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Morphometric and vitality structure of *Platanthera chlorantha* (Orchidaceae) in the Greater Caucasus within Azerbaijan

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Abstract: The article presents the results of the study of the morphometric and vitality structure of cenopopulations (CP) of the rare species *Platanthera chlorantha* in the Greater Caucasus. The studies were conducted in Khizi, Siyazan, Guba, Gusar, Shamakhi, Gabala and Shaki districts during 2017-2024 years. The aim of the research is to investigate morphometric, vitality structure of the cenopopulation of *P. chlorantha* and reveal the influence of climatic and edaphic factors to them. The average value of morphometric indicators shows that the length of the flower axis was observed at the highest value in CP 4, and the lowest value in CP 5. According to the results of the variability analysis, the number of flowers was the most variable parameter. It shows the highest variability in CP 2, CP 4 and CP 5. The results of the correlation analysis show that a very strong correlation relationship was observed between the length of the flower axis and the number of flowers in all cenopopulations. According to the results of the vitality analysis, a predominance of individuals belonging to the upper and middle vitality class ($Q>c$) was revealed in seven cenopopulations. They are classified as flowering type. But CP 2 and CP 9 are depressive type. The *Iq* values of the cenopopulations ranged from 0.11 to 3.07. The highest *Iq* values were observed in CP 5, and the lowest in CP 9. The values of the vitality index ranged from 0.14 to 0.79. The highest value of this index was observed in CP 6, while in other cenopopulations it was lower. The results of the regression analysis conducted between the morphoparameters of plant height and number of flowers in individuals of *P. chlorantha* show that the relationship between these morphoparameters was positive in all cases. This indicates that the self-renewal process of the plant will be strong in these areas in the future and its number will remain stable.

Keywords: *correlation, climate, ecology, plasticity, rare species*

INTRODUCTION

Information on population structure and dynamics can provide fundamental insights for the conservation and management of rare and endangered plant species [Zhihao Su et al., 2021]. The structural characteristics and dynamics of plant populations are one of the main areas of plant ecology research [Lei et al., 2022]. Understanding population response strategies to the environment, elucidating ecological processes and demonstrating the dynamic characteristics of populations are very important [Li, Zhang, 2015]. Knowledge of population dynamics, vegetation and habitat relationships is a useful tool for the conservation and management of rare and endangered plant species. By studying critical stages of the life cycle of rare plants, the dynamics of individuals can be revealed [Laface et al., 2022].

The study of the causes and mechanisms of long-term and stable population levels of species is an urgent issue in modern plant ecology. This is directly related to the conservation of biodiversity. Monitoring of cenopopulations (CPs), analysis of biomorphs, ontogenetic composition and demographic indicators helps to identify the characteristics of dynamic processes reflecting the development of populations and the change of generations of individuals [Cheryomushkina et al., 2021].

When working with rare plant species, morphometric methods are one of the main ways to obtain information about the state of specific populations of plant species growing in different ecological conditions and at different levels of anthropogenic impact [Karimova et al., 2015].

The differentiation of individuals in a population by vitality is one of the forms of internal qualitative diversity of the population system. It is precisely in that population that individuals have secondary hierarchical forms due to their size,

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vitality, the rates stages of ontogenesis, etc. Each species is represented by a grouping of individuals with different vitality in natural conditions. A certain degree of vitality of individuals is important, first of all, for their survival. This biological function can be considered a fundamental property of living organisms and, one might say, is even more important than their ability to reproduce. The spectrum of differentiation of the size of individuals and morphological structural elements gives rise to differences in the appearance of individuals [Zlobin, 2013].

Individuals with high vitality, ensuring reproduction, significantly change the habitat, when individuals with low vitality form a reserve that can quickly fill the gaps during phytocoenoses disruption and succession. Individuals with weak vitality are the most enriched with mutations and are a promising side of microevolution [Zlobin, 1989]. The vitality hierarchy of individuals in cenopopulations is formed at the initial stages of growth and development. Unlike the age hierarchy, the vitality state of individuals is reversible and therefore is characterized by significant dynamism [Chich, 2009].

Taking into account the above, morphometric, variability, correlation, vitality, and regression analyses were conducted on the morphoparameters of individuals in the cenopopulations of the rare species *Platanthera chlorantha* in the Greater Caucasus. As a result of these analyses, the morphometric and vitality structure of the cenopopulations was studied, and their dependence on the climatic and edaphic factors of the area was determined.

MATERIAL AND METHODS

Two species of the genus *Platanthera* L. belonging to the Orchidaceae Juss. family are distributed in Azerbaijan: *P. chlorantha* and *P. bifolia* [Flora 1952]. The object of the study *P. chlorantha*, is a rare species included in the 3rd edition of the Red Book of the Republic of Azerbaijan [2023] (Fig. 1).

The studies were conducted in Khizi, Siyazan, Guba, Gusar, Shamakhi, Gabala and Shaki districts during 2017-2024 years (Fig. 2). Morphometric analysis was carried out according to the method of Y.A.Zlobin [2013], selecting the appropriate parameters individually for each plant under study.

To assess the amplitude of variability, the empirical scale of S.A. Mamaev [1972] was used, six levels of variability are indicated: 1) CV < 7% - very weak; 2) CV=8-12% - weak; 3) CV = 13-20% - medium; 4) CV=21-30% - high; 5) CV= 31-40% - high; 6) CV> 40% - very high.

The study of the vitality structure of the cenopopulation was carried out according to the method of Y.A. Zlobin [2013]. At the first stage, the morphometric parameters of 30 individuals of average generative age in each cenopopulation were assessed. Correlation and factor analysis were conducted to determine the complex of traits characterizing vitality among the parameters, which reflect the key parameters of the generative and vegetative spheres. At the second stage, the assessment of the vitality status of the studied individuals was carried out by traits: individuals were divided into three vitality classes according to the following formula:

$$X \pm t0.05 \times Sx$$

was used to select the values of the determinant traits. Where, X – average value, Sx – standard deviation, t – Student's T-criterion

If the plant individuals exceed the interval X ± t0.05 x Sx, they form a high class of vitality (a), if they are in the interval X ± t0.05 x Sx, they form a medium class of vitality (b), if they are less than the interval X ± t0.05 x Sx, they form a low class of vitality (c).

Figure 1. *Platanthera chlorantha* (Custer) Rchb. in the nature.

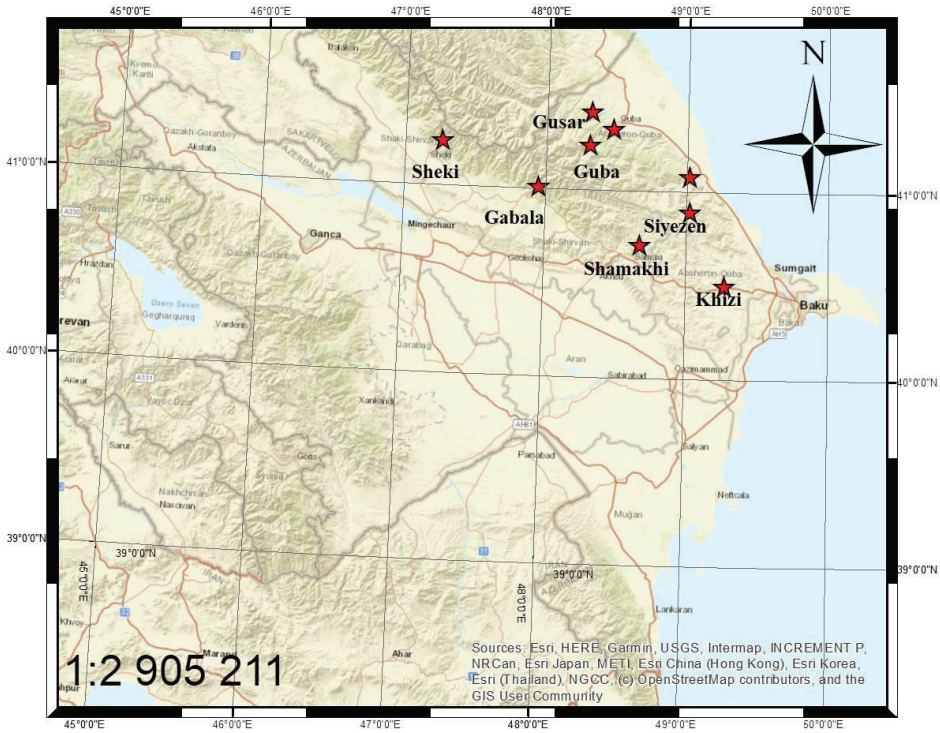

Figure 2. Research routes of this study.

The value of the Student's T-criterion is determined according to the number of measurements (p=0.05). Based on the quality of the index Q=1/2(a+b), the cenopopulation falls into one of the vitality types: flowering, stable, depressed.

The cenopopulation vitality index (IVC) was used to characterize the vitality of the population. The population vitality index was calculated according to the following formula [Ishbirdin & Ishmurotova, 2004; Ishbirdin, 2005]

$$IVC = \frac{\sum_{i=1}^{N} \frac{X_i}{\overline{X}_i}}{N},$$

Where, X_i- the value of the i-character in the cenopopulation, X – the average value of the i-character in all cenopopulations, N – the number of characters.

The IQ index is used to assess the degree of flowering or depression of the cenopopulation.

$$IQ = (a+b)/2c$$

Statistical analysis. Statistical processing was performed for each parameter. The arithmetic mean was used to determine the error (M ± m), standard deviation (SD). Hierarchical clustering was performed based on the mean values of morphological parameters using Ward's Euclidean distance. All statistical analyses were performed in PAST 3.15 [Hammer et al., 2001] and Microsoft Excel 2010. Distribution maps of the research routes were compiled in ArcGIS 10.5.

RESULTS AND DISCUSSION

Morphometric analyses. The morphometric and vitality structure of *P. chlorantha* was studied in the cenopopulations in Balbulag (CP 1), Gacrash villages of Guba district (CP 2), Khuray village of Gusar district (CP 3), Altiaghach village of Khizi district (CP 4), Galaalti village of Siyazan district (CP 5), Gizmeydan village (CP 6), and Pirgulu villages of Shamakhi district (CP 7), Gamarvand village of Gabala district (CP 8), around Shambaghi area of Shaki district (CP 9). The following morphoparameters of the generative individuals of the plant in the cenopopulations were selected for morphometric and vitality analyses: leaf length and width, flower axis length and width, number of flowers and number of vessels in the leaf. Table 1 reflects the results of the morphometric analysis.

Table 1 shows the results of the variability analysis of morphometric parameters of *P. chlorantha*. The number of flowers was the most variable parameter.

Table 1. Average morphometric parameters and variability of generative individuals of *Platanthera chlorantha* (Custer) Rchb.

CP	Flower axis length (cm)	Flower axis width (cm)	Leaf length (cm)	Leaf width (cm)	Number of flowers	Number of leaf vessels
	CV (%)					
1	14.52 ± 2.3 15	0.24 ± 0.1 21	12.37 ± 2.5 24	6.27 ± 1.4 24	16.15 ± 3.7 26	13.05 ± 2.5 17
2	15.11 ± 3.3 22	0.23 ± 0.1 20	13.12 ± 2.4 23	5.46 ± 1.1 23	15.18 ± 4.4 32	12.42 ± 2.1 17
3	16.25 ± 2.7 19	0.33 ± 0.1 15	15.11 ± 2.2 16	5.21 ± 1.3 28	18.68 ± 5.1 28	19.29 ± 4.4 23
4	18.68 ± 4.9 28	0.24 ± 0.6 20	17.21 ± 5.6 34	6.32 ± 1.4 24	21.45 ± 7.1 34	15.77 ± 3.1 21
5	6.44 ± 1.7 26	0.22 ± 0.1 19	12.89 ± 2.1 16	4.19 ± 0.7 16	6.33 ± 2.4 37	14.11 ± 3.5 25
6	16.64 ± 4.2 25	0.33 ± 0.1 15	15.15 ± 1.7 12	5.42 ± 1.2 25	18.62 ± 4.4 26	17.45 ± 5.3 32
7	15.31 ± 3.9 26	0.32 ± 0.1 16	13.72 ± 2.2 15	5.1 ± 1.2 25	17 ± 4.5 28	16.72 ± 4.7 30
8	16.25 ± 3.2 27	0.37 ± 0.2 15	14.72 ± 2.3 16	5.4 ± 1.1 24	20 ± 4.5 27	19.32 ± 4.2 30
9	13.24 ± 3.8 25	0.34 ± 0.1 14	13.11 ± 2.2 15	4.9 ± 1.1 23	17 ± 4.6 27	15.21 ± 4.4 29

Note: CV is the coefficient of variation.

Thus, it shows the highest variability in CP 2, CP 4 and CP 5. The remaining morphoparameters show low and medium variability.

The results of the analysis of morphological parameters of *P. chlorantha* show that very high levels of variability were not recorded among morphoparameters in cenopopulations. Strong and moderate levels of variability were shown by the morphoparameters of the number of flowers and leaf vessels. These parameters have high plasticity properties. Low levels of variability were recorded in the morphoparameter of the width of the flower axis. This parameter shows little plasticity and remains stable under different conditions.

The average value of morphometric indicators of generative individuals of *P. chlorantha* shows that the highest value of the length of the flower axis was recorded in CP 4. The highest value of the length and width of the leaf was observed in CP 4, but the lowest value in CP 1 and CP 5. The number of flowers is observed most in CP 4 and least in CP 5. The highest number of vessels in the leaf was recorded in CP 8 and least in CP 2 (Fig. 3).

Cluster analysis. Cluster analysis revealed two main clusters with high bootstrap index (100%) (Fig. 4). The first of these included CP 5. The morphological parameters of individuals in this population were smaller than in other populations.

The remaining cenopopulations (47%) with a mediate bootstrap index are divided into two subclusters. Three cenopopulations (CP 2, CP 7 and CP 9) belong to the second subcluster. Four cenopopulations (CP 3, CP 4, CP 6, CP 8) belonging to the first subcluster are distinguished by higher average morphological parameters of individuals. The cenopopulation included in the first cluster was found in Siyazan district, and the cenopopulations included in the second cluster were found in Guba, Gusar, Khizi, Shamakhi, Gabala and Shaki districts.

Correlation analysis. An important indicator of the condition of any plant individual is its level of morphostructural and physiological integration. The main method for assessing plant integrity is to study the variability of parameters and the relationship between them [Zlobin, 2013]. To study the relationships between different parts of the plant, we conducted a correlation

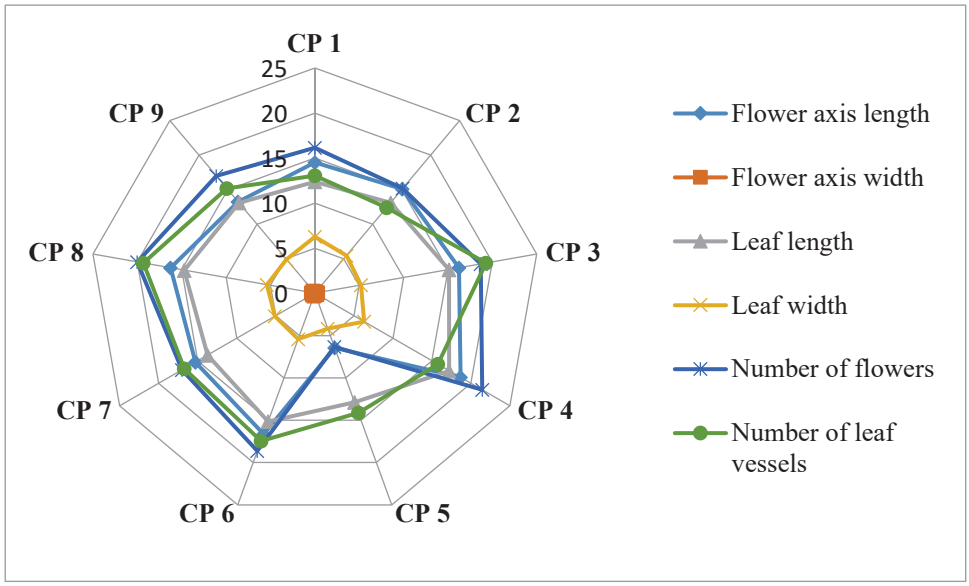

Figure 3. Morphograms of cenopopulations of *Platanthera chlorantha* (Custer) Rchb.

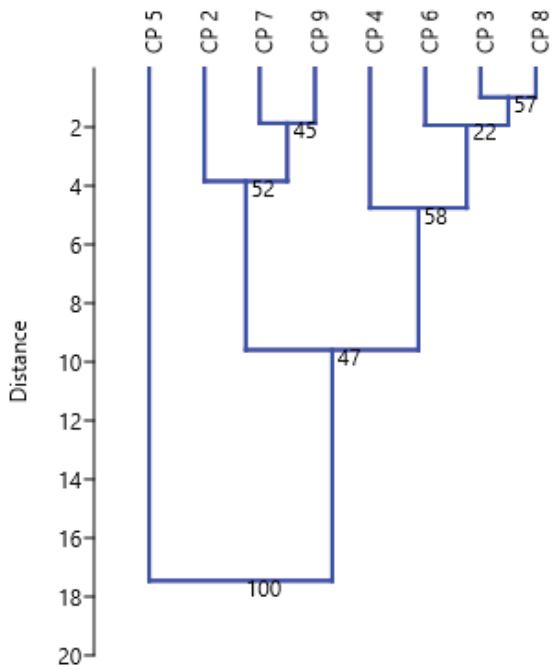

Figure 4. Dendrogram of average values of morphological parameters of individuals of *Platanthera chlorantha* (Custer) Rchb. in the studied cenopopulations.

analysis, the results are given in Table 2. Based on the results the strongest relationship was observed between the length and width of the flower axis in CP 5, CP 9, as well as between the length and width of the leaf in CP 2-9, and between the width of the leaf and the number of leaf vessels in CP 4, CP 9. A very strong correlation was observed between the length of the flower axis and the number of flowers in all cenopopulations. An inverse relationship between the length and width of the flower axis was observed in CP 2-4 and CP 6, CP 8 and between the width of the leaf and the number of leaf vessels in CP 1-2 and CP 6 (Tab. 2).

Table 2. Correlations of morphometric parameters of individuals of *Platanthera chlorantha* (Custer) Rchb.

Parametrs	CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	CP9
Flower axis length ~ flower axis width	0.14	-0.05	-0.47	-0.49	0.80	-0.13	0.09	-0.25	0.82
Leaf length ~ leaf width	0.29	0.56	0.68	0.76	0.90	0.63	0.63	0.56	0.76
Flower axis length~number of flowers	0.80	0.86	0.72	0.99	0.77	0.79	0.74	0.87	0.78
Leaf width ~ number of leaf vessels	-0.26	-0.07	0.15	0.85	0.39	-0.02	0.42	0.38	0.66

Vitality structure. Vitality is a morphostructural expression of the vital state of plants. The concept of vitality is based on the fact that individuals in each population have different growth and development rates due to the spatial diversity of population areas and other reasons (climate, content of soil, antropogenic factors e.t.c.). This allows us to assess the overall vital state of the population by the ratio of plants with different vital capacities in the population [Zlobin, 1989]. We conducted analysis to study the vitality of individuals of *P. chlorantha* in the studied cenopopulations.

According to the results of the analysis, in seven populations, the predominance of individuals belonging to the upper and middle vitality class ($Q>c$) was revealed. They are classified as flowering type. But CP 2 and CP 9 are depressive type. The *Iq* values of the cenopopulations ranged from 0.11 to 3.07. The highest *Iq* values were observed in CP 5, and the lowest in CP 9. The values of the vitality index ranged from 0.14 to 0.79. The highest value of this index was observed in CP 6, while in other cenopopulations it was lower (Tab. 3).

Based on the results of the vitality analysis, it can be said that despite the fact that the studied cenopopulations are at different altitudes and are under the influence of many biotic and abiotic factors, the vitality quality of individuals in seven cenopopulations is a flowering type. The highest value of vitality index in CP 6. This indicates that the vitality abilities of individuals in the cenopopulation are also high. Based on the assessment of the vitality structure of the coenopopulations of the studied taxa, the *Q*, *Iq* and IVC indices, it was determined that CP 2, CP 9 are depressive type, others cenopopulations of the *P. chlorantha* species are of the flowering type.

Regression analysis was performed between the morphoparameters of plant height and number of flowers in individuals of *P. chlorantha* in all cenopopulations. The results of the analysis show that the relationship between these morphoparameters was positive in all cases. This indicates that in areas where the number of flowers and the height of plant is high, the self-renewal process of the plant will also be strong in the future, which may help to maintain its number (Fig. 5).

In natural biocenoses, orchids have a long reproduction (8-12 years), which is associated with the peculiarities of biology, dependencies of biology, dependence on specific pollinators, endomycorrhizal fungi. An important role in the conservation of these plants is played by the search for methods of accelerated reproduction, introduction into culture, repatriation to natural phytocenoses, as well as the creation of gene banks and collections for the conservation of the gene pool.

Localization of endophytic imperfect mycorrhizal fungi in the cells and tissues of the orchid root system is due to its morphological and anatomical features. The underground part of tuberous species of *P. chlorantha* is represented by two root tubers and plagiotropic adventitious roots. The roots are close together, located at a depth of up to 5 cm. Their length varies from 3.7 ± 0.3 cm to 7.2 ± 0.2 cm. The root tubers are elongated-ovoid, pulled together at the end into a cord-like ending. One of the root tubers is withering, soft, wrinkled, dark in color. The length of the active functioning root tuber is 2.5 ± 0.2 - 3.2 ± 0.4 cm, and the diameter is 1.8 ± 0.3 - 2.2 ± 0.2 cm. The adventitious roots are covered with rhizoderm. Under the rhizoderm is the primary cortex, which in the peripheral part is differentiated into a two-layer exoderm, mesoderm and endoderm of typical structure. The central cylinder is represented by a radial bundle with polyarch xylem [Teplitskaya et al., 2003].

When studying the localization of endophytic fungal hyphae in the tissues of roots and root tubers of the species under study, certain patterns were revealed.

Table 3. Vitality structure indicators of cenopopulations of *Platanthera chlorantha* (Custer) Rchb.

CP	Share of individuals by class, %			Quality Index *(Q)*	Flowering or depressive level *(Iq)*	Vitality index (*IVC*)	Vitality type
	a	b	c				
1	0.17	0.55	0.28	0.36	1.28	0.14	Flowering
2	0.22	0.32	0.46	0.27	0.59	0.15	Depressive
3	0.28	0.48	0.24	0.38	1.58	0.46	Flowering
4	0.26	0.48	0.26	0.37	1.42	0.14	Flowering
5	0.36	0.55	0.14	0.43	3.07	0.19	Flowering
6	0.18	0.51	0.31	0.34	1.11	0.79	Flowering
7	0.26	0.4	0.26	0.37	1.42	0.14	Flowering
8	0.31	0.45	0.24	0.38	1.58	0.46	Flowering
9	0.14	0.54	0.32	0.34	0.11	0.46	Depressive

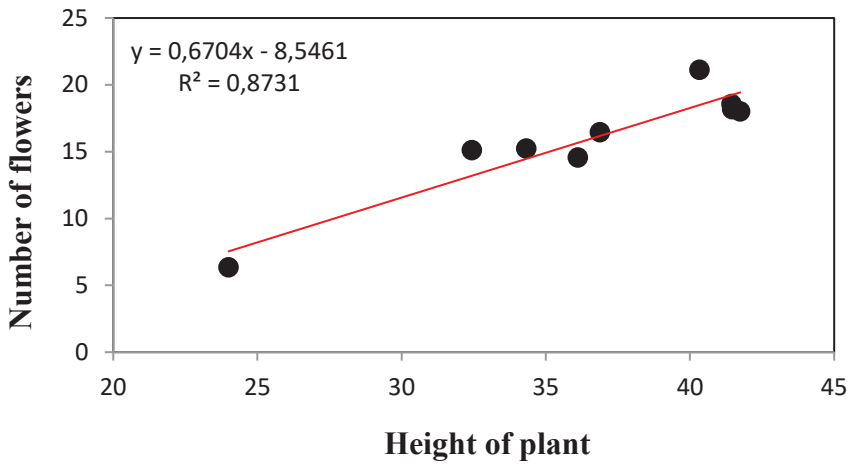

Figure 5. Regression analysis between the morphoparameters plant height and number of flowers of *Platanthera chlorantha* (Custer) Rchb.

Hyphae are absent in the epiblema cells, but they can sometimes be seen in the root hairs themselves. M.G. Vakhromeeva, M.V. Rakova [Vakhrameeva, Rakova, 1987] call them communication hyphae. These hyphae connect dense hyphal balls (pellotons) located in the subepidermal layers of the primary cortex with the external environment. In the central zone of the mesoderm, "digestion" (splitting) of fungal hyphae is noted. This process is more active near the nucleus of the host plant cell. Only shapeless lumps - excretions - remain in the cell. Hyphae were not found in the endoderm and central cylinder. The degree of mycotrophy increases from the apex to the base of the root by 2 times.

CONCLUSION

According to the scale of E. Landolt [1977], *P. chlorantha* is a dark or shade-preferring plant. This species mainly grow in alkaline soils, on moderately dry to moist soils, avoids very dry and very wet soils. The soils on which this species grows (especially due to their nitrogen content) are ranked as the second type of poor soil on the scale. Morphometric analyses show that individuals with the longest flower axis are observed in CP 4. The highest values of leaf length, width and number of flowers are observed mainly in Khizi, Altiaghach forest. This area is similar to Shamakhi-Ismayilli district in terms of climatic and edaphic characteristics. Although the morphological parameters of individuals in these study areas are satisfactory, populations are at risk of

extinction due to the low number of viable individuals. The lowest values of the morphoparameters flower axis length and the number of flowers were observed in CP 5. Here the cenopopulation area is the most affected by oil pollution and anthropogenic impact. The climate type is characterized by dry, hot summers and mild winters. We think that the hot and dry nature of the area and additional impacts cause the individuals in the cenopopulation to be small. Based on our results, it can be said that the most favorable conditions for the *P. chlorantha* are observed in Khizi and Shamakhi districts with a mild, warm and humid climate and mountain-brown soil type.

The results of the vitality analysis show that, despite the fact that the studied cenopopulations are at different altitudes and are under the influence of many biotic and abiotic factors, the vitality quality of individuals in seven cenopopulations is a flowering type, CP 2 and CP 9 are depressive type.

According to the results of cluster analysis more favorable environment for development *P. chlorantha* was determined, resulting from the combination of climatic conditions and soil types. It has been noted that distributing in temperate, warm and humid climates and mountain-brown soils, individuals of *P. chlorantha* with larger morphological parameters and are significantly higher viability.

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Böyük Qafqaz ərazisində (Azərbaycan daxilində) *Platanthera chlorantha* (Orchidaceae) növünün senopopulyasiyalarının morfometrik və vitalitet strukturu

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Məqalədə ilk dəfə olaraq *Platanthera chlorantha* nadir növünün Böyük Qafqaz ərazisində senopopulyasiyalarının morfometrik və vitalitet strukturunun tədqiqinin nəticələri əks olunmuşdur. Tədqiqatlar 2017-2024-cü illər ərzində Xızı, Siyəzən, Quba, Qusar, Şamaxı, Qəbələ və Şəki rayonlarında aparılmışdır. Tədqiqatın məqsədi *P. chlorantha* növünün senopopulyasiyalarının morfometrik və vitalitet strukturunu araşdırmaq, onlara iqlim və edafik amillərin təsirini müəyyən etməkdir. Morfometrik parametrlərin orta qiyməti göstərir ki, çiçək oxunun uzunluğunun ən yüksək qiyməti SP 4-də, ən aşağı isə SP 5-də müşahidə edilmişdir. Dəyişkənlik təhlilinin nəticələrinə görə ən çox dəyişən parametr çiçəklərin sayı olmuşdur. Parametrin ən yüksək qiyməti SP 2, SP 4, SP 5-də müşahidə olunur. Korrelyasiya təhlilinin nəticələri göstərir ki, bütün senopopulyasiyalarda çiçək oxunun uzunluğu ilə çiçəklərin sayı arasında çox güclü korrelyasiya müşahidə olunur. Vitalitet strukturun analizinin nəticələrinə əsasən, yeddi senopopulyasiyada yuxarı və orta vitalitet siniflərinə ($Q>c$) aid olan fərdlər üstünlük təşkil edir. Onlar çiçəklənən tip kimi təsnif edilir. Lakin SP 2 və SP 9 depressiv tipə aiddir. Senopopulyasiyaların *Iq* qiymətləri 0.11 ilə 3.07 arasında dəyişir. Ən yüksək *Iq* qiyməti SP 5-də, ən aşağı isə SP 9-da müşahidə edilir. Vitalitet indeksinin qiymətləri 0.14 ilə 0.79 arasında dəyişir. Bu indeksin ən yüksək qiyməti SP 6-da müşahidə olunur, digər senopopulyasiyalarda isə daha aşağıdır. Yaşıl ləçəkotu bitkisinin fərdlərində bitkinin hündürlüyü və çiçəklərin sayı morfoparametrləri arasında aparılmış regresiya analizinin nəticələri göstərir ki, bu morfoparametrlər arasında bütün hallarda əlaqə müsbət olmuşdur. Bu da gələcəkdə həmin ərazilərdə bitkinin özünübərpa prosesinin güclü gedəcəyini və sayının sabit qalacağını göstərir.

Açar sözlər: *korrelyasiya, iqlim, ekologiya, plastiklik, nadir növ*

Морфометрическая и витальная структура *Platanthera chlorantha* (Orchidaceae) на Большом Кавказе (в пределах Азербайджана)

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Впервые представлены результаты исследования морфометрической и виталитетной структуры ценопопуляций редкого вида *Platanthera chlorantha*

на Большом Кавказе. Исследования проводились в Хызынском, Сиязанском, Губинском, Гусарском, Шемахинском, Габалинском и Шекинском районах в течение 2017-2024 гг. Целью исследования является изучение морфометрической, виталитетной структуры ценопопуляции *P. chlorantha* и выявление влияния на них климатических и эдафических факторов. Среднее значение морфометрических показателей указывает на то, что длина оси цветка наблюдается при наибольшем значении в ЦП 4, а наименьшем - в ЦП 5. Согласно результатам анализа изменчивости, наиболее изменчивым параметром оказалось число цветков. Наибольшая изменчивость наблюдается в ЦП 2, ЦП 4, ЦП 5. Результаты корреляционного анализа показывают, что очень сильная корреляционная связь наблюдается между длиной оси цветка и числом цветков во всех ценопопуляциях. По результатам анализа виталитетности в семи ценопопуляциях выявлено преобладание особей, относящихся к верхнему и среднему классу виталитетности ($Q>c$). Они отнесены к цветковому типу. Но ЦП 2 и ЦП 9 относятся к депрессивному типу. Значения *Iq* ценопопуляций варьируют в пределах от 0.11 до 3.07. Самые высокие значения *Iq* наблюдались в ЦП 5, а самые низкие в ЦП 9. Значения индекса виталитетности варьировались от 0.14 до 0.79. Самое высокое значение этого индекса наблюдалось в ЦП 6, тогда как в других ценопопуляциях оно было ниже. Результаты регрессионного анализа, проведенного между морфопараметрами высоты растений и числа цветков у особей *P. chlorantha*, показывают, что связь между этими морфопараметрами была положительной во всех случаях. Это свидетельствует о том, что процесс самообновления растений в этих районах в будущем будет сильным, а его численность останется стабильной.

Ключевые слова: *корреляция, климат, экология, пластичность, редкий вид*