

RARE FLORA OF THE KHADZHOKH RECREATIONAL AREA OF THE  
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**Abstract:** The problem of preserving the diversity of the Earth's flora is extremely relevant due to the increasing impact of economic and other human activities on the natural environment. The most fragile and very significant part of the flora in need of protection are rare, endangered and threatened with extinction species. From a biological point of view, these categories include: species that are not threatened with extinction, but their number on the planet is very small; species that are dying out as a result of evolutionary processes; species that are potentially vulnerable due to their biological characteristics; widespread species that reduce their range and numbers as a result of anthropogenic influences. The article shows that the Khadzhokh recreational area of the Republic of Adygea includes three settlements: the villages of Dakhovskaya, Kamennomostsky and Pobeda, which are the most attractive for the local population and tourists from all the regions of Russia and abroad. Based on the survey of the territory of the area in 2017–2022, we studied landscape and botanical monuments of nature and identified rare plants. The rare flora of the area includes a large proportion of relict and endemic species. The rarest plant species are recommended for inclusion in the third edition of the Red Book of the Republic of Adygea, which will be published in 2023. The limiting factors of the rare flora of the area are revealed. The aim of the work is to study the Khadzhokh recreational zone of the Republic of Adygea, identify the species composition of plants in this territory and identify rare species, assess the current state of their populations and determine the category of rarity status for the third edition of the Red Book of the Republic.

**Keywords:** Republic of Adygea, Khadzhokh recreational area, natural monuments, rare plants, endemics, relics, Red Book of the Republic of Adygea.

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## RESEARCH ARTICLE

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## 1. Introduction

The reduction of plant diversity affects the stability of natural ecosystem functioning, that is, their productivity and resistance to the introduction of invasive species decrease while the pest activity increases. At the same time, it should be noted that each species makes a certain contribution to ensuring the stability not only of its local ecosystem, but also of the biosphere as a whole, participating in biogeochemical, climatic and other planetary processes. Changes in the plant world caused by human activity have a number of consequences for the process of evolution: intraspecific genetic diversity decreases, populations are divided into a number of isolated fragments, previously separated taxa hybridize, endemics of technogenic substrates and polluted territories appear, etc. [*Gorchakovsky and Shchurova, 1982*]. Also, the extinction of plants leads to the loss of potential sources of economically useful resources for humanity: food, medicinal, decorative, construction and other resources. All this makes the preservation of the diversity of flora one of the most significant problems of our time.

## 2. Research methods

The study used literary sources and herbarium collections of the Caucasian State Natural Biosphere Reserve named after H. G. Shaposhnikov (CSR), Adygea State University (MAY) and the National Museum of the Republic of Adygea. The collection of factual material was carried out in 2017–2022 during expeditionary surveys of the area. The determinants of A. A. Grossheim [Grossheim, 1949], I. S. Kosenko [Kosenko, 1970] and A. A. Galushko [Galushko, 1980], “Flora of the Northwest Caucasus” [Zernov, 2006] were used to determine the plants. Latin names of species are given according to Cherepanov [Cherepanov, 1995]. The research included the development of proposals on the status of rare species in order to include them in the third edition of the Red Book of the Republic of Adygea.

## 3. Study area

The Republic of Adygea (RA) is the only region in the Russian Federation (RF) surrounded on all sides by another region (Krasnodar Krai) (Figure 1). The republic is located in the northwestern part of the Caucasus on the left bank of the Kuban and Laba rivers. The area of Adygea is 7792 km<sup>2</sup>. The northern part of the Republic is a slightly undulating Pre-Kuban inclined plain, the southern part is composed of the foothills (up to 300 m above sea level) and mountains (Mount Chugush, up to 3238 m above sea level) of the Greater Caucasus. The climate is moderately warm and humid. The average temperature in January in the capital (Maykop) is –1.6 °C, in July is 22.2 °C. Precipitation falls about 700 mm per year. The frost-free period lasts 180 days. Chernozems are common in most of the territory. The massifs of plavnevo-meadow, meadow-marsh and mountain forest soils are significant.

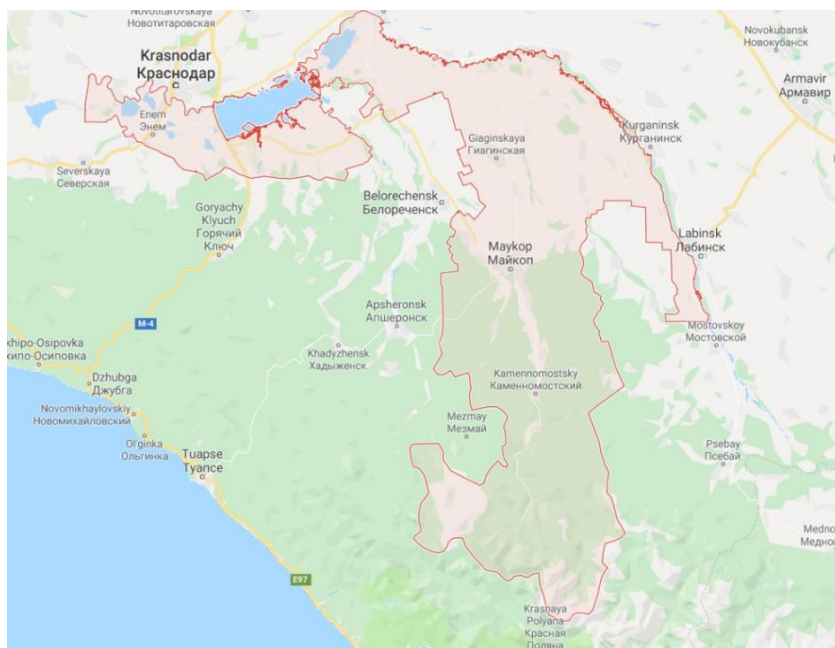


Figure 1. Map of the Republic of Adygea.

Several geographical zones and vertical vegetation belts is replaced from the north to the south on the territory of the Republic: forest–steppe – up to 500 (600) m above sea level; oak and hornbeam forests – 500 (600)–900 (1000) m above sea level; beech forests – 900 (1000) – 1400 m above m.; dark coniferous forests of Caucasian fir with “islands” of pine forests 1200 (1400)–2220 m above sea level; subalpine belt of a complex of crooked forests, woodlands, rhododendron thickets and tall grass meadows – 1800–2300 (2500) m above sea level. m.; the alpine belt consists of a complex of shrubs, low-grass meadows, carpets and rock communities – 2500 (2600)–2800 (3200) m above sea level; the nival belt of “eternal” snows and glaciers.

A distinctive feature of Adygea is a significant landscape and biological diversity and a high level of endemism and relict flora. About 14% of the territory of the republic are UNESCO World Natural Heritage Sites “Western Caucasus” [Zhane, 1999] and more than 30% of the Republic's area is occupied by specially protected natural areas (protected areas) [Kozmenko, 2007]. Currently, there are 20 protected areas on the territory of the republic: two of them are of federal significance (the Northern Department of the Caucasian State Natural Biosphere Reserve named after H. G. Shaposhnikov (KGPPZ) and the Arboretum of the Adygea State University), 18 – of regional subordination. The protected areas of regional subordination are comprised of 3 natural parks, 2 nature reserves and 13 natural monuments. They are as follows: the nature parks “Bolshoy Tkhach”, “Gornaya Adygea” and “Upper Reaches of the Tsitsa River”, botanical reserves of Maykop and Kuzhorsky; natural monuments: “Bujny Ridge”, “Waterfalls of Rufabgo Creek”, “Granite Gorge”, “Monk Mountain”, “Syuk River Valley”, “Ammonite Valley”, “Natural plantings of chestnut”, “Canyon of the Aminovka River”, “Canyon of the Meshoko Creek”, “Maiden Stone”, “Canyon of the Sakhray River”, “Colchis boxwood massif” and “Khadzhokh gorge” [Official Internet site of the executive bodies of state power of the Republic of Adygea, 2000].

Currently, the species diversity of the higher plants of the republic is estimated at about 2000 species: about 1500 species of vascular plants and 400 species of mossy. A significant number of relicts, endemics, rare and endangered plants have been noted in the flora. In our opinion, the presence of 133 species of relict plants belonging to 99 genera from 48 families in the flora of Adygea should be considered reliable [Sirotyuk et al., 2013]. According to M. D. Altukhov, about 350 Caucasian endemic species grow in the North-Western Caucasus. of these, more than 150 species grow in Adygea [Altukhov, 1985], including 33 species of rare orchids [Sirotyuk and Zhemadukova, 2020]. Rare and endangered plants of Adygea are more than 300 species of higher spore and seed plants, of which 140 species are included in the Red Book of the Republic of Adygea [The Red Book of the Republic of Adygea, 2012], including 27 endemic Caucasian species and 21 relicts, 55 species (39.2%) are listed in the Red Book of the Russian Federation [Bardunov, 2008].

The local centers of speciation in Adygea are the Fisht-Oshten massif and the Bolshoy Tkhach Mountain. The subalpine and alpine vegetation of these mountain systems contains approximately 36% of the endemic species of the republic. It should be noted that all modern forest-forming rocks of Adygea are relicts of the tertiary period.

A high degree of economic development of the territory of the republic, intensive development of recreation and tourism can jeopardize the stability of natural ecosystems and existence of many unique habitats and rare species of flora. However, the main danger is the intensive development of the territory for the needs of the national economy, during which there is not only a violation of the locations of rare flora species, but also the destruction of the soil cover [Lebedev et al., 2021].

#### 4. Research results

The Republic of Adygea is a tourist and recreational region. 13 places of concentration of tourist and recreational facilities have been identified at the recreational area level in the Republic, where natural resources are supplemented by historical, cultural and infrastructural ones. The most attractive for the local population and tourists from the regions of Russia is the Khadzhokh recreational area, which covers the village of Dakhovskaya and the villages of Kamennomostsky and Pobeda. There are 23 tourist routes in the area. The number of natural objects is 97 pcs., historical and cultural – 11 pcs., hospitality – 43 pcs. There are regional branches of road and rail transport in the village of Kamennomostsky [Sviridova, 2022].

The largest river of Adygea, the Belaya, flows in the Khadzhokh recreational area and it has many tributaries (more than 3000): Pshekh, Kurdzhips, Kisha, Dakh, Aminovka, Bolshoy Rufabgo, etc. The Belaya forms two large canyons: on the southwestern outskirts of the village is Kamennomostsky – Khadzhokhsky (Figure 2) and in the Dakhovsky gorge is Granite (Figure 3), as well as many waterfalls, gorges, caves and rock formations.



**Figure 2.** Khadzhokh Canyon.



**Figure 3.** Granite Canyon.

The village of Dakhovskaya is the administrative center of the Dakhovsky rural settlement and the center of tourism in Adygea [[goryuga.ru/dahovskaya.php](http://goryuga.ru/dahovskaya.php)]. The village is located at the foot of Mount Gut at an altitude of 480 m above sea level, on the right bank of the Belaya River at the confluence of the Dakh tributary (Figure 4).



**Figure 4.** The village of Dakhovskaya.

Ridges with oak, beech and fir forests on both sides surround Dakhovskaya: on the left, it is Una-Koz, which is a part of the Rocky Ridge; on the right – Azish-Tau. The village is located 7 km south of the village Kamennomostsky, where the nearest railway station Khadzhokh is located. The highway to the village of Guzeripl passes through the village along the gorge of the Belaya River. A little to the north there is a bridge over which there is a road to the Azish pass and the Lagonak Highlands.

The villages of Kamennomostsky and Pobeda have a rich tourist history and are widely known in the countries of the former USSR. Numerous and diverse recreational resources have been developed on their territory such as dolmens, waterfalls, grottos, canyons, and caves. Tourist flows are formed in the village of Kamennomostsky, heading throughout the mountainous Adygea. There is a tourist camp “Gornaya”, built in 1935, from which

the thirtieth All-Union hiking tourist route “Along Adygea to the Black Sea”, the oldest in Russia, began. It should also be mentioned the sanatorium “Lesnaya Skazka”, which is located 5 km from the village of Kamennomostsky and operates on the basis of hydrogen sulfide waters. Diseases of the musculoskeletal and central nervous systems are treated here.

The village of Pobeda, so named in May 1945, is the highest mountainous settlement of the Maykop district. It has a wide range of historical, cultural and natural monuments. There is a male Orthodox monastery (St. Michael-Athos Zakubanskaya male cenobitic monastery), founded in 1877, on the territory of which there is a holy spring, an underground temple, caves and monastic cells, which attract numerous pilgrims and tourists.

Natural monuments of various types are concentrated on the territory of the Khadzhokh recreational area of the republic: “Maiden Stone” (geological); “Waterfalls of Rufabgo creek” (landscape-geological); “Canyon of the Aminovka River” (landscape-botanical), “Canyon of the Meshoko creek” (landscape-botanical), “Khadzhokhskaya gorge” (landscape-botanical), which are visited by tourists from all the regions of Russia all year round. Intensive development of recreation and a high degree of economic development of the territory of natural monuments lead to changes and destruction of species habitats.

The forestry and mining industry of the republic is concentrated in the village of Kamennomostsky. The village has been developing and as a large industrial center for many years. Its further development is also connected with industry. New mining and sand pits, workshops for processing wood and natural stone are being opened. Concentration of recreational and industrial centers of the mountainous region of the mountainous region on the same industrial zone of the village of Kamennomostsky is at least irrational in terms of environmental and aesthetic parameters [Popov, 2020].

In addition, an industrial complex has been built in the village of Kamennomostsky, which includes: a plant for the production of gypsum and gypsum-binding mixtures with a capacity of 240 thousand tons per year, a plant for the production of cellular concrete blocks with a capacity of 450 thousand tons per year, a plant for the production of hyper-pressed bricks with a capacity of 24 million pieces per year, a lime plant with a capacity of 80 thousand tons per year, as well as a railway terminal for transshipment of non-metallic and construction materials, crushing and sorting units, a carpool for the placement of equipment intended for the transportation of non-metallic raw materials from quarries to the industrial zone [zavodfoto.livejournal.com].

The soils of the district are polluted with toxic chemicals coming from industrial emissions into the atmosphere and exhaust gases of motor vehicles, sewage, industrial and household waste, as well as agrochemicals (in particular, pesticides) used for plant treatment [Lebedev et al., 2021]. Data have been obtained that the soils are contaminated with petroleum products and destructive processes have begun. There are no diatoms in soil cyano-algosinusions, which are the main indicators of oil pollution of soils, and cyanobacteria resistant to soil contamination with petroleum products and heavy metals predominate [Sirotyuk and Zhemadukova, 2020].

The area is dominated by a broad-leaved forest mid-mountain landscape. However, the flora of the area has not been studied enough and the information about its composition and rare species is fragmentary. The deterioration of the state of natural monuments in the form of weakening of stands due to anthropogenic impact and the introduction of alien landscape elements reduces the recreational attractiveness of these tourist sites [Varzareva, 2009].

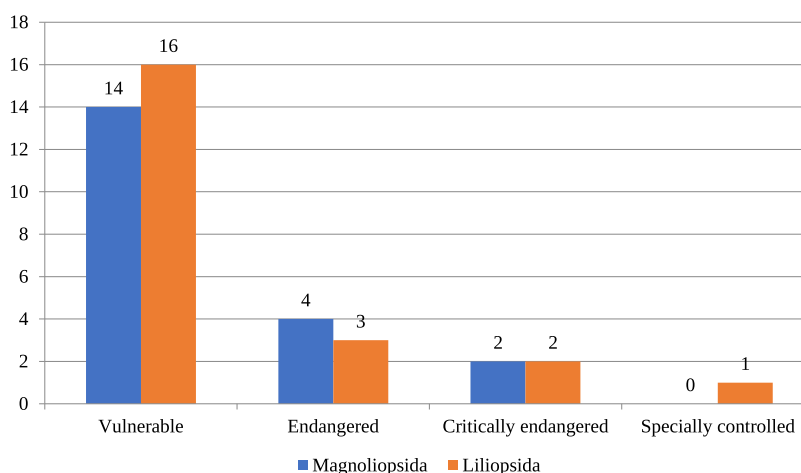
The rare plants growing in the Khadzhokh recreational area have the following threats:

- construction of roads, economic and tourist facilities;
- creation of recreation areas on the banks of rivers with remnants of primary natural vegetation, fragments of which have survived on the floodplain terraces;
- massive deforestation in the mountains;
- collecting plants for bouquets by the population of adjacent villages and tourists;
- the highest recreational load on ecosystems, including protected areas;

- long-term natural factors caused by cyclical climate changes leading to habitat isolation and fragmentation of regional plant ranges;
- the introduction of foreign species with significant tolerance to many environmental factors that can displace stenotopic relict and ancient endemic plants from their habitats.

As a result of the conducted research, 42 rare species of plants growing in the area were identified. All of them are recommended for inclusion in the third edition of the Red Book of the Republic of Adygea. The list of flowering plant species from two classes are Magnoliopsida Brongn., 1843 and Liliopsida Batsch, 1760, includes 20 orders and 23 families, including the Magnoliopsida class – 16 orders and 16 families, the Liliopsida class – four orders and 7 families. The most widely represented species will be the family Orchidaceae Juss. (14 species).

The share of relict (15 species – 36%) and endemic species (8 species – 20%) is significant in the composition of the rare flora of the Khadzhokh recreational area. The degree of threat of species extinction varies (Figure 5). The majority of species (30 species, or 71.4%) are recommended to be classified in the third edition of the Red Book of the Republic of Adygea as “Vulnerable”, seven species (16.7%) – as “Endangered”, four species (9.5%) – as “Critically endangered”. The orchid *Dactylorhiza urvilleana* (Steud.) H. Baumann & Kunkele (2.4%) is classified as “Specially controlled”.



**Figure 5.** The degree of threat of extinction of plant species in the Khadzhokh recreational area of Adygea.

The following plant species are recommended to be included in the third edition of the Red Book of the Republic of Adygea with the category of the rarity status of V (Vulnerable): *Helleborus caucasicus* A. Braun, *Berberis vulgaris* L., *Paeonia caucasica* (Schipcz.) Schipcz., *Ilex colchica* Pojark., *Euonymus leiophloea* (Stev.) Prokh., *Cyclamen coum* Mill. subsp. *caucasicum* (C. Koch) O. Schwarz, *Genista albida* Willd., *Astragalus demetrii* Kharadze, *Staphylea pinnata* L., *Gentianopsis blepharophora* (Bordz.) Galushko, *Scopolia caucasica* Kolesn. ex Kreyer, *Solananthus biebersteinii* DC., *Digitalis ferruginea* subsp. *schischkinii* (Ivanina) K. Werner, *Campanula pendula* Bieb., *Lilium monadelphum* Bieb., *Colchicum umbrosum* Steven, *Crocus speciosus* Bieb., *Gladiolus tenuis* Bieb., *Muscari neglectum* Guss., *Ornithogalum ponticum* Zahar., *Anacamptis pyramidalis* (L.) Rich., *Cephalanthera damasonium* (Mill.) Druce, *Cephalanthera longifolia* (L.) Fritsch, *Neottia ovata* Bluff & Fingerh., *Neotinea tridentata* (Scop.) R.M. Bateman, Pridgeon & M.W. Chase, *Orchis mascula* (L.) L., *Orchis militaris* L., *Orchis purpurea* Huds., *Platanthera chlorantha* (Cust.) Rchb., *Carex elata* Bell. ex All.

The following plant species are recommended to be included in the third edition of the Red Book of the Republic of Adygea with the category of the rarity status of E (Endangered): *Anemone blanda* Schott et Kotschy, *Corylus colurna* L., *Ostrya carpinifolia* Scop., *Genista angustifolia* Schischk., *Cephalanthera rubra* (L.) Rich., *Spiranthes spiralis* (L.) Chevall. and

*Stipa pennata* L. *Anemone blanda* – a rare Caucasian-Asian species. *Corylus colurna* – an ancient Eastern Mediterranean relict species that reduces the area of growth and abundance due to the violation of growing conditions and weak natural renewal. *Ostrya carpinifolia* – a Mediterranean relict species with a declining number of plants as a result of anthropogenic impact. *Genista angustifolia* – a limited-spread Western Caucasian endemic with a low population, facing a high risk of extinction in the wild life. *Cephalanthera rubra* – European-Mediterranean-Near-Asian species with low population density and declining numbers. In the conditions of Adygea, the species was recorded in a wide altitude range, that is, at altitudes of 209–1724 m above sea level. It occurs in single instances, rarely in small groups [Sirotyuk et al., 2022]. *Spiranthes spiralis* – European-Mediterranean-Near-Asian species. It is very rare in Adygea, only three localities are known in meadows in the belt of broad-leaved forests. *Stipa pennata* – a rare Eurasian steppe species with declining numbers and isolated locations.

The following plant species are recommended to be included in the third edition of the Red Book of the Republic of Adygea with the category of the rarity status of C (Critically endangered): *Buxus colchica* Pojark., *Pyracantha coccinea* (L.) M. Roem., *Orchis pallens* L. and *Orchis spitzelii* Saut. ex Koch. *Buxus colchica* – a tertiary relic of the ancient Colchian forests that survived the ice Age. The species could have completely disappeared from the face of the earth in 2013 due to human negligence. Volunteers and environmentalists of Adygea have been restoring an ancient relic for several years. The seedlings of Colchis boxwood were planted in 2018. The results of the inspection in 2021 showed a satisfactory condition of the relic. There were no characteristic traces of the presence of boxwood firewebs, nests and gnawing, as well as traces of other possible pests. *Pyracantha coccinea* – a rare species, a representative of the post-glacial xerothermal period, a South European-Anteroasiatic species. *Orchis pallens* – a rare European-Asian relict species. *Orchis spitzelii* – a South European-Caucasian-Asia Minor endemic species with declining numbers, in critical condition.

The third edition of the Red Book of the Republic of Adygea defines the priority of protection III for the majority of rare and endangered plant species (29 species, or 69%), because their conservation does not require the implementation of additional environmental measures [Sirotyuk et al., 2022]. Separate special measures (priority II) are required for the conservation of 12 plant species (28.6%): *Anemone blanda*, *Corylus colurna*, *Ostrya carpinifolia*, *Pyracantha coccinea*, *Genista angustifolia*, *Scopolia caucasica*, *Crocus speciosus*, *Cephalanthera rubra*, *Orchis pallens*, *Orchis spitzelii*, *Spiranthes spiralis*, *Stipa pennata*. Priority I has been determined for *Buxus colchica*, because the species is in critical condition and special comprehensive measures are being taken to preserve it in the Republic of Adygea.

## 5. Conclusion

The limiting factors and threats to the rare flora of the Khadzhokh recreational area are anthropogenic impacts such as: economic development of territories, changing their hydrological regime; trampling due to recreation and tourism; burning stubble and weeds; fires; collecting plants for bouquets; digging up plants, picking up plants by the population for food, etc. Natural factors also limit the existence of species: narrow or fragmentary range; stenotopy; relict; endemism; low competitive capacity; low population size; method of reproduction; low seed productivity; low number of pollinators, etc.

In connection with global climate change, intensive economic use of land, habitat destruction, activation of various types of recreation and tourism, increasing collection of plants by the population for various purposes, one should probably expect a deterioration in the populations of the most vulnerable species. The negative impacts of anthropogenic and natural nature create a decrease in the living condition of species and the threat of their extinction in some localities. The population sizes of some species have significantly decreased compared to earlier descriptions and have a regressive type of succession dynamics. All of the above requires an objective scientific analysis that would allow us to

assess the current state of the populations of rare plants of the Khadzhokh recreational area, study the mechanisms of self-support and develop conservation measures.

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