Трансформация экосистем
Ecosystem Transformation

ISSN 2619-0931 Online
www.ecosysttrans.com

DOI: https://doi.org/10.23859/estr-250430
EDN: https://elibrary.ru/fvnxgq
UDC 502.051; 574.3

Article

A swampy forest as a refugium for Orchidaceae Juss. in the suburban zone of Tyumen (Western Siberia)

M.N. Kazantseva

Institute of the Problems of Northern Development, Tyumen Scientific Center, Siberian Branch of the Russian Academy of Sciences, Chervishevsky Trakt St. 13, Tyumen, 625008 Russia

mnkazantseva@yandex.ru

Abstract. This article presents the results of the survey (August 2024) of a swampy pine forest in the suburban zone of Tyumen (Western Siberia, Russia). High species richness of the phytocenosis and the presence of eight orchid species, four of which are rare and listed in the Red Data Books of various ranks, have been identified. Two species, *Hemipilia cucullata* (L.) Y. Tang, H. Peng & T. Yukawa and *Platanthera bifolia* (L.) Rich., form large cenopopulations numbering over 200 and 100 individuals, respectively. Analysis of the ontogenetic structure suggests that cenopopulations of these species are stable and have a good reproductive potential. They are not inferior in these indicators to populations developing under automorphic conditions of a green moss pine forest. Vitality of cenopopulations of both species corresponds to the category "flourishing". Unlike *P. bifolia*, *H. cucullata* demonstrates higher vitality in the swampy stands compared to dry habitats. These data point up the value of swampy forests for maintaining rich biodiversity in the rapidly developing suburban area of Tyumen and make it possible to consider them as refugia for rare orchid species.

Keywords: suburban area, grass-marsh pine forest, biodiversity, *Hemipilia cucullata*, *Platanthera bifolia*, cenopopulation, ontogenetic structure, vitality

Funding. The work was carried out within the framework of the State Assignment of the Ministry of Science and Higher Education of the Russian Federation (project No. FWRZ-2026-0022).

ORCID:
M.N. Kazantseva, https://orcid.org/0000-0002-1227-6720

To cite this article: Kazantseva, M.N., 2026. A swampy forest as a refugium for Orchidaceae Juss. in the suburban zone of Tyumen (Western Siberia). *Ecosystem Transformation* **9** (4), 60–73. https://doi.org/10.23859/estr-250430

Received: 30.04.2025
Accepted: 07.08.2025
Published online: 30.10.2026

DOI: https://doi.org/10.23859/estr-250430
EDN: https://elibrary.ru/fvnxgq
УДК 502.051; 574.3

Научная статья

Заболоченный лес как рефугиум для растений семейства орхидных (Orchidaceae Juss.) в зоне субурбанизации г. Тюмени (Западная Сибирь)

М.Н. Казанцева

Институт проблем освоения Севера Тюменского научного центра СО РАН, 625008, Россия, г. Тюмень, ул. Червишевский тракт, д. 13

mnkazantseva@yandex.ru

Аннотация. Приведены результаты обследования заболоченного соснового леса в субурбанической зоне г. Тюмени (Западная Сибирь, Россия), выполненного в августе 2024 г. Выявлено высокое видовое богатство фитоценоза и наличие в его составе 8 видов семейства орхидных, 4 из которых являются редкими и занесены в Красные книги разных рангов. Два вида, *Hemipilia cucullata* (L.) Y. Tang, H. Peng & T. Yukawa и *Platanthera bifolia* (L.) Rich., образуют здесь крупные ценопопуляции численностью более 200 и 100 особей соответственно. Анализ онтогенетической структуры позволяет характеризовать состояние ценопопуляций этих видов как устойчивое, с хорошим воспроизводственным потенциалом, не уступающим по этим показателям контрольным популяциям, развивающимся в автоморфных условиях сосняка зеленомошного. Виталитетный тип ценопопуляций обоих видов соответствует категории «процветающая». При этом *H. cucullata,* в отличие от *P. bifolia*, демонстрирует более высокие показатели жизненности в условиях заболоченного леса по сравнению с суходолом. Полученные данные указывают на ценность заболоченных лесов для поддержания высокого биоразнообразия в условиях интенсивно развивающейся пригородной зоны г. Тюмени, а также позволяют рассматривать их в качестве рефугиумов для редких видов растений семейства орхидных.

Ключевые слова: пригородная зона, сосняк травяно-болотный, биоразнообразие, *Hemipilia cucullata*, *Platanthera bifolia*, ценопопуляция, онтогенетическая структура, виталитет

Финансирование. Работа выполнена в рамках государственного задания Министерства науки и высшего образования РФ (проект № FWRZ-2026-0022).

ORCID:
М.Н. Казанцева, https://orcid.org/0000-0002-1227-6720

Для цитирования: Казанцева, М.Н., 2026. Заболоченный лес как рефугиум для растений семейства орхидных (Orchidaceae Juss.) в зоне субурбанизации г. Тюмени (Западная Сибирь). *Трансформация экосистем* **9** (4), 60–73. https://doi.org/10.23859/estr-250430

Поступила в редакцию: 30.04.2025
Принята к печати: 07.08.2025
Опубликована онлайн: 30.10.2026

Introduction

Suburbanization is the growth and development of the suburban zone of large cities due to an urban population outflow to the outskirts (Breslavsky, 2024). The suburban environment is formed from the existing rural settlements, gardening associations, cottage communities, and supporting non-residential suburban infrastructure. The status and functioning of these facilities are constantly changing; their number and environmental impacts are accordingly growing (Khomyakov, 2017).

The suburban zone of Tyumen city covers vast (30–50 km) territories. The anthropogenic load on natural landscapes here is determined both by intensive economic activity and increased human visitation of forests and other natural sites for purposes of recreation, mushrooming, berry and other wild species gathering. All this creates additional threats to rare and vulnerable plants native to this area.

Representatives of the orchid family (Orchidaceae Juss.) are among the most sensitive components of natural ecosystems. Many of these highly specialized species respond to negative environmental changes by declining their vitality and population sizes. Often, even relatively common species of this family completely disappear in the developed areas (Efimov, 2010; Kazantseva and Artyomenko, 2021; Sulimenkina, 2011). This is the reason for a widespread inclusion of orchids in the regional Red Data Books (up to 100% of the family's species in some regions). The Red Data Book of the Tyumen Region contains 23 out of 30 orchid species (Krasnaya Kniga..., 2020).

Despite the intensive development of the Tyumen suburban zone, there are virtually unvisited places occupied by natural vegetation, namely, swampy forested stands located in the lowering terrains. They are typically impassable and overgrown with shrubs. Being of little recreational or economic value, such areas can serve as refugia for vulnerable plant species capable of colonizing hydromorphic ecotopes. Other authors, who study the flora of swampy forests in southern Western Siberia (Pisarenko and Lashchinsky, 2020), have reached a similar conclusion. They note a high floristic richness of these biocenoses and the presence of rare plant species, including the representatives of the orchid family. At the same time, the researchers emphasize that swampy forest communities have been poorly studied.

The aim of this study is assessing the species diversity and vitality of orchid plants in the swampy woody plot of the suburban zone of Tyumen.

Materials and methods

The study area is located within the small-leaved forest subzone (subtaiga) of the West Siberian Plain. Zonal types of grassy aspen and birch forests, as well as pine stands growing on sandy soils of river terraces are common here. Secondary forests have a mixed composition with varying proportions of coniferous and deciduous species. On average, swampy state of the entire subzone makes up approximately 20% (Rastitelnyi pokrov..., 1985).

The forest under study is located 30 km southwest of Tyumen in the floodplain of the Kamenka River, a right tributary of the Tura River (Fig. 1). Sprawling rural settlements are seen on both sides of the plot, which adjoins a paved road to the east and the Kamenka River to the northwest. A cottage village is under construction on the south side.

The forest is represented by grass-marsh pine stands with the presence of *Betula pubescens* Ehrh. The pine forest is dense and largely bushy (Fig. 2); the microrelief is hummocky; in some places, waterlogged depressions occupy from 20 to 40% of its area. The projective cover reaches 90%. Herbage is dominated by *Equisetum palustre* (L.), *Phragmites australis* (Cav.) Trin. ex Steud., *Achnatherum calamagrostis* (L.) P. Beauv., *Carex dioica* (L.), *Carex appropinquata Schumach.* Among forbs, *Cirsium palustre* (L.) Scop., *Comarum palustre* (L.), *Peucedanum palustre* (L.) Moench are common. More than half of the ground surface and waterlogged depressions are covered by sphagnum and hypnum mosses.

In early August 2024, the area of 2500 m² was surveyed. Floristic studies revealed a high taxonomic richness of vegetation. A total of 67 vascular plant species from 54 genera and 29 families, including 8 species from the orchid family, were identified in this area. Four of the species are listed in the Red Data Book of the Tyumen Region and two in the Red Data Book of the Russian Federation (Krasnaya

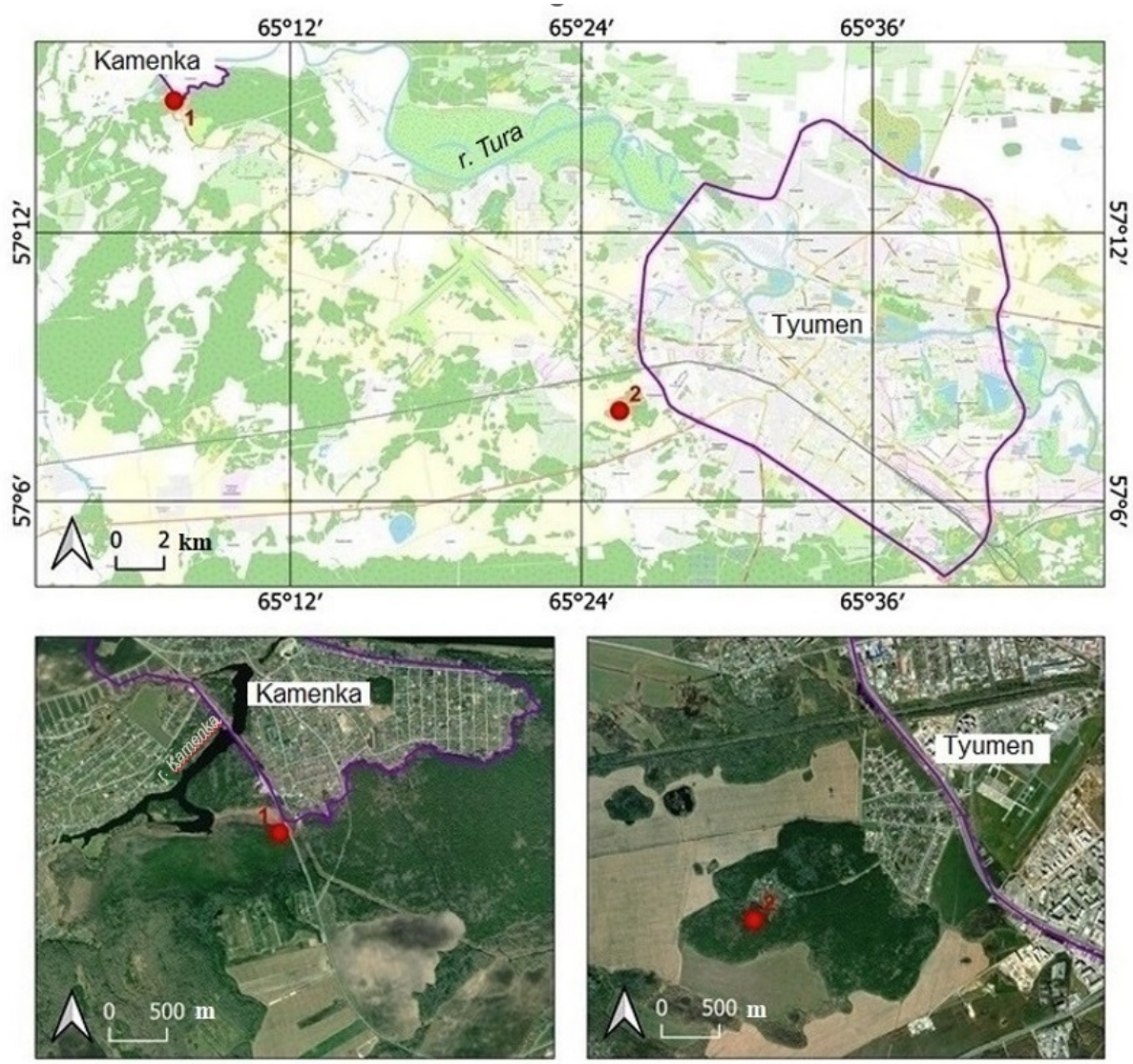


Fig. 1. Layout of the surveyed forest plots: 1 – experimental (swampy); 2 – control (dry).

Kniga..., 2024) (Table 1). All orchids contain generative individuals in blossom fading or fruiting stages that indicates the plants' ability to reproduce.

Orchid species are largely represented by single specimens or small groups, except for two abundant species *Hemipilia cucullata* (L.) Y. Tang, H. Peng & T. Yukawa, and *Platanthera bifolia* (L.) Rich, having over 200 and 100 individuals respectively. This allows to evaluate the ontogenetic structure and vitality of their coenopopulations (CPs), a well as species existence in the given biocenosis as prosperous.

Both species are herbaceous summer-green tuberous perennials. *P. bifolia* has a broad eurytopic distribution; it is found in forests with a varying species composition and open herbaceous communities growing on dry and in extremely wetted soils, even in conditions of stagnant moistening (Vakhrameeva et al., 2014).

Hemipilia cucullata refers to a highly specialized species, characteristic of forest biocenoses with a pronounced moss cover. This species is considered a typical mesophyte, which prefers moderate moisture content and good soil aeration (Speranskaya et al., 2021; Vakhrameeva and Zhirnova, 2003;Vakhrameeva et al., 2014). In the Tyumen Region, the majority of known habitats of *H. cucullata* are confined to dry and moderately moistened pine and mixed forests with a green moss cover. However, the recent data report about the detection of this species in wetlands as well (Kapitonova, 2023; Kuzmin and Drachev, 2007).

To assess the impact of hydromorphic conditions on *P. bifolia* and *H. cucullata*, the comparative surveys of their CPs were conducted in the control dryland plot of a green moss-small-grass pine forest located in the green zone of Tyumen. Here, cenopopulations exist close to each other within the same forest area subject to minor anthropogenic impacts. The living ground cover of the pine forest is relatively sparse, with a projective grass cover of approximately 60% formed from *Galium boreale* (L.), *Veronica chamaedrys* (L.), *Fragaria vesca* (L.) and representatives of taiga small grasses *Pyrola minor* (L.), *P. rotundifolia* (L.), and *Orthilia secunda* (L.) House. Mosses occupy less than 20% of the soil surface.

Cenopopulations of *P. bifolia* and *H. cucullata* in the swampy pine forest (experimental plot) were designated as *P-E* and *H-E*, while in the control as *P-C* and *H-C*, respectively.

During the survey, we conducted a complete census of individuals in all CPs, determined their ontogenetic state in accordance with the existing classifications (Vakhrameeva et al., 2014), compiled the ontogenetic spectra from the data obtained, and derived the cenopopulation recovery index *Ir* estimated as the number of offspring per generative plant (Osmanova and Zhivotovsky, 2020).

In generative individuals, the following morphological intravital parameters were measured in situ: plant height, inflorescence length, length and width of a lower leaf. The number of formed fruits was also counted.

The status of CP vitality was determined using the *Q* criterion by the method of Yu.A. Zlobin (1989). To calculate this indicator, individuals in the reproductive age were ranked by height into three vitality classes: *a* – highest, *b* – intermediate, *c* – lowest. The boundaries of the intermediate class (*b*) were established within the limits of the confidence interval for the difference of means ($x \pm \sigma$). The *Q* criterion was calculated using the following formula:

$$Q = 1/2(a + b)$$

A vitality type of CPs was determined based on the ratio of *Q* and *c* values. For instance, at $Q > c$, the population was considered to be prosperous, at $Q = c$, it was in equilibrium, and at $Q < c$ depressed.

The vitality index *IVC* (used for CPs comparison) was derived from the weighted average based on the complete set of morphological characteristics (Ishbirdin and Ishmuratova, 2004):

$$IVC = (\Sigma Xi/Xj)/N,$$

where *Xi* – is the mean value of the *i-th* trait in CP, *Xj* is the mean of the *i-th* trait for both CPs, and *N* is the number of traits.

Microsoft Office Excel, version 2606 was employed for statistical data processing and the Student's t-test for determination of the difference in the average. Differences were significant at $p < 0.05$.

The nomenclature of vascular plant species is given in accordance with the WFO Plant List[1].

[1] WFO Consortium. World Flora Online Plant List June 2025 (2025-06). Data set. https://doi.org/10.5281/zenodo.15704590 (accessed: 30.06.2025).



Fig. 2. General view of the grass-swamp pine forest.

Table 1. The species composition and representatives of the orchid family in the surveyed area; * – included in the Red Data Book of the Tyumen Region, ** – included in the Red Data Book of the Russian Federation.

No.	Species	Number of plants, ind.
1	**Cypripedium guttatum* Sw.	6
2	*, ***Cypripedium macranthos* Sw.	2
3	*Dactylorhiza fuchsii* (Druce) Soó	9
4	*Epipactis helleborine* (L.) Crantz	20
5	*Goodyera repens* (L.) R. Br.	3
6	**Malaxis monophyllos* (L.) Sw.	4
7	*Platanthera bifolia* (L.) Rich.	112
8	*, ***Hemipilia cucullata* (L.) Y. Tang, H. Peng & T. Yukawa [*Neottianthe cucullata* (L.) Schltr. in the Red Data Book of the Tyumen Region (Krasnaya Kniga..., 2020); *Ponerorchis cucullata* (L.) X. H. Jin, Schuit. & W. T. Jin in the Red Data Book of the Russian Federation (Krasnaya Kniga..., 2024)]	210

Results and discussion

In the swampy pine forest, CPs of both species occupy larger areas, being more abundant than in the control. At the same time, they are distinguished by a significantly lower density (Table 2) that is, apparently, explained by a limited number of suitable habitats for plant settlement, as well as by their uneven distribution.

Owing to biological and ecological species characteristics, *Hemipilia cucullata* exhibits a clumped distribution pattern both in the control and experimental samples (Fardeeva, 2018; Kazantseva, 2024). Clusters often consist of several dozen individuals. In the control, they are confined to moss cover fragments, whereas in the swampy biocenosis they are encountered on tops of hummocks and on a "moss cushion" of waterlogged depressions. In the swampy area, *P. bifolia* is found primarily in small groups of 3–5 individuals and less frequently singly in the relatively well-drained micro elevations. In the control, plants of this species are compactly and rather uniformly distributed.

The ontogenetic spectra of the examined CPs are normal, complete, with a predominance of mature vegetative – virginal (v) individuals (Fig. 3). In terms of age spectrum of both species, the proportion of young individuals (j+im) from the wetted plot is significantly higher than in the control: *H. cucullata* (13%) and *P. bifolia* (19%). On the contrary, the share of virginal individuals is just as lower (14 and 16%, respectively). Relative proportions of generative (g) individuals in the control and experimental plots are similar for both species.

Table 2. Abundance and density of the surveyed cenopopulations with *Hemipilia cucullata and Platanthera bifolia*. *H* – *Hemipilia*, *P* – *Platanthera*, *E* – experiment (swampy forest), *C* – control (dry forest).

Parameter	*H. cucullata*		*P. bifolia*	
	H-E	*H-C*	*P-E*	*P-C*
Area, m^2	625	100	400	50
Number of plants, ind.	134	78	111	43
Density, ind./m^2	0.2	0.8	0.3	0.9

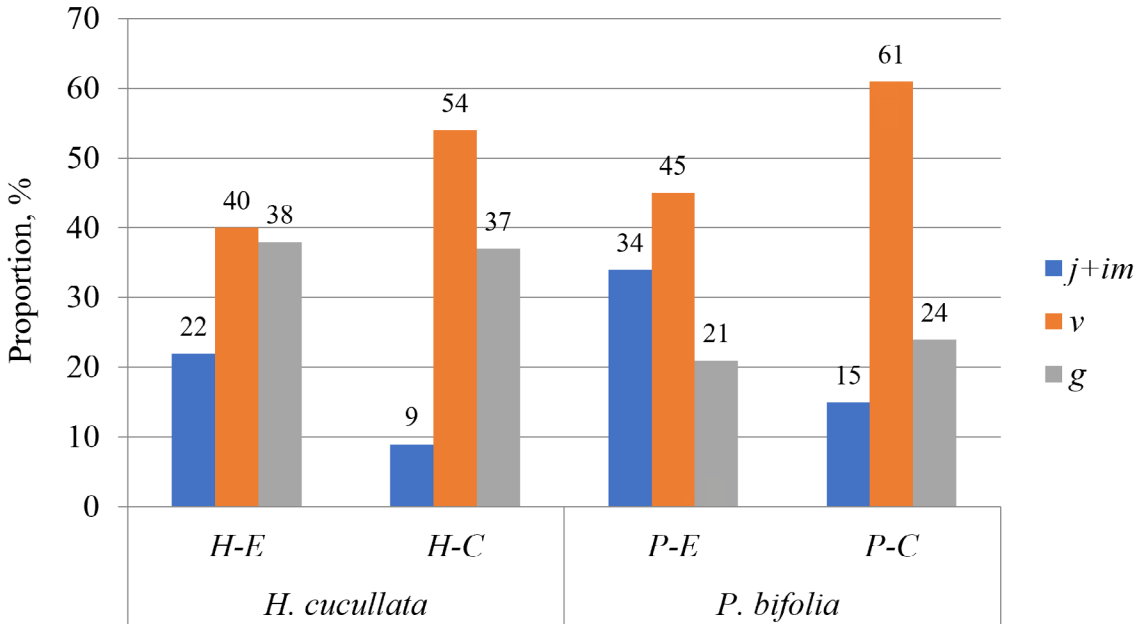


Fig. 3. Age-based distribution of plants in coenopopulations with *Hemipilia cucullata* and *Platanthera bifolia*: j+im – juvenile + immature, v – virginal, g – generative. *H* – *Hemipilia*, *P* – *Platanthera*, *E* – experimental (swampy forest), *C* – control (dry forest).

Habitat conditions can influence the age spectra structure, exerting either favorable or inhibitory effects on plant growth and development at different stages of ontogenesis. The most critical periods in orchid ontogenesis are transitions from under- to aboveground existence and from virginal to generative age when more than 80% of protocorms and up to 60% of virginal individuals die off (Vakhrameeva, 2007). Thus, a high proportion of young plants in CPs from the swampy area can be explained by their better survival during the transition to an aboveground lifestyle, as well as by the reduced loss of immature and juvenile plants.

The observed redistribution of plant age groups has little effect on the recovery index (*Ir*) of CPs of both species. For *P. bifolia* in the swampy forest and in the control, *Ir* accounts for 3.8 and 3.2. For *H. cucullata*, this index makes up 1.6 and 1.7, respectively. All CPs have a recovery index *Ir* > 1 that characterizes them as stable and effectively self-sustaining (Osmanova and Zhivotovsky, 2020).

It is well to bear in mind instability across years when assessing the ontogenetic spectra of orchids. Thus, the ratio of different age groups in CPs can fluctuate significantly during the growing season because of weather and climatic conditions (Efimov, 2010; Kazantseva, 2022). Unfavorable weather conditions often lead to a break in plants flowering and their transition to an underground mycotrophic existence, sometimes for quite a long period. The maximum recorded duration of such periods for *P. bifolia* and *H. cucullata* reaches 6 and 10 years, respectively (Zhmylev et al., 2018). Dates of their vegetation stages also differ. For instance, the same weather conditions at the beginning or in the middle of the current growing season, as well as at the end of the previous growing season can cause different responses. Therefore, the comparative dynamics of age spectra of CPs in the control and experimental plots requires long-term monitoring.

The developmental stage of individuals and their size indicators serve as an objective reflection of the species' living conditions. In our study, both species in the swampy biocenosis differed from the control in size of their reproductive specimens (Table 3). All the measured morphometric parameters turned out to be lower in *P. bifolia* plants from the experimental sample than in the control, but they were higher in *H. cucullata*. Both species from control and experimental sites differed in some indicators that was statistically confirmed. The obtained results suggest that the conditions for realization of the *H. cucullata* growth potential were more favorable in the swampy site (at least during this period) as compared to the control. It should be noted that *H. cucullata* had the highest morphological characteristics unlike other CPs growing in the monitored (for several years) Tyumen suburbs (Kazantseva, 2024).

Table 3. Average morphometric parameters of generative individuals of *Hemipilia cucullata* and *Platanthera bifolia* in the surveyed cenopopulations. n – number of measured specimens; *X* ± *m* – mean value with error; *CV* – coefficient of variation, %; * – differences with the control are significant at p < 0.05.

Parameter	*H. cucullata*				*P. bifolia*			
	H-E (n = 51)		*H-C* (n = 41)		*P-E* (n = 23)		*P-C* (n = 10)	
	X ± *m*	*CV*	*X* ± *m*	*CV*	*X* ± *m*	*CV*	X ± m	CV
Plant height, cm	*19.1 ± 0.76	28.4	16.0 ± 0.59	20.1	*38.1 ± 1.94	24.4	44.3 + 1.74	15.1
Inflorescence length, cm	*6.5 ± 0.42	46.3	4.8 ± 0.25	27.9	*11.3 ± 0.73	31.7	15.5 ± 1.56	28.4
Number of fruits, pcs.	*11.6 ± 0.68	41.7	9.6 ± 0.60	33.5	12.3 ± 0.74	29.2	14.9 ± 1.93	36.7
Leaf length, cm	*4.4 ± 0.18	29.5	5.0 ± 0.17	18.5	12.6 ± 0.85	27.3	14.1 ± 0.93	18.7
Leaf width, cm	2.0 ± 0.09	32.8	1.9 ± 0.10	26.9	*3.5 ± 0.17	22.8	5.1 ± 0.47	27.0

Many authors mention a small size of *P. bifolia* plants from hydromorphic habitats. Some of them believe this is the result of plant suppression (Fedchenko, 2010), while others propose to consider *P. bifolia* from marshy biotopes as a separate ecological form of the species adapted to certain conditions (Summerhayes, 1951).

Most of the morphological traits of individuals in all CPs exhibit a high degree of variability. Variations in parameters of *H. cucullata* is generally higher than in *P. bifolia*. For both species, this indicator is higher in the swampy area. Plant height and leaf length demonstrate the least variability in contrast to such highly variable generative traits of orchids as inflorescence length and fruit number. Some authors also point to high variability of generative traits of orchids (Egorova and Suleimanova, 2024).

In coenopopulations, individuals with the average vitality parameters (*b*) significantly predominate throughout (Table 4). All the examined CPs belong to the "flourishing" vitality type (*Q* > *c*); they are well adapted to specific conditions of habitats. It is worth noting that in the swampy pine stand, the proportion of individuals of the highest vitality class is 1.8 times higher in *H. cucullata* than in *P. bifolia* and as for the lowest class representatives – 3 times less.

The use of CP vitality index (IVC) allows for a pairwise comparison of populations in different hydrological conditions based on a set of plant morphological traits. The obtained index values are indicative of the highest vitality of the *H. cucullata* population developing under hydromorphic conditions of a swampy forest. As for *P. bifolia*, CPs from the automorphic habitat exhibit higher vitality (Fig. 4).

High vitality of *H. cucullata* in the swampy pine stand allows to reconsider this species as a typical mesophyte. Apparently, under certain conditions, it can demonstrate a stronger tolerance to moisture content in soil than it is commonly believed. Our research provides grounds for classifying *H. cucullata* as a mesohygrophyte plant. The ability of *H. cucullata* to successfully colonize hydromorphic habitats increases the chances of preserving this rare species in the absence or reduction of suitable mesophytic areas.

Conclusion

The surveyed area of the swampy pine forest in the suburban zone of Tyumen is characterized by high floristic diversity and the presence in its phytocoenosis of eight orchid species, including four rare to be protected plants. Two orchid species – *H. cucullata* and *P. bifolia*, are represented here by large and stable coenopopulations with a good reproductive potential and high vitality. This underscores the value of swampy biocoenoses as refugia for protecting vulnerable plant species. It is advisable to identify reference sites in these forests and grant them the conservation status to maintain overall biological diversity and save rare orchid species in conditions of intensive development of the Tyumen suburban zone.

Table 4. Vitality indicators of the surveyed *Hemipilia cucullata* and *Platanthera bifolia* cenopopulations. Vitality classes of individuals: *a* – highest, *b* – intermediate, *c* – lowest. *Q* – indicator of cenopopulation vitality type.

Species	CP	Proportion of individuals by vitality class, %			*Q*
		a	*b*	*c*	
H. cucullata	*H-E*	14	77	9	45.5
	H-C	13	70	17	41.5
P. bifolia	*P-E*	8	64	28	36.0
	P-C	13	74	13	43.5

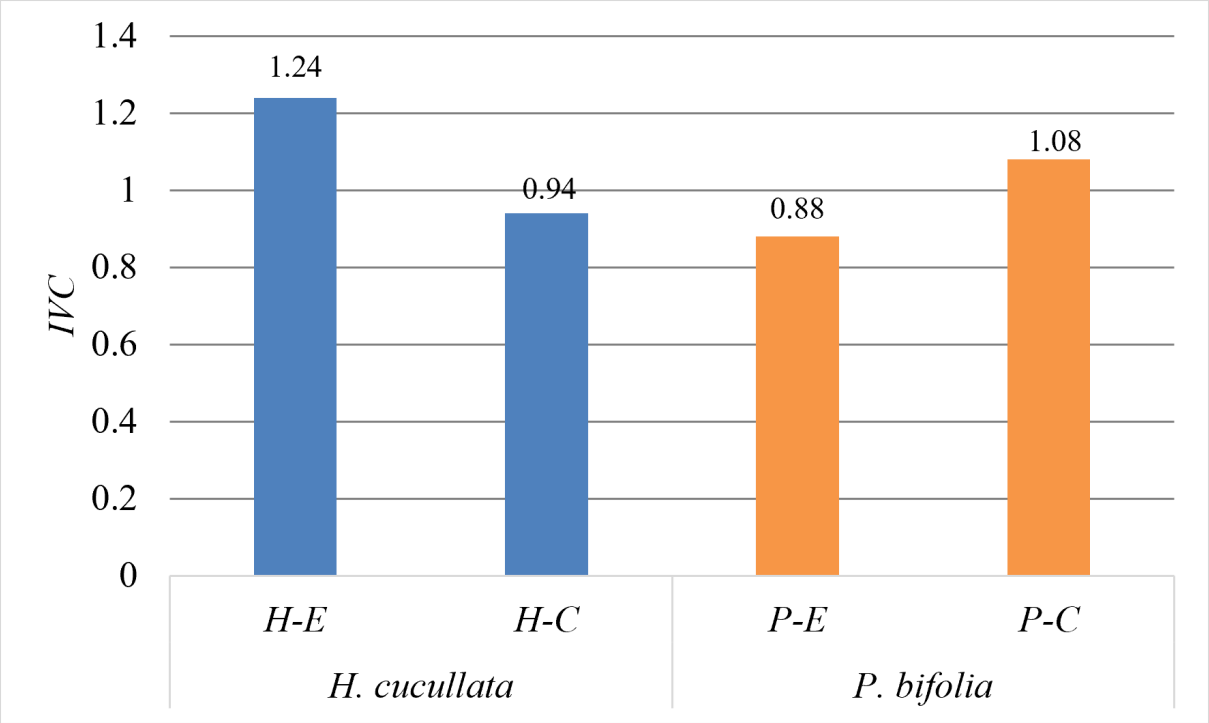


Fig. 4. Vitality indices (*IVC*) of the surveyed coenopopulations with *Hemipilia cucullata* and *Platanthera bifolia* (legend as in Fig. 3).

References

Breslavsky, A.S., 2024. Suburbanizatsiya i budushcheye rossiyskikh gorodov. Vvedeniye v problematiku [Suburbanization and the future of Russian cities. Introduction to the problematic]. Center for Humanitarian Initiatives, Moscow, Russia, 170 p. (In Russian).

Egorova, N.Yu., Suleimanova, V.N., 2024. Formation of life strategies of plants of technogenic ecotopes on the example of short-rhizome orchids. *Ecosystem Transformation* **7** (2), 176–188. https://doi.org/10.23859/estr-221228

Efimov, P.G., 2010. Sokhraneniye orkhidnykh (Orchidaceae Juss.) kak odna iz zadach okhrany bioraznoobraziya [Conservation of orchids (Orchidaceae Juss.) as one of the tasks of biodiversity protection]. *Biosfera [Biosphere]* **2** (1), 50–58. (In Russian).

Fardeyeva, M.B., 2018. Prostranstvennaya neodnorodnost' populyatsiy klubneobrazuyushchikh orkhidey i metody yeye izucheniya na primere *Neotianthe cucullata* (L.) Schlechter [Spatial heterogeneity of tuber-forming orchid populations and methods for its study using Neottianthe cucullata (L.) Schlechter as an example]. *Ekosistemy [Ecosystems]* **16** (46), 75–85. (In Russian).

Fedchenko, E.A., 2010. Ekologo-biologicheskiye osobennosti *Platanthera bifolia* (L.) Rich. i Dactylorhiza hebridensis (Wilmott.) Aver. na yuge Tyumenskoy oblasti [Ecological and biological characteristics of *Platanthera bifolia* (L.) Rich. and *Dactylorhiza hebridensis* (Wilmott.) Aver. in the south of Tyumen Region]. *PhD in Biology thesis abstract*. Perm, Russia, 24 p. (In Russian).

Ishbirdin, A.R., Ishmuratova, M.M., 2004. Adaptivnyy morfogenez i ekologo-tsenoticheskiye strategii vyzhivaniya travyanistykh rasteniy [Adaptive morphogenesis and eco-cenotic strategies of survival of herbaceous plants]. *Materialy VII vserossiyskogo populyatsionnogo seminara «Metody populyatsionnoy biologii». Ch. II [Proceedings of the VII All-Russian population seminar "Methods of population biology". Part II]*. Syktyvkar, Russia, 113–120. (In Russian).

Kazantseva, M.N., 2022. Vliyaniye zasukhi 2021 goda na tsenopopulyatsii orkhidnykh (Orchidaceae) v gorodskikh lesakh Tyumeni [The impact of the 2021 drought on Orchidaceae cenopopulations in urban forests of Tyumen]. *Materialy natsional'noy nauchno-prakticheskoy konferentsii s mezhdunarodnym uchastiyem «Vodnyye resursy – osnova regional'nykh proyektov po obustroystvu Rossii, Sibiri i Arktiki v XXI veke». T. 1 [Proceedings of the National Scientific and Practical Conference with International Participation "Water Resources – the Basis of Global and Regional Development Projects for Russia, Siberia and the Arctic in the 21st Century". Vol. 1].* Tyumen, Russia, 224–229. (In Russian).

Kazantseva, M.N., 2024. Sostoyaniye i dinamika tsenopopulyatsiy *Neottianthe cucullata* (L.) Schltr. (Orchidaceae) v yuzhnoy chasti Tyumenskoy oblasti [The state and dynamics of cenopopulations of *Neottianthe cucullata* (L.) Schltr. (Orchidaceae) in the southern part of the Tyumen region]. *Vestnik Udmurtskogo universiteta. Seriya Biologiya. Nauki o Zemle [Bulletin of Udmurt University. Series Biology. Earth Sciences]* **34** (1), 7–15. (In Russian).

Kazantseva, M., Artyomenko, S., 2021. Wild orchids of Tyumen and challenges, related to their preservation. *BIO Web of Conferences* 38, 00053. https://doi.org/10.1051/bioconf/20213800053

Kapitonova, O.A., 2023. O novykh mestakh nakhozhdeniya *Neotianthe cucullata* (L.) Schltr. (Orchidaceae) v Tyumenskoy oblasti [On new locations of *Neottianthe cucullata* (L.) Schltr. (Orchidaceae) in the Tyumen region]. *Prirodnoye i istoriko-kul'turnoye naslediye Sibiri [Natural, Historical and Cultural Heritage of Siberia]* **1** (1), 39–45. (In Russian). https://doi.org/10.25713/HS.2023.1.1.008

Khomyakov, D.A., 2017. Zakonomernost' razvitiya i optimizatsii rosta stolichnykh zhilykh prigorodov [Patterns of development and optimization of growth of capital residential suburbs]. *Naukovedeniye [Science Studies]* **9** (2). (In Russian).

Krasnaya kniga Tyumenskoy oblasti: zhivotnyye, rasteniya, griby [Red Data Book of the Tyumen Region: Animals, Plants, Mushrooms], 2020. 2nd edition. Petrova, O.A. (ed.). LLC TEKHNOPRINT, Kemerovo, Russia, 460 p. (In Russian).

Krasnaya kniga Rossiyskoy Federatsii. Rasteniya i griby [Red Data Book of the Russian Federation. Plants and Fungi], 2024. 2nd edition. Geltman, D.V. (ed.). All-Russian Research Institute "Ecology", Moscow, Russia, 944 p. (In Russian).

Kuzmin, I.V., Drachev, N.S., 2007. Rasprostraneniye i razmer populyatsiy *Neottianthe cucullata* (L.) Schlechter (Orchidaceae) v Tyumenskoy oblasti [Distribution and population size of *Neottianthe cucullata* (L.) Schlechter (Orchidaceae) in the Tyumen region]. *Vestnik Tverskogo gosudarstvennogo universiteta. Seriya: biologiya i ekologiya [Bulletin of Tver State University. Series: Biology and Ecology]* **3**, 209–213. (In Russian).

Osmanova, G.O., Zhivotovsky, L.A., 2020. Ontogeneticheskiy spektr kak indikator sostoyaniya tsenopopulyatsiy rasteniy [Ontogenetic spectrum as an indicator of the state of plant cenopopulations]. *Izvestiya Rossiyskoy akademii nauk. Seriya Biologicheskaya [Bulletin of the Russian Academy of Sciences. Series Biological]* **2**, 144–152. (In Russian). https://doi.org/10.31857/S0002332920020058

Pisarenko, O.Yu., Lashchinsky, N.N., 2020. Zabolochennyye lesa podtaygi i lesostepi Sibiri [Swampy forests of the subtaiga and forest-steppe of Western Siberia]. *Vestnik Tomskogo gosudarstvennogo universiteta. Biologiya [Bulletin of Tomsk State University. Biology]* **50**, 52–78. (In Russian). https://doi.org/10.17223/19988591/50/3

Rastitel'nyy pokrov Zapadno-Sibirskoy ravniny [Vegetation cover of the West Siberian Plain], 1985. Vorobiev, V.V., Belov, A.V. (eds.). Nauka, Novosibirsk, Russia, 249 p. (In Russian).

Speranskaya, L.Yu., Lyashchenko, A.D., Zhembrovskaya, T.A., 2021. Obzor sostoyaniya populyatsiy *Neotianthe cucullata* (L.) Schlechter v razlichnykh regionakh Rossiyskoy Federatsii [Review of the

state of *Neottianthe cucullata* (L.) Schlechter populations in various regions of the Russian Federation]. *Problemy botaniki Yuzhnoy Sibiri i Mongolii [Problems of Botany of Southern Siberia and Mongolia]* **20** (1), 414–423. (In Russian). https://doi.org/10.14258/pbssm.2021083

Sulimenkina, O.Yu., 2011. Vidovoy sostav, rasprostraneniye i okhrana tuberoidnykh orkhidnykh v Altayskom kraye [Species composition, distribution and protection of tuberoid orchids in the Altai Territory]. *Izvestiya Altayskogo Gosudarstvennogo universiteta. Biologicheskiye nauki. Nauki o Zemle. Khimiya [Bulletin of the Altai State University. Biological sciences. Earth sciences. Chemistry]* **3-1** (71), 44–47. (In Russian).

Summerhayes, V.S., 1951. Wild Orchids of Britain. Collins, London, UK, 336 p.

Vakhrameyeva, M.G., 2007. Zhizn' populyatsiy yevraziatskikh nazemnykh orkhidnykh [Life of populations of Eurasian terrestrial orchids]. *Vestnik Tverskogo gosudarstvennogo universiteta [Bulletin of Tver State University]* **3**, 75–81. (In Russian).

Vakhrameeva, M.G., Zhirnova, T.V., 2003. Neottiante klobuchkovaya [*Neottiante cucullata*]. In: Pavlov, V.N., (ed.), *Biologicheskaya flora Moskovskoy oblasti. Vyp. 15. [Biological flora of the Moscow region. Issue 15].* Grif i K., Moscow, Russia, 50–61. (In Russian).

Vakhrameyeva, M.G., Varlygina, T.I., Titarenko, I.V., 2014. Orkhidnyye Rossii (biologiya, ekologiya, okhrana) [Orchids of Russia (biology, ecology, conservation)]. KMK Scientific Press Ltd, Moscow, Russia, 437 p. (In Russian).

Zhmylev, Yu.P., Tatarenko, I.V., Vakhrameeva, M.G., Voronina, E.Yu., Lazareva, G.A. et al., 2018. «Spyashchiye krasavitsy»: kratkiy obzor raznoobraziya prodlennogo sezona u rasteniy ["Sleeping Beauties": a brief overview of the diversity of extended dormancy in plants]. *Byulleten' MOIP. Otdel biologicheskiy [Bulletin of Moscow Society of Naturalists. Biological Department]* **123** (3), 41–53. (In Russian).

Zlobin, Yu.A., 1989. Printsipy i metody izucheniya tsenoticheskikh populyatsiy rasteniy [Principles and methods of studying coenotic populations of plants]. Kazan University Publishing House, Kazan, Russia, 147 p. (In Russian).

Список литературы

Бреславский, А.С., 2024. Субурбанизация и будущее российских городов. Введение в проблематику. Центр гуманитарных инициатив, Москва, Россия, 170 с.

Вахрамеева, М.Г., 2007. Жизнь популяций евразиатских наземных орхидных. *Вестник Тверского государственного университета* **3**, 75–81.

Вахрамеева, М.Г., Жирнова, Т.В., 2003. Неоттианте клобучковая. В: Павлов В.Н. (ред.), *Биологическая флора Московской области*. *Вып. 15*. Гриф и К., Москва, Россия, 50–61.

Вахрамеева, М.Г., Варлыгина, Т.И., Титаренко, И.В., 2014. Орхидные России (биология, экология, охрана). Товарищество научных изданий КМК, Москва, Россия, 437 с.

Егорова, Н.Ю., Сулейманова, В.Н., 2024. Формирование жизненных стратегий растений техногенных экотопов на примере коротко-корневищных орхидей. *Трансформация экосистем* **7** (2), 176–188. https://doi.org/10.23859/estr-221228

Ефимов, П.Г., 2010. Сохранение орхидных (Orchidaceae Juss.) как одна из задач охраны биоразнообразия. *Биосфера* **2** (1), 50–58.

Жмылев, Ю.П., Татаренко, И.В., Вахрамеева, М.Г., Воронина, Е.Ю., Лазарева, Г.А. и др., 2018. «Спящие красавицы»: краткий обзор разнообразия продленного покоя у растений. *Бюллетень МОИП. Отдел биологический* **123** (3), 41–53.

Злобин, Ю.А., 1989. Принципы и методы изучения ценотических популяций растений. Издательство Казанского университета, Казань, Россия, 147 с.

Ишбирдин, А.Р., Ишмуратова, М.М., 2004. Адаптивный морфогенез и эколого-ценотические стратегии выживания травянистых растений. *Материалы VII всероссийского популяционного семинара «Методы популяционной биологии». Ч. II.* Сыктывкар, Россия, 113–120.

Казанцева, М.Н., 2022. Влияние засухи 2021 года на ценопопуляции орхидных (Orchidaceae) в городских лесах Тюмени *Материалы национальной научно-практической конференции с Международным участием «Водные ресурсы – основа глобальных и региональных проектов обустройства России, Сибири и Арктики в XXI веке». Т. 1.* Тюмень, Россия, 224–229.

Казанцева, М.Н., 2024. Состояние и динамика ценопопуляций *Neottianthe cucullata* (L.) Schltr. (Orchidaceae) в южной части Тюменской области. *Вестник Удмуртского университета. Серия Биология. Науки о Земле* **34** (1), 7–15. https://doi.org/10.35634/2412-9518-2024-34-1-7-15

Капитонова, О.А., 2023. О новых местонахождениях *Neottianthe cucullata* (L.) Schltr. (Orchidaceae) в Тюменской области. *Природное и историко-культурное наследие Сибири* **1** (1), 39–45. https://doi.org/10.25713/HS.2023.1.1.008

Красная книга Тюменской области: животные, растения, грибы. Издание 2-е, 2020. Петрова, О.А. (ред.). ООО ТЕХНОПРИНТ, Кемерово, Россия, 460 с.

Красная книга Российской Федерации. Растения и грибы. Издание 2-е. 2024. Гельтман, Д.В. (ред.). ВНИИ "Экология". Москва, Россия, 944 с.

Кузьмин, И.В., Драчев, Н.С., 2007. Распространение и размер популяций *Neottianthe cucullata* (L.) Schlechter (Orchidaceae) в Тюменской области. *Вестник Тверского государственного университета. Серия: биология и экология* **3**, 209–213.

Османова, Г.О., Животовский, Л.А., 2020. Онтогенетический спектр как индикатор состояния ценопопуляций растений. *Известия Российской академии наук. Серия Биологическая* **2**, 144–152. https://doi.org/10.31857/S0002332920020058

Писаренко, О.Ю., Лащинский, Н.Н., 2020. Заболоченные леса подтайги и лесостепи Западной Сибири. *Вестник Томского государственного университета. Биология* **50**, 52–78. https://doi.org/10.17223/19988591/50/3

Растительный покров Западно-Сибирской равнины, 1985. Воробьев, В.В., Белов, А.В. (ред.). Наука, Новосибирск, Россия, 249 с.

Сперанская, Л.Ю., Лященко, А.Д., Жембровская, Т.А., 2021. Обзор состояния популяций *Neottianthe cucullata* (L.) Schlechter в различных регионах Российской Федерации. *Проблемы ботаники Южной Сибири и Монголии* **20** (1), 414–423. https://doi.org/10.14258/pbssm.2021083

Сулименкина, О.Ю., 2011. Видовой состав, распространение и охрана тубероидных орхидных в Алтайском крае. *Известия Алтайского Государственного университета. Биологические науки. Науки о Земле. Химия* **3-1** (71), 44–47.

Фардеева, М.Б., 2018. Пространственная неоднородность популяций клубнеобразующих орхидей и методы ее изучения на примере *Neottianthe cucullata* (L.) Schlechter. *Экосистемы* **16** (46), 75–85.

Федченко, Е.А., 2010. Эколого-биологические особенности *Platanthera bifolia* (L.) Rich. и *Dactylorhiza hebridensis* (Wilmott.) Aver. на юге Тюменской области: *Автореферат диссертации на соискание ученой степени кандидата биологических наук*. Пермь, Россия, 24 с.

Хомяков, Д.А., 2017. Закономерности развития и оптимизация роста столичных жилых пригородов. *Науковедение* **9** (2).

Kazantseva, M., Artyomenko, S., 2021. Wild orchids of Tyumen and challenges, related to their preservation. *BIO Web of Conferences* 38, 00053. https://doi.org/10.1051/bioconf/20213800053

Summerhayes, V.S., 1951. Wild Orchids of Britain. Collins, London, UK, 336 p.