.1.2. Floristic and ecosystem diversity

The variety of physical-geographical conditions, geographical location at the intersection of the different floristic centers (Mediterranean, South-West Asia, Turan, Europe, etc.), geological past, modern geomorphological and geochemical processes determine both the floristic and ecosystem diversity of the Tbilisi environs. In M. Sakhokia's words [12], the Tbilisi area is a kind of "botanical junction" in the South Caucasus, where the areas of various floristic centers are intersected. About 1,600 species of vascular plants are distributed in this small area [13, 14], which is about 25% of the total flora of the Caucasus. At the same time, a diverse and completely different structure and ecology vegetation types is developed, which by their origin and florogenetic connections are linked to different floristic centers. The deciduous forests of the foothills, lower and middle mountain belts, various types of shrubberies and steppe play the main role in forming the landscapes and vegetation cover. In addition to them, there are various plant communities of xerophytic forests (arid woodlands), coniferous forests of the middle mountain belt, tragacanthic shrubberies, meadow-steppes, subalpine meadows, saline meadows, desert-semidesert, floodplain forest and wetlands. In the Tbilisi area, they in the form of small plots are distributed fragmentally or have a local area. There are also floristic complexes of rocky and scree-stony ecotopes [15-26].

### 2.2. Data and assessment of the target species

The data collection on the target species was carried out during the field work. Various literary data [6, 13, 14, 27, 28, 29, 30, 31], as well as material stored in different herbariums of Georgia (TBI, GMU, BATU), were used to determine plant areas, along with own research.

The short description of the habitats includes both plant communities and key physical-geographical characteristics.

Regional assessment of the species was carried out according to the IUCN categories and criteria [1]. Along with the new research, our recent research papers are also used [2, 32, 33, 34].

Endemics of the Caucasus are discussed within the scope of the Caucasus ecoregion [35]. The life forms of plants are based on the classifications of Raunicher [36] and Serebryakov [37].

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## 3. Results and discussion

40 rare and endangered species for flora of Georgia were identified in the Tbilisi environs. Each of them was assessed according to the IUCN categories and criteria. Regionally (Georgia) 6 of these species are Critically Endangered (CR), Endangered (EN) – 10, Vulnerable (VU) – 12, Near Threatened (NT) – 8. 4 species were classified to category "Data Deficient" (DD).

Among the 40 target species, 19 are endemic of Caucasus. These are: *Acer ibericum* M. Bieb., *Anthemis saguramica* Sosn., *Asphodeline prolifera* (M. Bieb.) Kunth, *Astragalus cyri* Fomin, *Astragalus tanae* Sosn., *Daphne oleoides* subsp. *transcaucasica* (Pobed.) Halda, *Gagea charadzeae* Davlian., *Galanthus lagodechianus* Kem.-Nath., *Gypsophila robusta* Grossh., *Iris iberica* Steven, *Iris spuria* subsp. *carthalinae* (Fomin) B. Mathew, *Ornithogalum magnum* Krasch. & Schischk., *Prunus georgica* (Desf.) Eisenman, *P. violacea* subsp. *georgica* (Rupr.) Lufarov, *Pyrus demetrii* Kuth.,

*Pyrus fedorowii* Kuth., *Pyrus ketzkhovelii* Kuth., *Pyrus sachokiana* Kuth., *Tulipa eichleri* Regel. Among them 2 species - *Astragalus cyri* Fomin and *Anthemis saguramica* Sosn. are endemics of Georgia.

Of the 40 species 14 are trees, 6 – shrubs, 2 - semi-shrub, undershrub, 17 - perennial herbs and 1 – annual. According to the classification of Raunchier [36], the species are classified as follows: phanerophytes - 21 species, chamaephytes - 1, hemicryptophytes - 4, geophytes - 13 and therophytes - 1.

It is important that the identified rare and endangered species are plants of different bioecology and are distributed in the various types vegetation and habitats.

The list of the target species is given below, which includes: key synonyms of species, name of family, habitats (within Tbilisi environs) and plants life form. IUCN categories and criteria (within Georgia) are also indicated.

### 3.1. List of rare and endangered plants of the flora of Georgia common in the Tbilisi environs

#### 3.1.1. Abbreviations

CR – Critically endangered; DD – Data deficient; EN - Endangered; NT – Near threatened; VU - Vulnerable;

An – Annual; Ch – Chamaeephyte; G – Geophyte; H – Hemicryptophyte; PH - Perennial herb; Ph – Phanerophyte; Sh – Shrub; SSh - Semishrub or dwarf semishrub; T – Tree; Th – Therophyte.

- *Acer ibericum* M. Bieb. [*A. monspessulanum* subsp. *ibericum* (M. Bieb.) Yalt.] (*Sapindaceae*)
  - On the slopes and in the ravines with grey-cinnamonic and cinnamonic soils; in the hemixerophilous shrubberies and forests edges; T, Ph; VU B1ab (iii, v).
- *Anthemis saguramica* Sosn. (*Asteraceae*)
  - On the slopes and plane places with cinnamonic soils; in the meadow and forest edge; PH, H; CR B1ab (iii, v) + 2ab (iii, v).
- *Asphodeline prolifera* (M. Bieb.) Kunth (*Xanthorrhoeaceae*)
  - On the dry slopes with cinnamonic and grey-cinnamonic soils; in the steppe and hemixerophilous shrubberies; An, Th; EN B1ab (iii) + 2ab (iii).
- *Astragalus cornutus* Pall. (*Fabaceae*)
  - On the slopes with cinnamonic soils; in the hemixerophilic shrubberies; SSh, Ph; DD.
- *Astragalus cyri* Fomin (*Fabaceae*)
  - On the dry clayey and clay-sandy slopes and plane places; in the xerophytic complexes; PH, H; EN B1ab (iii, v) + 2ab (iii, v).
- *Astragalus tanae* Sosn. (*Fabaceae*)
  - On the slope with thin and stony soils; in the tragacanthic shrubberies and hemixerophilous complexes; Sh, Ph; EN B1a + 2a.
- *Buxus sempervirens* L. (*B. colchica* Pojark.) (*Buxaceae*)
  - On the slopes and ravines; on the cinnamonic and brown forest soils; in the deciduous forests of the foothills and lower mountain belt; Sh, Ph; CR A2acde.
- *Celtis glabrata* Steven ex Planch. (*C. planchoniana* K. I. Chr.) (*Ulmaceae*)
  - On the dry slopes and rocky ecotopes; T or Sh, Ph; EN B1ab (iii).
- *Cotoneaster melanocarpus* Fisch. ex Blytt (*Rosaceae*)
  - On the slopes with cinnamonic soils; hemixerophilous shrubberies; Sh, Ph; EN B1ab (iii).
- *Crataegus pontica* K. Koch (*Rosaceae*)
  - On the slopes with cinnamonic soils; in the forests, forest edges and shrubberies; T, Ph; VU B1bc.
- *Daphne oleoides* subsp. *transcaucasica* (Pobed.) Halda (*Thymelaeaceae*)
  - On the slopes and ravines; in the forest on the stony and rocky ecotopes; Sh; Ph; VU D2.
- *Eremurus spectabilis* M. Bieb. (*Xanthorrhoeaceae*)
  - On the dry clayey slopes; in the hemixerophilic complexes; PH, G; DD.
- *Fritillaria caucasica* Adam (*Liliaceae*)
  - On the slopes with cinnamonic soils; hemixerophilous shrubberies; PH, G; VU D2.
- *Gagea caroli-kochii* Grossh. (*Liliaceae*)
  - On the dry slopes with cinnamonic soils; in the herbaceous plant communities and hemixerophilous shrubberies; PH, G; EN B1ab (iii).
- *Gagea charadzeae* Davlin. (*Liliaceae*)
  - On the slopes with cinnamonic soils; in the meadow by the forest; PH, G; VU D2

- *Galanthus lagodechianus* Kem.-Nath. (*Galanthus kemulariae* Kuth.); (*Amaryllidaceae*)
  - On the slopes with brown forest soils; in the deciduous forests and forest edges; PH, G; VU D2.
- *Gypsophila robusta* Grossh. (*Caryophyllaceae*)
  - On the dry slopes with stony cinnamonic soils and on the sandy riverside terraces; PH, H; endemic of Caucasus; VU B2ab (iii, v).
- *Helianthemum georgicum* Juz. & Pozdeeva (*Cistaceae*)
  - On the slope with thin and stony soils; in the tragacanthic shrubberies and various hemixerophilous complexes; SSh, Ch; EN B1ab (iii, v) + 2ab (iii, v).
- *Iris iberica* Steven (*Iridaceae*)
  - On the dry, clay-containing slopes; hemixerophilous shrubberies; PH, G; EN B2ab (v).
- *Iris paradoxa* Steven (*Iridaceae*)
  - On the dry, clay-containing slopes; in the hemixerophilous shrubberies; PH, G; DD.
- *Iris spuria* subsp. *carthaliniae* (Fomin) B. Mathew (*Iris carthaliniae* Fomin) (*Iridaceae*)
  - On the moist ecotopes; PH, G; CR B1ab (iv, v).
- *Ophrys sphegodes* subsp. *taurica* (Aggeenko) Soó ex Niketic & Djordjevic [*Ophrys caucasica* Woronow ex Grossh.; *Ophrys sphegodes* subsp. *caucasica* (Woronow ex Grossh.) Soó; *Ophrys sphegodes* subsp. *mammosa* (Desf.) Soó ex E. Nelson; *Ophrys mammosa* subsp. *caucasica* (Woronow) Soó; *Ophrys caucasica* subsp. *cyclocheila* Aver.; *Ophrys mammosa* subsp. *cyclocheila* (Aver.) B.Baumann, H.Baumann, R.Lorenz & Ruedi Peter] (*Orchidaceae*)
  - On the slopes with cinnamonic soils; in the hemixerophilous shrubberies and it edges, in the hemixerophilous herbaceous plant communities; H, G; NT.
- *Ornithogalum magnum* Krasch. & Schischk. (*Asparagaceae*)
  - On the slopes with cinnamonic and brown forest soils; in the deciduous forests and forest edges; PH, G; VU D2.
- *Pistacia atlantica* Desf. [*Pistacia mutica* Fisch. & C. A. Mey.; *Pistacia atlantica* subsp. *mutica* (Fisch. & C. A. Mey.) Rech. F.] (*Anacardiaceae*)
  - On the slopes and ravines; on the cinnamonic and grey-cinnamonic soils; in the xerophytic forests and forest edges; T, Ph; VU B1 ab (iii).
- *Prunus georgica* (Desf.) Eisenman (*Rosaceae*)
  - On the soils with cinnamonic soils; in the hemixerophilous shrubberies; Sh, Ph; NT.
- *Pulsatilla violacea* subsp. *georgica* (Rupr.) Luferov (*Ranunculaceae*)
  - On the rocky and stony ecotopes; PH, H; EN B1ab (iii, v)+2ab (iii, v).
- *Pyrus demetrii* Kuth. (*Rosaceae*)
  - On the slopes with cinnamonic soils; in the hemixerophilous plant communities; T, Ph; CR D.
- *Pyrus fedorowii* Kuth. (*Rosaceae*)
  - In the slopes with cinnamonic soils; in the hemixerophilous shrubberies; T or Sh; Ph; EN B1ab (iii, v).
- *Pyrus ketzkhoveli* Kuth. (*Rosaceae*)
  - On the slopes with cinnamonic soils; in the deciduous forest edges and shrubberies; T, Ph; CR B2ab (iii).
- *Pyrus sachokiana* Kuth. (*Rosaceae*)
  - On the slopes with cinnamonic soils; in the various types of shrubberies and edges of deciduous forests; T, Ph; CR D.
- *Quercus macranthera* Fisch. & C.A. Mey. ex Hohen. (*Fagaceae*)
  - On slopes with brown forest soils; in the deciduous forests of the lower and middle mountain belt; T, Ph; NT.
- *Quercus robur* subsp. *pedunculiflora* (K. Koch) Menitsky (*Quercus pedunculiflora* K. Koch) (*Fagaceae*)
  - On the riverside terraces with alluvial soils; in the floodplain forests and their derivatives; T, Ph; VU B1ab (i, ii, iii).
- *Sternbergia colchiciflora* Waldst. & Kit. (*Amaryllidaceae*)
  - On the slopes and plain places with cinnamonic and grey-cinnamonic soils; in the steppe and meadow-steppe; PH, G; NT.
- *Taxus baccata* L. (*Taxaceae*)
  - On the slopes with brown forest and cinnamonic soils; in the deciduous forests and forest edges; T, Ph; VU B1ab (i, ii).
- *Tulipa biebersteiniana* Schult. & Schult. f. [*Tulipa sylvestris* subsp. *australis* (Link) Pamp.] (*Liliaceae*)
  - On the slopes with cinnamonic soils; in the deciduous forests and forest edges of foothills; PH, G; DD.
- *Tulipa eichleri* Regel (*Liliaceae*)
  - On the dry clayey slopes; in the xerophilic complexes; PH, G; NT.



- *Ulmus glabra* Huds. (*Ulmaceae*)
  - On the slopes with cinnamonic and brown forest soils; in the deciduous forests; T, Ph; NT.
- *Ulmus minor* Mill. (*Ulmaceae*)
  - On the slopes, plane places, riverside terraces and in the ravines; on the cinnamonic, brown forest and alluvial soils; in the deciduous forests, forest edges and shrubberies; T or Sh, Ph; NT.
- *Vitis sylvestris* C.C.Gmel. [*V. vinifera* subsp. *sylvestris* (C.C. Gmel.) Hegi] (*Vitaceae*)
  - On the riverside terraces and in the moist ravines; on the alluvial and moist cinnamonic soils; in the floodplain forests and their derivatives; Sh (liana), Ph; NT.
- *Zelkova carpinifolia* (Pall.) K. Koch (*Ulmaceae*)
  - On the slopes with cinnamonic soils; in the deciduous forests of the foothills and lower mountain belt; T, Ph; VU B1ab (iii).

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#### 4. Conclusion

The results of the research show that the rare and endangered plant species of the flora of Georgia, spread in the Tbilisi area, are components of different habitats. The new data will contribute to the development of in-situ conservation measures for these species. The survival and preservation of species, in turn, implies the protection and preservation of their habitats. Accordingly, the obtained results and their consideration in the field of urban and recreational development of the city will play an important role in the protection of the biodiversity of the Tbilisi environs (and the Caucasus in general).

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#### Compliance with ethical standards

##### *Disclosure of conflict of interest*

There is no conflict of interest with the research and data presented in the article.

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