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Distribution, ecological and biological features and the state of cenopopulations of species of the genus *Cephalanthera* Rich. (Republic of Adygea)

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There are three species of the genus *Cephalanthera* in the Republic of Adygea. All species are rare and listed in the Red Book of the Republic. They grow in forests of various types at altitudes from 209 m to 1724 m above sea level. The review provides a brief morphological description and some features of biology and ecology. Special attention is paid to identifying the locations of species, their phytocenotic association, analyzing the ontogenetic structure of cenopopulations and assessing their condition. Limiting factors were identified and possible ways of preserving the cenopopulation diversity of species were recommended.

Keywords: *Cephalanthera longifolia*, *Cephalanthera damasonium*, *Cephalanthera rubra*, monitoring, locations, phytocenotic confinement, cenopopulations, number of individuals, ontogenetic structure, assessment of the condition.

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1 Introduction

The problem of preserving the planet's biodiversity is becoming especially significant with the increase in anthropogenic pressure on the environment and global climate change. One of the most vulnerable species of plant communities are representatives of the family *Orchidaceae* Juss., owing to the features of their biology and ecology: highly specialized entomophily, undifferentiated embryo, prolonged formation of protocorm, low competitiveness, narrow ecological amplitude and high sensitivity to anthropogenic influences. A thorough study of the distribution and ecological and biological features of *Orchidaceae* species is the first step towards organizing their protection [*Ivanov and Kovaleva*, 2005].

The genus *Cephalanthera* is predominantly Eurasian, currently numbering from 15 to 20 species in the world according to various sources [*WCSP*, 2020]. There is evidence in the literature that quaternary climate fluctuations played a significant role in the formation of the genetic diversity of the genus [*Chung et al.*, 2018; *Delforge*, 2006]. Almost all species of the genus *Cephalanthera* are distributed in the temperate zone of Eurasia, seven species are in Europe and some are in North Africa. One saprophytic species occurs in northwestern North America; four species are endemic to China.

The species of the genus *Cephalanthera* growing in Russia have been studied at the population-ontogenetic level [*Perebora*, 2011; *Tatarenko*, 1996; *Vakhrameeva et al.*, 2014]. However, there are regions in which such studies have not been conducted. These include the Republic of Adygea, on the territory of which there are three red book species of the genus. Since a new (third) edition of the Red Book is being prepared, the studies to obtain information about the distribution, features of biology and ecology and the state of cenopopulations are relevant for the Republic of Adygea.

The purpose of the research is to study the distribution, ecological and biological features and the state of cenopopulations of species of the genus *Cephalanthera* in the territory of the Republic of Adygea.

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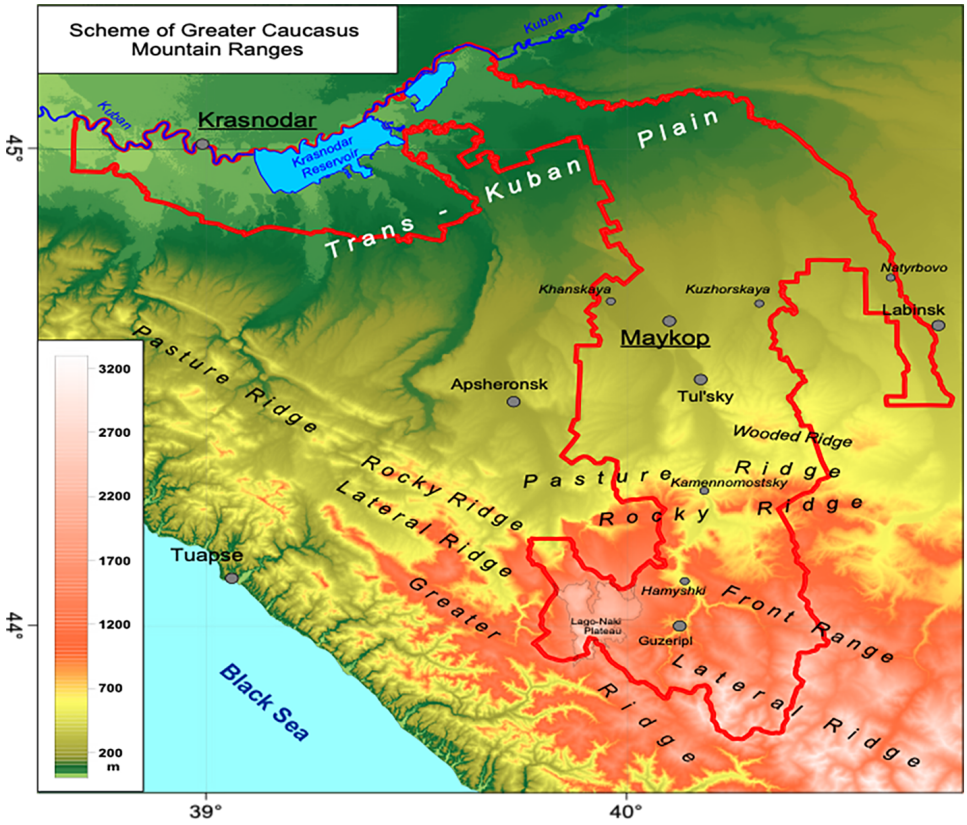

Figure 1: Republic of Adygea relief map based on SRTM 4.0 with spatial resolution 30 m [*Lebedev et al.*, 2020]

2 Research area

The Republic of Adygea is one of the subjects of the Russian Federation, which is part of the Southern Federal District and is part of the North Caucasus Economic Region (Figure 1). The Republic is located in the central part of the North-Western Caucasus between 45°13' and 43°46' N and 38°41' and 40°46' E in the basins of the Kuban, Laba, Belaya, Pshish and Psekups Rivers. The capital of Adygea is the city of Maykop, located at the foot of the Nagiezh-Uashkh ridge at an altitude of 210–230 m above sea level.

The Maykopsky district is the largest of the seven districts of the Republic of Adygea, which occupies 48% of the territory of the Republic. The district is located in the southern part of the Republic, where the plain to the south of Maykop is replaced by foothills, mountain ranges stretch out, rising to a height of 3238 m above sea level. In general, Adygea is an ecologically safe region with huge natural potential. However, due to the high degree of economic development of the territory, intensive development of recreation and mass tourism, the degradation of the natural environment occurs, which threatens the existence of rare and endangered species of flora.

3 Objects of research

The objects of the study are *Cephalanthera longifolia* (L.) Fritsch., *C. damasonium* (Mill.) Druce and *C. rubra* (L.) Rich. (Figure 1).

Cephalanthera longifolia is a perennial herbaceous plant with a height of 15–45 cm. The rhizome is horizontal, shortened, with cord-like roots. The stem has 6–9 linear-lanceolate, pointed leaves folded along and arranged in two rows. The inflorescence is spike-shaped, straight, 5–10 cm long, sparse, with 3–20 small white flowers directed upwards. The flowers are 12–18 mm long. The fruit is a dry fusiform capsule.

Cephalanthera damasonium is a perennial herbaceous plant with a straight stem 20–60 cm high and a short horizontal rhizome with numerous roots penetrating deeply into the soil. Up to 10–12 flowering stems originate from the rhizome. The leaves are ovate or elliptical. Inflorescence is straight, loose, up to 12 cm long, rare (3–16 flowers), bracts are large leaf-shaped, lanceolate, pointed. The flowers are white, directed upwards, large (up to 2 cm) with a yellowish kidney-shaped labellum. The fruit is a dry, straight capsule.

Cephalanthera rubra is a plant 25–60 cm tall, with 5–8 lanceolate alternate bluish-green leaves and a shortened, ascending or almost vertical rhi-

zome. The stem is pubescent at the top, the leaves are up to 12 cm long, lanceolate, pointed. The inflorescence (brush) is straight, sparse with a densely pubescent axis of 4–12 large (up to 2.5 cm) flowers of purple-pink color distant from each other, completely devoid of nectar. The outer leaves of the perianth are lanceolate, with five veins, the inner ones are ovate-lanceolate. Labellum is with a triangular pointed anterior lamina of the same length with the outer tepals. The fruit is a dry capsule.

The studied species of the genus *Cephalanthera* reproduce by seeds and vegetatively. The flowers are collected in inflorescences. The petals of the perianth are bell-shaped, the inner ones are slightly shorter and wider. Labellum is intercepted in the middle by a narrow cut into two parts: hypochil and epichile. The hypochil is concave with oval-triangular lateral lobes at the base, sometimes extended into a short spur. The epichile is broadly oval or kidney-shaped, obtuse or pointed with slightly wavy edges, with comb-like keels on top. The ovary is sessile, cylindrical, slightly twisted. The fixed anther is located at the top of a straight and long column, and under it is the snout disc [Kom, 1935]. Species do not produce nectar, they are characterized by non-specialized entomophily [*Tatarenko*, 1996] Pollinators can be bees, wasps, bumblebees, butterflies, but the main pollinators are considered to be flies of the family Syrphidae Latreille, accounting for about 90% of all pollination cases [*Shibanova*, 1996].

The vegetative reproduction of *Cephalanthera longifolia* occurs by dividing the rhizome and developing adventitious buds on the roots [*Irmisch*, 1853]. The role of vegetative reproduction in maintaining populations is significant and its intensity depends on the degree of mycotrophy of plants [*Vakhrameeva, Varlygina, and Kulikov*, 1996] The type of pollination is exclusively allogamous [*Nazarov*, 1995]. The outgrowths of the epichile are painted bright yellow, imitating anthers. It is assumed that outgrowths are additional attractants for bees [*Dafni and Ivri*, 1981]. The tightening of the labellum allows the epichile to bend down under the weight of the insect's body, which significantly expands the circle of pollinators due to large bees. It is noted that the attractiveness of flowers for bees increases sharply when there are model plants in their places of growth, the flowers of which look like orchid flowers, but unlike them contain pollen and nectar: *Polygonatum orientale* Desf., *P. odoratum* (Mill.) Druce, *Symphytum tauricum* Willd., *Cistus salviifolius* L. and *Convallaria majalis* L. [*Korzhenevsky et al.*, 2011]. *Bombus haematurus* Kriechbaumer and *Andrena symphyti* Schmied can take part in pollination of flowers. The probability of pollination is low in *Cephalanthera longifolia*, but its seed reproduction is ensured by high seed productivity of one fruit (flower productivity coefficient is 0.768) [*Nazarov*, 1995]. Reproductive tactics are characterized by a low reproductive effort of one reproductive episode, but their number in ontogenesis is significant [*Kucher*, 2014].

Cephalanthera damasonium reproduces by seeds and vegetatively. Renewal buds are formed in the axils of cataphylls on rhizomes. The species is optionally autogamic [*Nazarov*, 1995]. The anthesis time of the flower is much shorter than that of *C. longifolia* and *C. rubra*. Pollen sprouts in the anther lobes on the third or fourth day after the flower opening, which is associated with the penetration of mucus from the snout into the pollinium area. The perianth closes, blocking the entrance to insects. The flowers of *Cephalanthera damasonium* are occasionally visited by bees from the genus *Halictus* in habitats with acceptable sunlight. However, allogamous pollination is possible only within two to three days from the moment of anthesis time [*Kucher*, 2014].

Cephalanthera rubra reproduces by seeds and vegetatively by forming sprouts on the roots. The flowers are pollinated by bees of the genus *Chelostoma* Latreille, which pollinate *Campanula taurica* Juz. The orchid attracts bees by imitating the flowers of *Campanula taurica*, because the anthesis time of the species coincide. There is an increase in seed productivity by 7 times in cases when two plants grow together. It is assumed that bees are attracted to the creamy ribs on the labellum of the *Cephalanthera rubra* flower, since they resemble pollen sources [*Nazarov and Ivanov*, 1990]. It is noted not only morphological similarity with *Campanula taurica*, but also the identity of the spectral composition of the light reflected by the petals in the visible range for bees. Up to 90% of flowers can be pollinated in the inflorescence of *Cephalanthera rubra* due to the significant similarity with the flowers of "rewarding" plants, and the productivity coefficient of the generative sprout has an average value for species of the genus [*Nazarov*, 1995]. In this regard, the contribution of phytomass to the reproductive organs in the anthesis is higher in *Cephalanthera rubra* than in the allogamous *C. longifolia*, and is almost equal to the contribution of *C. damasonium*.

The percentage of fruiting of *Cephalanthera* species of temperate latitudes depends on the sufficiency of light or its deficiency according to the literature data. S. A. Mamaev et al. [*Mamaev et al.*, 2004] found that the percentage of fruiting of *Cephalanthera longifolia* is 21.6–37.4% in light parvifoliate forests and under the canopy of lime and dark coniferous-lime forests is only 1.9–4.2%. The percentage of fruiting of C. *rubra* is

(a) *Cephalanthera longifolia* **(b)** *Cephalanthera rubra* **(c)** *Cephalanthera damasonium*

Figure 2: Species of the genus *Cephalanthera*

28.1% in normal light conditions in parvifoliate forests, and is almost always absent in deep shade. The research conducted in 2005–2007 by N. L. Shibanova and Ya. V. Dolgikh confirm this information [*Shibanova*, 1996]

The anthesis time of *Cephalanthera longifolia* and *C. rubra* are clearly delineated in time. It is believed that such isolation serves as a barrier to interspecific hybridization [*Shibanova*, 1996] There is evidence that the aromatic components of the flowers of *Cephalanthera damasonium* and *C. rubra* are similar in chemical composition and slightly differ from the chemical composition of *C. longifolia*. Aromatic substances of *Cephalanthera longifolia* contain compounds that create a different smell [*D'Auria et al.*, 2019] The presence of different smells allows species to attract certain pollinators.

4 Materials and methods of research

The results of field research in 2017-2021 and analysis of herbarium funds of the Caucasian State Natural Biosphere Reserve named after H. G. Shaposhnikov (CSR), Adygea State University (MAY), the National Museum of the Republic of Adygea and literary sources were used in the work. The population approach based on the classical works of T. A. Rabotnov [*Rabotnov*, 1950] A. A. Uranov [*Uranov*, 1975] and their followers was applied in the study of species with some clarifications recommended for orchids [*Vakhrameeva et al.*, 1987; *Denisova et al.*, 1986]. The ontogenetic states of plants: juvenile (j), immature (im), virginal (v), generative (g) are distinguished on the basis of qualitative and quantitative morphological features. Protocorms and sprouts were not taken into account, since their study requires a violation of the substrate. Senile individuals were absent in cenopopulations. The recommendations of Yu. A. Zlobin [*Zlobin*, 2009] and N. P. Stetsuk [*Stetsuk*, 2006] were used to assess the state of cenopopulations of species. The latin names of the species are given in accordance with the summary of S. K. Cherepanov [*Cherepanov*, 1995].

5 Results and discussion

12 cenopopulations of *Cephalanthera longifolia*, six of *C. damasonium* and 11 of *C. rubra* were found during field work. The species grow in beech, oak, hornbeam, oak-hornbeam and coniferous forests, more often in open areas and forest edges. They prefer humus, moderately moist, aerated limestone soils. They are mesophytes, silvants and margants in ecological terms. *Cephalanthera longifolia* and *C. damasonium* are heliosciophytes, *C. rubra* is a sciophyte and a petrophant. The species are threatened with extinction and are listed in the Red Book of the Republic of Adygea with the category of rarity status 3 "Rare" [*Red Book of the Republic of Adygea 2nd ed. part 1*, 2012]. These species are also recognized on the territory of Russia as rare and are included in the Red Book of the Russian Federation with the status category 3 – rare species [*The Red Book of the Russian Federation (plants and fungi)*, 2008].

Cephalanthera longifolia (Figure 2a) is a rare European-Mediterranean-Near Asian relict

species with a disjunctive range. It is located on the territory of Russia on the north-eastern border of the European part of the range, and is represented by three separate fragments. The largest of them is located in Central Russia, the second is in the North Caucasus, the third is in the south of the Urals [*The Red Book of the Russian Federation (plants and fungi)*, 2008]. The species is included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Annex II) [*CITES*, 1973] and is listed in the Red Books of 18 subjects of the Russian Federation [*The Red Book of the Russian Federation (plants and fungi)*, 2008].

Cenopopulations of *Cephalanthera longifolia* were found within the limits of 209–714 m above sea level [*Sirotyuk et al.*, 2020a] (1100 m in the Red Book of the Republic of Adygea [*Red Book of the Republic of Adygea 2nd ed. part 1*, 2012] in the following locations: surroundings of Maykop: 1) Nagiezh-Uashkh ridge, green zone, 44°35'19" N, 40°06'29" E, 289 m above sea level [*Sirotyuk et al.*, 2020a; *Sirotyuk and Khiryanov*, 2020]; 2) Nagiezh-Uashkh ridge, green zone, slope of the northern exposure, 44°35'20.75" N, 40°06'10.84" E, 298 m above sea level; 3) Nagiezh-Uashkh ridge, green zone, ridge top, 44°35'19.04" N, 40°06'06.99" E, 334 m above sea level); Maykopsky district: 4) vicinity of Krasnooktyabrsky village, 44°29'17" N, 39°53'16" E, 425 m above sea level [*Sirotyuk et al.*, 2020a; *Sirotyuk and Khiryanov*, 2020]; 5) vicinity of Sadovy village, 44°13'11" N, 40°06'57" E, 312-324 m above sea level [*Sirotyuk et al.*, 2020a; *Sirotyuk and Khiryanov*, 2020]; 6) vicinity of Tulsky village, right bank of the Belaya River, 44°29'21" N, 40°10'52", E, 266 m above sea level [*Sirotyuk et al.*, 2020a; *Sirotyuk and Khiryanov*, 2020; *Sirotyuk et al.*, 2017]; 7) vicinity of Tulsky village, the slope of the western exposure with a steepness of 35°, 44°29'08" N, 40°11'09" E, 297 m above sea level; 8) Caucasian State Natural Biosphere Reserve, checkpoint "Cordon Guzeripl", 43°59'44" N, 40°08'14" E, 649–714 m above sea level [*Sirotyuk et al.*, 2020a; *Sirotyuk and Khiryanov*, 2020]; 9) Dudugush ridge, along the road to the top, 44°04'01.93" N, 40°10'35.14" E, 820–840 m above sea level; 10) between the villages of Dakhovskaya and Novoprokhladnoye, 44°13'19.32" N, 40°14'53.26" E, 581 m above sea level; 11) surroundings of Trehrechny village, 44°39'40" N, 40°23'20"E, 209 m above sea level; 12) the vicinity of Kuzhorskaya village, 44°40'33" N, 40°18'51" E, 232 m above sea level.

Cephalanthera damasonium (Figure 2c) is a European-Mediterranean nemoral species with a disjunctive range, located on the border of the range in Russia: it is found in the Stavropol and Krasnodar Krai, the Rostov Region, the Karachay – Cherkess Republic, the Republic of Dagestan, the Republic of Adygea. The species is included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Annex II) [*CITES*, 1973].

The species was found at altitudes from 298 to 581 m above sea level (1200 m in the Red Book of the Republic of Adygea [*Red Book of the Republic of Adygea 2nd ed. part 1*, 2012] in the following locations: surroundings of Maykop: 1) Nagiezh-Uashkh ridge, green zone, slope of the northwestern exposure, 44°35'20.75" N, 40°06'10.84" E, 298 m above sea level; 2) Nagiezh-Uashkh ridge, top of the ridge, 44°35'19.04" N, 40°06'06.99" E, 334 m above sea level; 3) Maykopsky district: vicinity of Krasnooktyabrsky village, 44°33'49" N 40°02'51" E, 325 m above sea level; 4) the vicinity of Sadovy village, the slope of the northwestern exposure, 44°33'11.93" N, 40°06'57.38" E, 312-324 m above sea level; 5) between the villages of Dakhovskaya and Novoprokhladnoye, 44°13'19.32" N, 40°14'53.26" E, 581 m above sea level; 6) the vicinity of Ust-Sakhray village, 44°12'27" N, 40°16' 53" E, 526 m above sea level.

The population fields are small, the location of individuals is diffuse, the abundance of sp. The average population density is 0.07 S/m^2. The number of individuals in various locations varies significantly from two to 61, which is also true for the Krasnodar Krai as noted by E. A. Perebora [*Perebora*, 2011].

Cephalanthera rubra (Figure 2b) is a rare European-Mediterranean-Near-Asian species with a disjunctive range. It is found in the European part of Russia, in the foothills and mountains of the North Caucasus: in the Republic of Dagestan, the Republic of Ingushetia, the Karachay – Cherkess Republic, the Republic of Adygea, in the Stavropol and Krasnodar Krai.

Cenopopulations of *Cephalanthera rubra* were found in the locations significantly isolated from each other: Maykopsky district: 1) the vicinity of Krasnooktyabrsky village, 44°33'49" N, 40°02'57" E, 260 m above sea level [*Sirotyuk et al.*, 2020a]; 2) along the road from Krasnooktyabrsky village to the city of Apsheronsk, Krasnodar Krai, 44°33'49" N, 40°02'51" E, 325 m above sea level [*Sirotyuk and Khiryanov*, 2020]; 3) the vicinity of Tulsky village, the right bank of the Belaya River, 44°29'21" N, 40°10'52" E, 266 m above sea level [*Sirotyuk et al.*, 2020a]; 4) between the villages of Dakhovskaya and Novoprokhladnoye 44°13'53.69" N, 40°15'23.13" E, 658 m above sea level; 5) Azish-Tau ridge, along the highway on the Lagonaki plateau, south-eastern slope with a steepness of 25°, 44°09'01" N, 40°04'24" E, 1278 m above sea level [*Sirotyuk et al.*, 2020a]; 6) vicinity of Ust-Sakhray village, 44°12'27" N, 40°16'

53" E, 526 m above sea level; 7) Taiwan tract, right bank of the Sakhray River, steep southern slope, 44°06'05.63" N, 40 22'41,31" E, 823–846 m above sea level; 8) Mount Koryto, the southwestern slope a steepness of 45°, 44°04'06" N, 40°21'03" E, 1724 m above sea level [*Sirotyuk et al.*, 2017; *Shadge and Shadge*, 2019a,b; *Sirotyuk et al.*, 2020b]; 9) Koryto ridge, the vicinity of the Jubileiny booth, 44°03'55" N, 40°21'03" E, 1621 m above sea level [*Sirotyuk et al.*, 2020a, 2017]; 10) Dudugush ridge, along the road to the top, 44°04'01.93" N, 40°10'35.14" E, 820–884 m above sea level; 11) Nature Park "Bolshoy Thach", 1661 m above sea level [*Sirotyuk et al.*, 2020a,b];

E. A. Perebora [*Perebora*, 2011] notes that *Cephalanthera rubra* is strictly confined to certain forest formations, and the species in the conditions of Adygea was noted by us in a wide altitude range: at altitudes from 209 to 1724 m above sea level [*Sirotyuk et al.*, 2020a,b]. The highest vertical proliferation height of 1500 m above sea level for the species is indicated in the Red Book of the Republic of Adygea [*Red Book of the Republic of Adygea 2nd ed. part 1*, 2012].

Cephalanthera rubra occurs in single specimens, rarely in small groups, which can be explained by a number of biological features, including the dependence of the number on the amount of precipitation over the spring-summer period [*Vakhrameeva et al.*, 2014] and the transition to underground existence for up to 20 years with strong shading [*Summerhayes*, 1951].

The ontogenetic structure of the cenopopulations of *Cephalanthera longifolia* was studied in the vicinity of Maykop, the villages of Trehrechny, Sadovy and Kuzhorskaya.

Juvenile plants of *Cephalanthera longifolia* are characterized by 1–2 leaves on a non-branching sprout and 2–3 adventitious roots. Immature plants have 3–4 leaves and 3–5 adventitious roots. Young virginal plants have 5–7 leaves and adult virginal plants have 8–11 leaves. Generative plants develop the same number of leaves. Ontogenetic structure of cenopopulations: 9g (Maykop), 2v:1g (Trehrechny), 6v:1g (Kuzhorskaya), 10v:2g (Maykop), 2im:12v:1g (Sadovy), 19g (Sadovy). One cenopopulation (Sadovy) is full-fledged, all the others are incomplete. The ontogenetic spectrum of all the studied cenopopulations is right-sided, the state is regressive (Figure 3).

The ontogenetic structure was studied in three cenopopulations of *Cephalanthera damasonium* in remote locations: in the vicinity of the villages of Ust-Sakhray and Krasnooktyabrsky. Juvenile plants of *Cephalanthera damasonium* have 1–2 leaves; immature plants – 3–5 leaves with long internodes; young virginal plants – 6–15 leaves; adult virginal plants – 16–24 leaves, but have not yet started flowering; generative plants bloom and bear fruit.

There are 27 plants in the cenopopulation of the species with a significant predominance of virginal individuals in the vicinity of Ust-Sakhray village. Cenopopulations are small (four and five plants) with a predominance of virginal individu-

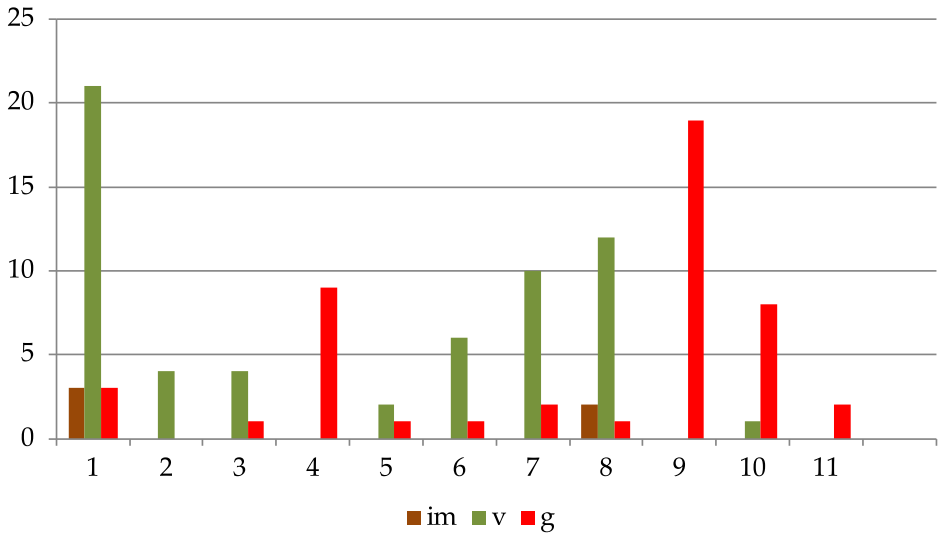

Figure 3: Ontogenetic structure of cenopopulations of species of the genus *Cephalanthera:* 1 – *C. damasonium* (Ust-Sakhray); 2 – *C. damasonium* (Krasnooktyabrsky); 3 – *C. damasonium* (Krasnooktyabrsky); 4 – *C. longifolia* (Maykop); 5 – *C. longifolia* Trehrechny); 6 – *C. longifolia* (Kuzhorskaya); 7 – *C. longifolia* (Maykop); 8 – *C. longifolia* (Sadovy); 9 – *C. longifolia* (Sadovy); 10 – *C. rubra* (Ust-Sakhray); 11 – *C. rubra* (Krasnooktyabrsky).

als in the vicinity of Krasnooktyabrsky village. Ontogenetic structure of cenopopulations of the type: 3im:21v:3g (Ust-Sakhray), 4v and 4v:1g (Krasnooktyabrsky). The first cenopopulation is full-fledged and it contains immature, virginal, generative plants; the second and third populations are incomplete. The ontogenetic spectra of all cenopopulations are right-sided with a predominance of virginal plants. The state of the first and third cenopopulations is regressive, the second cenopopulation is normal (Figure 3).

Juvenile plants of *Cephalanthera rubra* have two leaves, immature plants have three leaves, the shoot and internodes increase in length. Virginal and generative plants have a developed vegetative sphere. The ontogenetic structure of *Cephalanthera rubra* cenopopulations has been studied in two localities: 1v:8g (Ust-Sakhray), 2g (Krasnooktyabrsky). Both coenopopulations are incomplete, the ontogenetic spectra are right-sided with a predominance of generative plants. The state of the populations is regressive (Figure 3).

6 Conclusion

The monitoring of rare plants during the expedition surveys of the territory of the Republic has revealed their locations, provided an opportunity to study some ecological and biological features of species and assess the state of cenopopulations. The data obtained show that all the cenopopulations of species of the genus *Cephalanthera* studied on the territory of Adygea are small, have a right-sided spectrum with a maximum of generative individuals and a small number of immature plants. There are no germinants and juvenile individuals in the cenopopulations, the number of immature plants is insignificant. The natural limiting factors for the studied species are: weak competitive capacity, prolonged dormancy, complexity of pollination and reproduction, changes in global climate, low population numbers and density. The species of the genus are characterized by low resistance to anthropogenic influences: violation of the places of growth due to recreational development of the territory of the Republic, direct trampling and digging of plants.

In order to preserve the species diversity of the genus *Cephalanthera* and maintain the stability of populations, it is necessary to continue monitoring species to identify new locations, further study the features of biology and ecology, conduct population studies and develop specific measures to preserve the cenopopulation diversity of species. It is recommended to include all orchid species growing on the territory of the Republic in the new 3rd edition of the Red Book of the Republic of Adygea. The most important task is also environmental education of all age groups of the population of the Republic in order to form an ecological imperative.

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