Paeonia caucasica (Schipcz.) Schipcz. in phytocenoses of the Republic of Adygea

EMILIA A. SIROTYUK, AMINET E. SHADGE & GALINA N. GUNINA

Maykop State Technological University, Maykop, Russia. E-mail: emiliya09@yandex.ru

Abstract

Populations of Paeonia caucasica (Schipcz.) Schipcz., 1937 growing in various forest phytocenoses were discovered and studied during the monitoring of protected plant species in the Republic of Adygea. The allocation of the species to a certain range of altitudes above sea level and types of communities were defined. The ontogenetic structure and states of plants were identified, and the state of P. caucasica populations was assessed.

Key words: distribution, ecological features, reproduction, populations, numbers, ontogenetic structure, limiting factors.

Introduction

The Republic of Adygea is located in the Northwest Caucasus, in one of the most complex natural regions of the Caucasus with a diverse flora (Fig. 1).

The geographical position of the Republic has resulted in the presence of several geographical zones and vertical vegetation belts, significant landscape, phytocenotic and floristic diversity, as well as a high level of endemism and relict flora on its territory (Shadge et al. 2019, Sirotyuk 2019). According to M.D. Altukhov (Altukhov 1985) there are about 350 endemic Caucasian species in the Northwest Caucasus, which form the “face” of the flora and reflect its long-term evolution. The specially protected natural territories occupy about 30% of the territory of the Republic of Adygea and 14% of its lands are classified as a UNESCO World Natural Heritage Site “Western Caucasus” (Zhane 1999).

There are more than 2000 species of higher plants, including rare and protected ones in the flora of Adygea. The number of many species especially medicinal and ornamental ones is declining in distribution due to the intensive construction of economic facilities and the development of recreation and tourism. The rarest and the most endangered plant species are listed in the Red Lists of the Republic of Adygea (2012). The Red Book flora of Adygea includes 27 endemic Caucasian species (13.8%) and 21 relics (10.7%). The majority of plants and fungi (36.2%) belong to the category of the rarity status 3 "Rare", 28.6% – to the category 2 “Vulnerable”, 15.3% – to the category 1 A "In critical condition", 13.3% – to the category 1 B "Endangered", 3.1% – to the category 4 IS "Insufficiently studied" and 2% – to the category 5 SC "Specially
Controlled”. Thus, almost a third of protected plant and fungi species (28.6%) in the republic are in critical condition or endangered, and the same number of species are vulnerable (Sirotyuk et al. 2020).

Figure 1. Location of the Republic of Adygea (Bedanokov et al., 2020).

The protected plant species include representatives of the monotypic family Paeoniaceae Raf., including the genus Paeonia L., which is a relic of the ancient mesophilic Arcto-Tertiary flora (Kemularia-Natadze 1958). An important biological feature of the species of the genus is their longevity, the ability to grow in one place for a long time without signs of aging and particulation (Uspenskaya & Murashev 2019). However, members of the genus are vulnerable due to very low seed productivity, long seed germination period (Rudaya et al. 2016), and their ornamental and medicinal property.

The representatives of the genus are common in Europe, Southwest Asia, and in the Caucasus. According to D.Y. Hong (2011), the genus Paeonia has 33 species, distributed mainly in Europe, the Mediterranean, East and Southeast Asia. Two species are native to the western states of North America (Uspenskaya 1987). The most primitive representatives of the genus are concentrated in East Asia, especially in Southwest China in the mountain forests of the subtropical part at altitudes of 2360–4250 m (Takhtadzhyan 1966; Barykina et al. 1976). The Flora of the USSR contains 16 Paeonia species (Shipchinsky 1937). According to various authors, there are from 6 to 18 species of the genus Paeonia in the flora of Russia and on the adjacent territories (the republics of the former USSR), and from 5 to 12 species in Russia (Punina 2008).

Most species of the Paeonia genus are rare relict plants (Rare and endangered plants of Siberia 1980; Red Book of the Russian Federation 2008) that are insufficiently studied in natural conditions. E. O. Punina et al. (2008) suggest that there are 9 species and one subvariety of Paeonia in the Caucasus, and not 3 species, as some foreign researchers believe.

On the territory of Adygea, the Paeoniaceae family is represented by two species of the Paeonia genus: P. caucasica and P. arietina G. Anderson, 1818, which are included in the Red Book of the Republic (2012). The distribution, bioecological characteristics, ontogenetic structure and state of populations of both species on the territory of the Republic have not yet been studied. It is relevant for the Republic of Adygea to conduct population studies of species.

Material and methods

The material for the study was taken from the herbaria of the Botanical Institute of the Russian Academy of Sciences (LE), the H. G. Shaposhnikov Caucasian State Natural Biosphere Reserve (CSR), Adyghe State University (MAY) and own collections taken in the vicinity of Maykop and Maykop region of the Republic of Adygea. The collection of field material was carried out during expeditionary surveys of the territory. The ecologo-phytocenotic approach with stationary and semi-stationary research methods based on the classical works of T. A. Rabotnov (1950) and A. A. Uranov (1967) was used.
Figure 2. Ontogenetic states of *Paeonia caucasica*. 
Results

Populations of *P. caucasica*, an endemic Caucasian-Near-Asian species with a restricted range on the territory of Russia were found during the monitoring of protected plant species in 2017–2020. The species is included in the Red Book of the Russian Federation (2008) and listed in the Red List of the Endemic plants of the Caucasus … (2013).

Its range includes the Caucasus (Ciscaucasia; Western, Eastern and Southern Transcaucasia) and Southwest Asia (the peninsula of Asia Minor, Iranian and Armenian highlands). The species was previously recorded in the Republic of Adygea in the Maykop region: on the Azish-Tau ridge, the slope of Mount Koryto, before the confluence of the Sakhrai and Kun rivers, in the Belaya river valley, at the Lagerny cordon as well as in all divisions of the H. G. Shaposhnikov Caucasian State Natural Biosphere Reserve (Red Book of the Republic of Adygea 2012).

The monitoring of protected plant species has revealed nine (including new) locations of *P. caucasica*. On the territory of Adygea, populations of *P. caucasica* were found at altitudes from 220 to 846 m above sea level in various forest phytocenoses: oak, oak-hornbeam, hornbeam-oak, oak-beech, beech and beech-fir of the lower and middle mountain-forest belts.

There have been classified three age periods and five ontogenetic states of *P. caucasica* in the populations (Sirotuyk et all. 2019): latent (seeds characterized by underground germination – sm), pregenerative (seedlings – p, juvenile – j, immature – im, virginal – v) and generative – g (Fig. 2). Virginal and temporarily non-flowering generative plants were in one group with virginal plants. The number and ontogenetic structure of *P. caucasica* populations in the identified locations differ. The most numerous were two populations of *P. caucasica*: in the vicinity of Tulskiy village and Sevastopolskaya settlement.

The population of *P. caucasica* that occupies an area of 50 m² near Tulskiy village in an oak-hornbeam forest at an altitude of 297 m above sea level is complete. Ontogenetic spectrum is right-sided, single-peaked with the maximum on generative individuals (18j:18 im:19v:23g). The abundance of the species is cop1. The population of *P. caucasica* that grows near Sevastopolskaya settlement at an altitude of 571 m above sea level in an oak-beech forest covers an area of about 30 m². The population is complete (12j:9im:14v:19g) in terms of ontogenetic structure. The spectrum is right-sided, unimodal with the maximum on generative individuals. The abundance of the species is cop1.

![Figure 3. Ontogenetic structure of populations *Paeonia caucasica*:](image1)

The rest of the species populations are small, regressive and represented by one or several virginal or generative individuals due to the economic development of mountain slopes and intense recreational load (Fig. 3). Thus, two coenopopulations of *P. caucasica* were found in the vicinity of Maykop in an oak-
hornbeam forest. The first coenopopulation is at an altitude of 220 m above sea level (2g), the second one is at a height of 309 m above sea level (3v:2g). A species population of immature, virginal and generative individuals (3im:4v:5g) growing scattered was found at an altitude of 455 m above sea level in a hornbeam-oak forest along the roadway going from Krasnooktyabrsky settlement to the city of Apsheronsk, Krasnodar Territory. In the vicinity of Kamennomostskiy village, the population of *P. caucasica* (2v:2g) is located in an oak-hornbeam forest on the left bank of the Belaya River (near the waterfalls of the Rufabgo River) at an altitude of 652 m above sea level. The species population growing in an oak forest on the Una-Koz Ridge (SPNA "Mishoko Gorge") at an altitude of 509 m above sea level is incomplete (2v:2g) with right-sided ontogenetic spectrum. A small population of virginal and generative individuals *P. caucasica* (3v:2g) was found in a beech forest at an altitude of 652 m above sea level in the vicinity of Novoprokhladny village (near the Mankin Shum waterfall). According to the ontogenetic structure, the population is incomplete, the spectrum is right-sided. Seven individuals of the species were found in a beech–fir forest (1im:4v:2g) in the tract “Taiwan” on the right bank of the Sakhray River at altitudes of 823–846 m. The ontogenetic spectrum is right-sided.

The number, density and state of populations in different habitats differ significantly, as well as the degree of anthropogenic impact. Some compactly dispersed populations sometimes reach a high abundance where plants grow in dense groups. Most of the studied populations are small, regressive with a right-sided ontogenetic spectrum.

**Discussion**

*P. caucasica*, like most species of the genus, is characterized by long (10–16 months) underground seed germination with slow seedling development. There are several reasons for seed dormancy: an underdeveloped embryo; deep physiological dormancy of the epicotyl (point of the shoot growth); the presence of abscisic acid in the seeds; low enzymatic activity; the presence of lignin in the seed coat, a natural polymer that reduces the permeability of plant cells to water (Uspenskaya 1981). According to I.A. Ivanova (1969) and N.V. Zinger (1951), immature seeds with a denser shell germinate better than mature ones. The annual aerial regrowth of shoots occurs due to the bud reproduction of rhizomes at different depths.

The appearance of aerial parts of the plant are noted in early March in the Adygea (data from 2020). The duration of budding is 3–4 weeks. *P. caucasica* blooms in early April (Fig. 4). Its flowering period lasts about 10 days. There is an earlier period of flowering of the plant than it is indicated in the literature (Litvinskaya 2011; Red Book of the Republic of Adygea 2012; Red Book of Krasnodar Territory 2017).

*P. caucasica* is an entomophile. The flowers have a sweet smell, and the main pollinators are bees, wasps, flies, ants and small beetles. Plants of *P. caucasica* are not pollinated, but sometimes old generative plants change the shade of flowers to a lighter color when they are damaged by diseases and pests, as well as when the nitrogen content in the soil is increased. Fruiting of plants begins at the end of April. Dark blue seeds ripen in fruits (fruit aggregate) as well as aborted fleshy-red seeds that attract birds, which ensures the spread of seeds and dispersal of plants (Nemirovich-Danchenko 1981). Some of the mature seeds in the fruit remain until autumn (Fig. 2). The observed earlier occurrence of phenophases in *P. caucasica* plants can be explained by global warming.

According to some authors (Shipchinsky 1937; Litvinskaya 2011) *P. caucasica* grows in different light conditions and is a helioscyphyte and a xeromesophyte. However, all the identified populations were found only under sparse woodlands during the monitoring. According to our data, *P. caucasica* is a mesophyte and mesotroph in environmental manner and in ecophytocenotic - it is a sylvan. The plant is a geocryptophyte, growing on almost all types of soils, including acidic gray and brown forest soils (Koval & Bityukov 2001; Lebedev et all. 2020), but avoids damp wetlands or areas with high groundwater levels.

**Conclusions**

*P. caucasica* is an early flowering rhizome geophyte that has survived due to some biological features. The analysis of the geographical distribution of *P. caucasica* showed a high degree of population isolation, which ensures the population diversity of the species and its sustainable existence despite the small number of most
of them. The factors limiting the distribution of the species are biological features: complex reproductive biology, low seed germination, weak competitiveness of seedlings and juveniles, and the absence of vegetative reproduction of populations.

The scarcity and regressive ontogenetic structure of most of the studied populations of *P. caucasica* are associated with the impact of external factors: economic development of mountain slopes (logging, construction of roads, trails and recreational facilities), development of mass tourism and recreation, collection of flowering specimens for bouquets by the population, digging of plants for breeding in personal plots and use as medicinal raw materials).

The results of the study showed that *P. caucasica* is reducing the number and range within the Republic of Adygea. Further study of natural populations is needed to identify the species range and assess the state of the populations. It is necessary to preserve the species category of rarity in the new edition of the Red Book of the Republic of Adygea.

![Figure 4. Flowering of Paeonia caucasica](image)

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