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ECOLOGICAL-BIOLOGICAL FEATURES AND DISTRIBUTION OF *ORCHIDACEAE* FAMILY IN THE RESERVES OF TRANSBAIKALIA REGION

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The principal features of cenotic population and features of distribution of the species of *Orchidaceae* family in Transbaikalia region are under consideration in the paper. The species diversity of *Orchidaceae* family and the phytocenotic location in the reserves of Transbaikalia region are revealed. The characteristics of cenotic population are given taking the genera *Cypripedium* as an example. The state of six cenotic populations of *Cypripedium* species showed that they develop successfully that is supported by prevalence of virginal and generative individuals and as following the right-hand ontogenetic spectra. The cartographic schemes of altitudinal distribution of *Orchidaceae* species for the territory under consideration had been works out. Analysis of cartographic schemes of the species included in the Red Data Book on the territory of reserves in Transbaikalia showed the location of principal part of species in the valleys of big rivers with sufficient humidification.

Keywords: cenotic population, phytocenotic location, Transbaikalia, *Orchidaceae* family, altitudinal distribution.

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The aim of present research work is the revealing of the principal features of cenotic populations and the peculiarities of distribution of the species from the *Orchidaceae* family in Transbaikalia region. For the achieving of the goal the following tasks are set:

1. To identify the species diversity of Orchids and their phytocenotic location in the reserves of Transbaikalia region.
2. To give the characteristics of cenotic population, the number and age structure of the species taking the *Cypripedium* genera as an example.
3. The work out the altitudinal cartographic schemes of the Orchids distribution for the territory under consideration.
4. The reveal the principal ecological-biological features and principal peculiarities of distribution are attached to the tropical *Orchidaceae* family in the reserves of Transbaikalia region.

The *Orchidaceae* family is one of the most interesting among the Angiosperm species because of the features of their biology and anthropogenic vulnerability. Many species from this family are rare; some of them are included into the Red Books of various ranks.

The territory of Transbaikalia region is characterized by specific natural and climatic conditions (sharp continental climate, influence of the lake Baikal, orographic features, etc.) which create very specific conditions for the growing of the species of *Orchidaceae* family. The cartographic scheme of the territory under consideration with the reserves marked on the map is given at the Figure 1.

The *Orchidaceae* family is one of the biggest among the plants and accounts up to 750 genera, from 20,000 to 25,000 species (Dressler, 1981), and, according to some other data, there can be even more, up to 800 genera and 35,000 species (Vakhrameeva, 1991).

The species of this family are cosmopolitics. They could be met almost in all regions of the Earth suitable for habitation, from Sweden and Alaska in the north, to the Terra del Fuego and

Makkuori Island in the south. But the majority of them live in the tropical latitudes, especially, in tropical America and South-East Asia, where throughout the short dry season and under the high precipitation level they find the most favorable growing conditions. In the moderate latitudes their diversity is lower. Thus, in the moderate latitudes of the North hemisphere there are only 75 genera (10% of the total number) and 900 species (4.5%; Plant life, 1982).

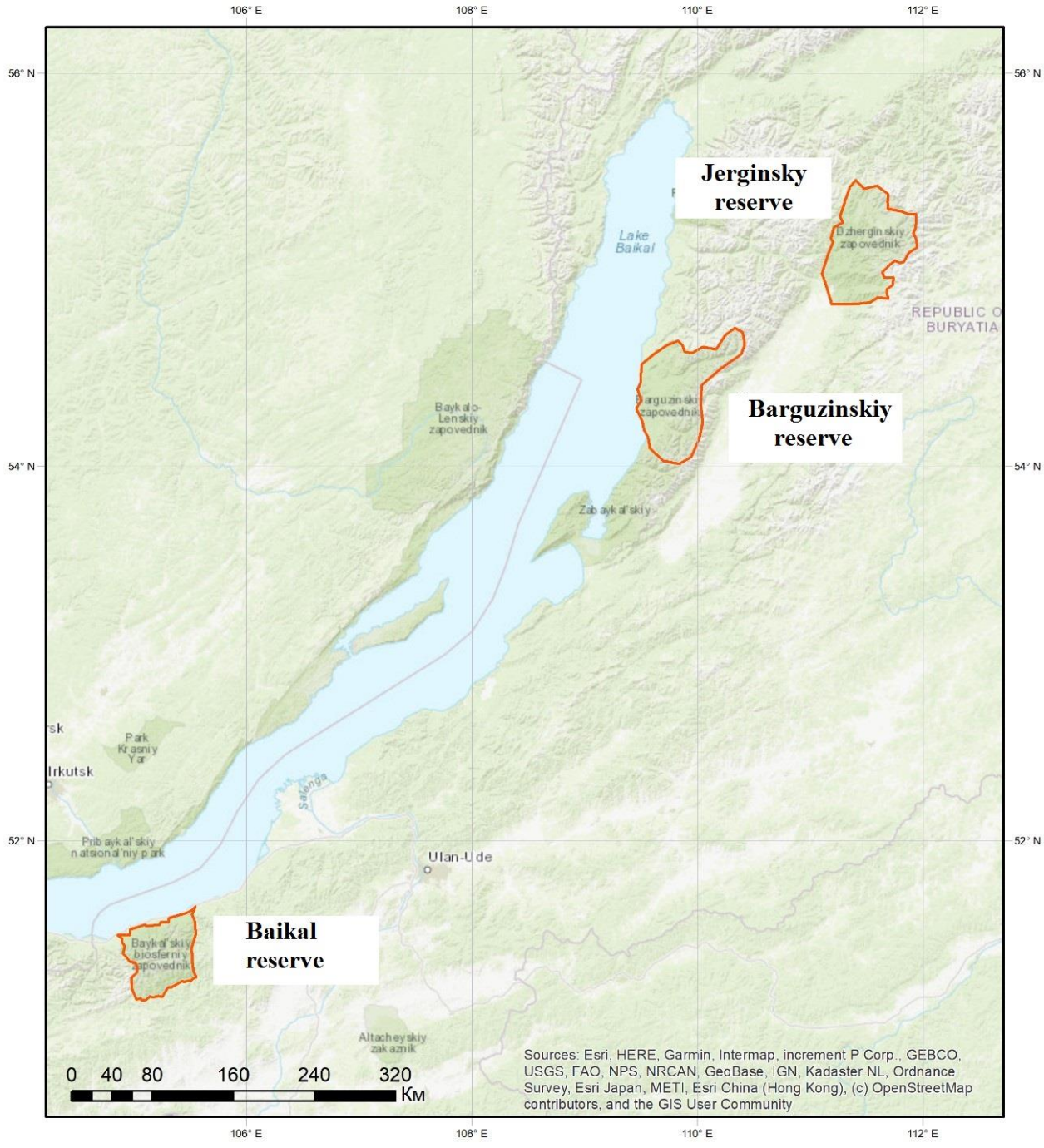

Fig. 1. Studied territories on the sketch map.

About 130 orchid species from 42 genera grow on the territory of Russia. They live almost everywhere (excluding the regions of Far North) under various ecological conditions. Many species

have big areas and could be found in various types of phytocenoses, and some of them have a narrow phytocenotic habitat (Vakhrameeva et al., 2014). They are various at the Far East (65 species from 33 genera) and at Caucasus (50 species from 19 genera), because these territories are close to south-east and Asia Minor centers of Orchid biodiversity (Averyanov, 1991).

The species of *Orchidaceae* family could be related to hemi-eurytopic plants. They are sensitive to soil, cenotic and micro-climatic conditions. Most of species are attached to certain ecological habitat conditions (Perebora, 2002). But, nevertheless, Orchid species grow almost everywhere: on the slopes of high mountains as well as in the forests, in the wetlands and waterbodies as well as in the dry steppes and desert oases. Most Orchids do not grow higher than 2000 meters above the sea level, but some of them could be met at the upper boundary of forest at the 5000 meters above the sea level (Plant life, 1982).The shadow and light wet forests are considered to be the primary habitats of Orchids (Averyanov, 1991). The most suitable habitats at the Russian territory are coniferous-broadleaved forests of the Far East (Tatarenko, 1996). Many species of Orchids are connected evolutionary with the moss communities because they switch from epiphytic to terrestrial existence (Vakhrameeva, 1991). The limits of ecological amplitude of Orchid species as a rule are not connected with the area size (Tatarenko, 1996).

Orchid species could be met almost in all natural zones of Russia, from tundra at the north to the dry steppes and semi-deserts in the south. In the mountains they can grow almost everywhere from the piedmont to the subalpine belt. Most species are allocated to the zonal vegetation, but many could be met in intrazonal types of vegetation, such as wetlands and solonets. Among orchid species the forest ones prevail in the moderate climate. This indicates that under the forest canopy there are optimal conditions for their existence and preservation in the moderate climate zone. They could be of various forest types with homogeneous composition or mixed forests: pine, larch, small-leaved, sparse forests, broad-leaved and mixed coniferous-small-leaved forests. The prevailing tree species could be various depending on the region (Vakhrameeva et al., 2014).

As orchid species have weak competitive ability, the number of their individuals in populations is not high. This is also the reason why they are not abundant in the phytocenoses. But sometimes some species could become subdominants in the vegetation communities, and very rarely they act as dominants: *Cypripedium guttatum*, *Dactylorhiza urvilleana* [1] and some other species (Vakhrameeva, 2014).

Orchidaceae family deserves attention for the aims of biodiversity conservation, because many species from this family are endangered not only due to anthropogenic impact but because of the specific features of their biology and ecology. They need protection on different levels: international, state and regional. That is why many representatives of this family are included into the Annex II to the “Convention on International Trade ...” (2009).

In the Europe the species that need special protection are included into the Annex to “Bern Convention”, including the Annex Bern-I, which contains the plant species in need of strict protection measures. Among them there are 9 orchids growing in European Russia and Caucasus: *Cephalanthera floribunda*, *Cypripedium calceolus*, *Himantoglossum caprinum*, *Liparis löeselii*, *Ophrys oestrifera*, *O. taurica*, *Orchis provincialis*, *O. punctulata* и *Steveniellasa tyrioides*. Two of them are included into the “Natural Habitats and Wild Fauna and Flora Protection Directive”: *Cypripedium calceolus* and *Liparis löeselii*.

In 1997 five species from Russia (*Cypripedium yatabeanum*, *Neottia ussuriensis*, *Himantoglossum f. ormosum*, *Ophrys caucasica* и *Ophrys oestrifera*) were included into the IUCN Red List (1997).

Other 66 species are included into the “Red Data Book of the Russian Federation” (2008).

[1] Latin names of plants are given according to S.K. Cherepanov plant guide “Vascular plants of Russia and adjacent countries” (1995).

As compared to the "Red Data Book of RSFSR" (1988), 22 more species were added, including 2 endemic species and 7 species that could be met in Russia and adjacent countries. The newly added plants are *Traunsteinera sphaerica*, *Gymnadenia odoratissima* and *Cypripedium ventricosum*. Besides, some species were found on the Russian territory not so long ago (*Cephalanthera erecta* and *C. floribunda*), or after a long period of their absence (*Neottia ussuriensis*). In total, the "Red Data Book of the Russian Federation" includes 25 species from the Far East, 22 from Caucasus, 3 from European part of Russia, and 16 from European and Asian parts, 8 of which have wide areas of distribution (Vakhrameeva et al., 2014). Recently the process of creation of the regional Red Data Books in Russia has become active, which allows scientists to generalize the data on the state of population of rare orchids.

Many rare and endangered species grow in the Specially Protected Natural Area, rare vegetation communities and natural complexes could be met. As experience shows species protection is well provided in the reserves on state level, but orchid species are rare in the reserves and despite the conservation measures the number of cenotic populations of some orchids is decreasing. According to the data of T.I. Varlygina (2003), the number of *Cypripedium calceolus* populations decreased in many reserves, as well as the number of sites with *Liparis loeselii*. Meanwhile some sub-endemic species and other species that have limited distribution in Russia (*Cypripedium shanxiense*, *Chamorchis alpina*, *Dactylorhiza euxina* etc.) are not protected on the territories of reserves. Therefore, the special territories should be allocated to organize new federal and regional reserves (where possible) and monuments of nature (Vakhrameeva, 2014).

In many countries besides protection the other methods of species conservation are used. In botanical gardens in Russia 60 species of orchids from natural flora are grown up. The attempts of orchid species cultivation have been underway for a long time. The new centers are organized and develop in our country (in Saint-Petersburg, Yekaterinburg, Moscow, Nizhniy Novgorod and others), where orchids are grown on nutrient mediums for seeds germination and for cultivation of tissues. Transplanting of cloned plants into nature is not advisable because the impoverishment of genetic diversity of species happen but also the reduction of stability of populations (Vakhrameeva et al., 2014).

Thus, the taxonomic diversity and ecological-biological features of orchids define their wide distribution on the Earth.

The specific "plasticity" of biology and ecology of orchids enable them to occupy various habitats. But despite this the species of *Orchidaceae* family form one of the most vulnerable plant groups which need studying of their ecological and biological features for conservation.

This work will be useful for further studying and planning of protection measures on the territory of Baikal, Barguzinsky and Dzerginsky reserves: we gave the features of Pribaikalsky orchids, their diversity and altitudinal distribution. The data on the state of cenotic populations of orchid species are necessary for correction of the features of protected objects in Specially Protected Natural Areas and their categories in the Red Data Books of federal and regional levels.

Materials and Methods

In our work we consider and analyze orchid species on the territory of three reserves: 1) Baikal state natural biosphere reserve, 2) Barguzinsky state natural biosphere reserve named after K.A. Zabelin, 3) Dzerginsky state natural reserve. We used "Chronicles of Nature" from these reserves (Ananin, Ananina, 2018; Kitaev et al., 2019; Budaeva, 2020), Red Data Books of regional and federal levels and other literature sources (Troitskaya, Fedorova, 1989; Elaev et al., 2000; Abramova, Volkova, 2011; Gamova, Krasnopevtseva, 2011; Gamova, Dudov, 2018), as well as our own materials on 2020 from the Barguzinsky reserve.

The studying of the features of individual plant development (ontogenesis) and representation

in cenotic populations of various age states play the great role in the estimation of the state and prognosis of the population development (Cenopopulations of plants …, 1976).

Cenotic population (cenopopulation) is the elementary object of population level organization for the plants. Cenopopulation includes all plants of certain species in the phytocenosis (Petrovskiy, 1961). The main characteristics of cenopopulation are: the number of individuals (density), age spectrum and type of age spectrum.

The age spectrum is the ratio of the plants in different age state (Uranov, 1977). Onthogenetic structure of cenopopulation is one of the most important features, reflecting the vital strategy of plants, as well as the state and perspectives of cenopopulation development (Glotov, 1998). Onthogenetic or so called age spectrum are presented in our work as diagrams.

The age groups pf plants are formed according to morphological (qualitative and quantitative) features. We accepted for our work proposed by T.A. Rabotnov (1950) and A.A. Uranov (Cenopopulations of plants …, 1976) the following age states for *Orchidaceae* family: juvenile (j), immature (im), virginal (v) and generative (g).

Method of the age states determination for orchids is based on analysis of metrical data of terrestrial organs. We analyzed the aboveground organs because the digging of orchid plants is impractical due to their rareness. The age state of orchids had been determined according to the following morphometric parameters: type of shoot (vegetative/generative), the height, length and width of leaves, number of ribs and parameters of upper and lower lips of the flower, holes. All metric data were collected in the tables; in our work we present the fragment of such table.

Besides the quantitative indices we took into consideration the total qualitative features of onthogenetic states (Uranov, 1975; Jukova, 1987):

Juvenile plants (j) are characterized by simplicity of organization, some embryonic structures (root, shoot), loss of connection with the seed, absence of cotyledon, unformed of features and properties typical for the mature plants, presence of leaves with different form and location, different type of growing and branching than the mature plants have.

Immature plants (im) have features and characteristics transitional from juvenile plants to mature: development of leaves and roots of transitional type, emergence of some mature features in the shoot structure, beginning of branching but simultaneously preserving of some elements of initial shoot.

Virginal plants (v) are characterized by emerging of principal features typical for certain vital form: the plants have typical for the species mature leaves, shoots and root system, generative organs are not formed yet, processes of withering away are not expressed yet excluding seasonal change of mono- and dicyclical shoots and death of some roots (sometimes of the main root, sometimes of adventitious root).

Generative plants (g) have emerging and development of generative organs, forming of mature structures: big shoots, leaves and the whole biomorph.

The ratio of the age groups in the structure of population characterizes its ability of reproduction and survival, and correlates with its indices of fertility and mortality.

In growing populations with high fertility the young individuals prevail that are not reproductive. Stable populations are as a rule uneven full-member populations in which certain number of individuals cross from the young age groups to older and the fertility equals to population decline. In diminishing population the base is formed by old individuals, renewal is absent or insignificant.

The age spectrum is of high significance. According to predominance of certain age groups in the spectrum we can judge about success and stability of certain cenotic population within the community or about the critical moments in its development. This characteristic is very important especially for rare species (Klinkova et al., 2010).

Variety of age spectrums known for rare species could be expressed in the following variants:

- With predominance of mature individuals (v, g);
- With predominance of young individuals (j, im, v);
- With maximum in young and old parts of cenopopulation.

In our work we revealed 3 types of onthogenetic spectrum: *left-hand* spectrum, which maximum is in the young individuals; *right-hand* spectrum, which maximum is in the mature individuals; and *bimodal* spectrum, which maximums are in immature and generative individuals (Bichenko, 1999; Cenopopulations of plants …, 1976).

The data received during our research works could be generalized and represented as statistical indices. One of them is *ageindex* (Δ), proposed by A.A. Uranov (1975), and calculated in our work for cenopopulations under consideration. It is weighted indicator of correlation of shares of the age groups in the composition of cenopopulation and is calculated as follows:

$$\Delta = \frac{\sum ki \times mi}{\mathrm{N}},$$

where *ki* is the number I of onthogenetic group, *mi* is the "valuation" of the age of one individual of the I onthogenetic group, and N (Σ*ki*) is the number (density) of cenopopulation.

Age index evaluate the onthogenetic level of cenopopulation in certain moment of time and give the real picture of the input of each onthogenetic group into the total age structure of cenopopulation. It varies from 0 to 1 and the higher it is, the elder is the cenopopulation (Uranov, 1975). For visualization we used the color scale (Table 1).

Table 1. Age coefficient scale.

Conditional color	Name of the cenopopulation type	Diapason of age index
	"adolescent"	0-0.1
	maturing	0.1-0.2
	young	0.2-0.4
	mature	0.4-0.6
	aging	0.6-0.8
	old	0.8-1

Results and Discussion

By now on the territory of Baikal reserve and in its protection zone we revealed 19 species of orchids. They are presented in the table below (Table 2) with indication of conservation status.

Thus, 8 species are included into the Red Data Book of the Republic of Buryatia (2013) and 4 are in the Red Data Book of the Russian Federation (2008). All of them have the "rare" status (or Near Threatened of the IUCN Red List), which means that they are not endangered, but their number is low and they could be found in such limited areas that they may disappear, as soon as the environmental conditions worsen. One species included into the regional Red Data Book belongs to the 7th category, i.e. it is not endangered in the Republic of Buryatia, but is listed in the Red Data Book of the Russian Federation.

On the territory of Dzherginsky Reserve 10 species of orchids grow (Table 3); 5 of them are included into the Red Data Book of the Russian Federation with category 2 (VU) – 1 species and with category 3 (NT) – 4 species. 6 species are included into the Red Data Book of Buryatia, while the majority of them are referred to the 3 category (NT), 1 species to category 2 (VU) and 1 – to 7 category.

12 species of orchids are revealed on the territory of Barguzinsky reserve (Table 4), 8 of them are included into the Red Data Book of the Republic of Buryatia (2013), including 4 species – into

the Red Data Book of Russia (Table 4).

Table 2. Orchid species that grow on the territory of Baikal Reserve. The list is compiled on the basis of numerous works (Red Data Book of Russian Federation, 2008; Red Data Book of Buryatia …, 2013; Chronicle of nature, 2019; Abramova, Volkova, 2011; Gamova, Krasnopevtseva, 2013; Gamova, Dudov, 2018).

Latin names of species	Red Data Book of the Republic of Buryatia (2013)	Red Data Book of the Russian Federation (2008)
Calypso bulbosa (L.) Oakes	3 (NT)	3 (NT)
Coeloglossum viride (L.) C. Hartman		
Corallorhiza trifida Chatel.		
Cypripedium guttatum Sw.	3 (NT)	
C. macranthon Sw.	3 (NT)	3 (NT)
Dactylorhiza cruenta (O.F. Mull.) Soó		
D. fuchsii (Druce) Soó		
D. incarnata (L.) Soó		
Epipactis helleborine (L.) Crantz	3 (NT)	
Goodyera repens (L.) R. Br.		
Gymnadenia conopsea R. Br.		
Herminium monorchis (L.) R. Br.		
Listera cordata (L.) R. Br.	3 (NT)	
L. ovata (L.) R. Br.	3 (NT)	
Malaxis monophyllos (L.) Sw.		
Neottianthe cucullata (L.) Schlecht.	7	3 (NT)
Orchis militaris L.	3 (NT)	3 (NT)
Platanthera bifolia (L.) Rich.	3 (NT)	
Spiranthes amoena (Bieb.) Sprengel		

In the table 5 (Table 5) we presented the species diversity of orchids (22 species, 17 genera) in all reserves under consideration. As we can see, the largest genera are *Cypripedium* and *Dactylorhiza* that include 3 species each. *Listera* genus is represented by two species, other genera – by only one species.

Plant species which comprise the special regional floras, in most cases have areas going beyond certain region and occupy vast territories up to Holarctic area (Tolmachev, 1974). In areorgraphic spectrum of orchids in the reserves of Transbaikalia we selected 6 groups (Fig. 2).

1) Eurasian – 10 species (*Cypripedium calceolus, C. macranthon, Dactylorhiza incarnata, Neottianthe cucullata, Orchis militaris, Herminium monorchis, Gymnadenia conopsea, Epipactis helleborine, Epipogium aphyllum, Listera ovata*);

2) Holarctic – 7 species (*Cypripedium guttattum, Coeloglossum viride, Listera cordata, Goodyera repens, Malaxis monophyllos, Corallorhiza trifida, Calypso bulbosa*);

3) Euro-Siberian – 2 species (*Dactylorhiza cruenta, D. fuchsii*);

4) Caucasian-Asia-Minor-Siberian – 1 species (*Platanthera bifolia*);

5) Eastern-European-Siberian-Far Eastern – 1 species (*Spiranthes amoena*);

6) Far Eastern – 1 species (*Neottia camtschatea*).

Most orchids have wide habitat areas: Eurasian (10 species), Holarctic (7 species), European-Siberian (2 species). The rest of the species is attached mostly to the territory of Asia: they are Eastern-Siberian, Far Eastern and Far Eastern species (1 species in each).

Table 3. Orchid species that grow on the territory of Dzherginsky Reserve. The list is compiled on the basis of numerous works (Red Data Book of Russian Federation, 2008; Red Data Book of Buryatia …, 2013; Budaeva, 2020; Chronicle of nature, 2017; Elaev et al., 2000).

Latin names of species	Red Data Book of the Republic of Buryatia (2013)	Red Data Book of the Russian Federation (2008)
Calypso bulbosa (L.) Oakes	3 (NT)	3 (NT)
Cypripedium calceolus L.	3 (NT)	3 (NT)
Cypripedium guttatum Sw.	3 (NT)	
C. macranthon Sw.	3 (NT)	3 (NT)
Epipogium aphyllum Sw.	2 (VU)	2 (VU)
Goodyera repens (L.) R. Br.		
Gymnadenia conopsea (L.) R. Br.		
Neottia camtschatea (L.) Reichenb. fil.	3 (NT)	
Neottianthe cucullata (L.) Schlecht	7	3 (NT)
Spiranthes amoena (Bieb.) Sprengel		

Table 4. Orchid species that grow on the territory of Barguzinsky Reserve. The list is compiled on the basis of numerous works (Red Data Book of Russian Federation, 2008; Red Data Book of Buryatia …, 2013; Chronicle of nature, 2018; Troitskaya, Fedorova, 1989).

Latin names of species	Red Data Book of the Republic of Buryatia (2013)	Red Data Book of the Russian Federation (2008)
Calypso bulbosa (L.) Oakes	3 (NT)	3 (NT)
Cypripedium calceolus L.	3 (NT)	3 (NT)
Cypripedium guttatum Sw.	3 (NT)	
C. macranthon Sw.	3 (NT)	3 (NT)
Dactylorhiza cruenta (O.F. Mull.) Soó		
D. fuchsii (Druce) Soó		
Epipactis helleborine (L.) Crantz	3 (NT)	
Epipogium aphyllum Sw.	2 (VU)	2 (VU)
Goodyera repens (L.) R. Br.		
Gymnadenia conopsea (L.) R. Br.		
Listera cordata (L.) R. Br.	3 (NT)	
Platanthera bifolia (L.) Rich.	3 (NT)	

According to phytocenotic preference of orchids (Fig. 3), we selected the following groups of species in the reserves of Transbaikalia:

1. Forest: *Cypripedium calceolus, C. guttatum, C. macranthon, Platanthera bifolia, Listeraovata, L. cordata, Neottianthe cucullata, Corallorhiza trifida, Calypso bulbosa, Goodyera repens, Epipactis helleborine, Epipogium aphyllum, Neottia camtschatea* (13 species);

2. Forest-meadow: *Coeloglossum viride* (1 species);

3. Meadow: *Dactylorhiza incarnata, D. cruenta* (2 species);

4. Meadow-forest: *Dactylorhiza fuchsii, Herminium monorchis, Gymnadenia conopsea, Malaxis monophyllos* (4 species);

5. Meadow-wetland: *Spiranthes amoena, Orchis militaris* (2 species).

This division into groups is conditional because many orchids have wide ecological amplitude

and could be met in various habitats.

Table 5. Summary table of orchids' presence in the reserves.

Latin names of species	Baikal Reserve	Dzherginsky Reserve	Barguzinsky Reserve
Calypso bulbosa	+	+	+
Coeloglossum viride	+		
Corallorhiza trifida	+		
Cypripedium calceolus		+	+
C. guttatum	+	+	+
C. macranthon	+	+	+
Dactylorhiza cruenta	+		+
D. fuchsii	+		+
D. incarnata	+		
Epipactis helleborine	+		+
Epipogium aphyllum		+	+
Goodyera repens	+	+	+
Gymnadenia conopsea	+	+	+
Herminium monorchis	+		
Listera cordata	+		+
L. ovata	+		
Malaxis monophyllos	+		
Neottia camtschatea		+	
Neottianthe cucullata	+	+	
Orchis militaris	+		
Platanthera bifolia	+		+
Spiranthes amoena	+	+	

As could be seen on the diagrams the highest number of orchid species belong to forest group – 13 species, the second place – meadow-forest species – 4, then the other typesof meadow group: meadow and meadow-wetland – 2 species each. Only 1 species belong to forest-tundra group.

Predominance of the forest group of species is conditioned by natural conditions of the Transbaikalia region in particular by predominance and variety of forest habitats. Some species of orchids are integral components of forest phytocenoses.

As species of narrow ecological amplitude we can mention *Calypso bulbosa, Neottianthe cucullata, Listera ovata, L. cordata,* as well as the forest bryophil *Epipogium aphyllum.* These species are very specific, their rare occurrence is conditioned not only by features of biology and ecology, but by destruction of their natural habitats and by degradation of communities as the result of anthropogenic activity (forest cutting, wetland drying, road construction, grazing and cattle driving, recreation load; Red Data Book …, 2008).

The typical forest species are *Calypso bulbosa, Epipactis helleborine, Neottianthe cucullata, Epipogium aphyllum, Goodyera repens.* To forest group of species belong the representatives of genera *Cypripedium* (*Cypripedium calceolus, C. guttatum, C. macranthon*). The species *Cypripedium calceolus* could be met mostly in mixed forests. *Cypripedium macranthon* could be met not only in the various types of forests but on the wetlands as well and in birch forests.

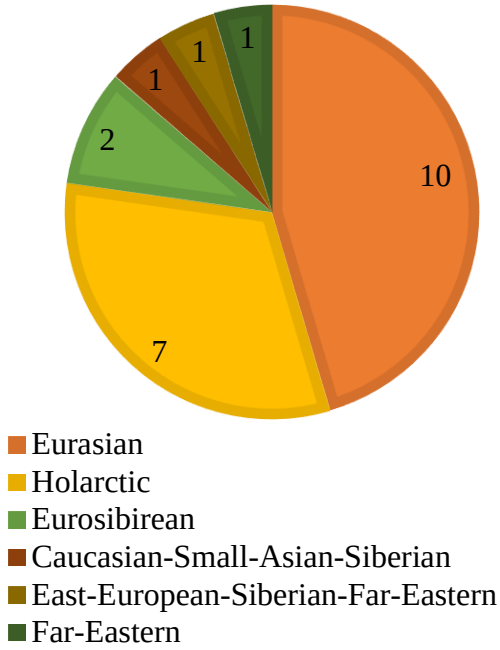

Fig. 2. Areographic groups of orchids in the reserves of Transbaikalia Region.

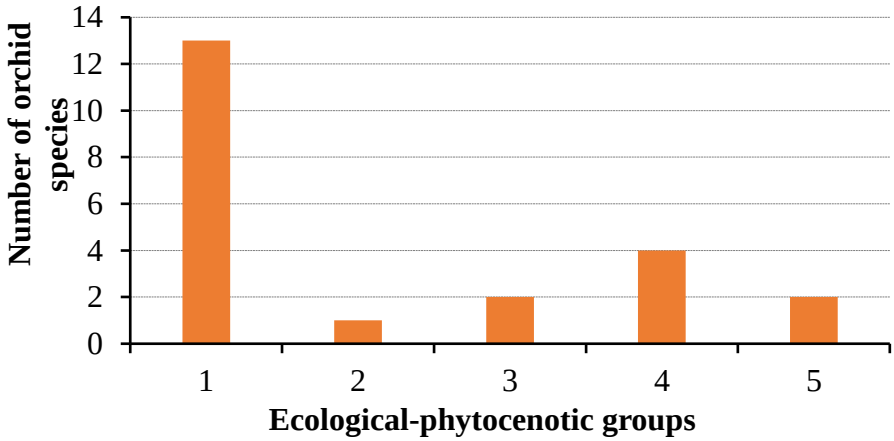

Fig. 3. Phytocenotic spectrum of orchids that grow in the reserves of Transbaikalia. *Legend:* 1 – forest, 2 – forest-tundra, 3 – meadow, 4 – meadow-forest, 5 – meadow-wetland.

Cypripedium guttatum is attached to different types of communities: birch-larch forests, forest margins, bush thickets, wetland meadows and birch forests. *Corallorhiza trifida* is mentioned mostly for wet mixed forests, birch-larch forests, along river banks, but sometimes could be met on the bogs, wet meadows and in the bush thickets.

The species *Coeloglossum viridis* is selected into the separate group. This species grows in the coniferous and mixed forest as well as in the lichen tundra.

Some species of the *Dactylorhiza* genus are attached to the meadow communities. They could be met on the wetland meadows - *Dactylorhiza salina. Dactylorhiza incarnate* и *D. Umbrosa* and in the sparse spruce forests as well.

Meadow-forest species we selected in a separate group: *Dactylorhiza meyeri, D. fuchsii, Herminium monorchis, Gymnadenia conopsea, Malaxis monophyllos*. These species could be met in spruce forests, on the wetland meadows, on sedge-herbaceous meadows as well as in the sparse

forests and on the forest glades, in the mixed and birch-larch forests.

We referred two species to meadow-wetland group: *Spiranthe samoena* и *Orhis militaris. Spiranthe samoena* grows on peat bogs and on the sedge-herbaceous meadows. *Orhis militaris* grows mostly on the herbaceous meadows on the bogs, but could be met on the forest glades, on the edges of bogs, close to creeks and on the meadows in the forests. (Abramova, Volkova, 2011; Elaev et al., 2000; Troitskaya, Fedorova, 1989; Vakhrameeva et al., 2014; Kazazaeva, 2009).

Methods used for research work of cenopopulations are described above.

In Barguzinsky reserve we studied five cenopopulations of *Cypripedium* genera during the practice works (2020 year), one cenopopulation has been described in Dzherginsky reserve according to literature data (Kazazaeva, 2009) and some data has been received from the Chronicle of Nature of the Reserve (Budaev, 2020). In Baikal reserve we collected some data that has been provided by research associate N.S. Gamova. On the territories of Baikal and Dzherginsky reserves monitoring of cenopopulations structure is not provided and there is not enough data.

Three species of *Cypripedium* genera grow in Barguzinsky reserve. Monitoring of *C. Guttatum* (and white-flower representatives of this species) is provided on the sites (10x10 meters): in the valley of the river South Birikan, in the valley of the river Bolshaya and on the cape Nemnianda. The rest two species *C. macranthon* and *C. Calceolus* were studied on the same site in the valley of the river Southern Birikan.

The permanent monitoring site of *Cypripedium macranthon* is situated in the rare pine-spruce-herbaceous forest. The patch is cluttered with dead wood, dead grass. The grass layer density is 15-25%. There is no moss-lichen layer.

The population of *Cypripedium calceolus*in the reserve is small in number. Association in the valley of the river Southern Birikan is pine-Siberian cedar-herbaceous. The grass layer density is 20-30%, the projective coverage of moss and lichens – 30%.

The population of *Cypripedium guttatum* is most numerous in the valley of the river Bolshaya, in the spruce forest. In the valley of the river Davsha (Nemnianda cape) we selected the Siberian cedar-blueberry-moss association. The grass layer density is 50%, the projective coverage of moss and lichens – 80%.

The principal population indices that reflect the structure of cenopopulation are given in the tables and in diagrams in the figures (Fig. 4-9), metrical data is given in the table 6.

Population of *Cypripedium guttatum* is one of the most numerous out of rare and vulnerable plant species of Barguzinsky reserve. Monitoring of *C. Guttatum* is provided on three sites (that had been described above). The total number of individuals is 138. In the valley of the river Southern Birikan only immature plants grow (Fig. 4). On the cape Nemnianda the generative and immature plants are equally in number and 4 virginal plants are mentioned (Fig. 5). In the valley of the river Boshaya the site for monitoring of *C. guttatum* with white flowers has been established among which the immature and generative individuals are mentioned (Fig. 6). The highest density of population is mentioned along the paths, where the competition with other species is weak. The age index of *Cypripedium guttatum* cenopopulation in the valley of the river Southern Birikan is 0.05 with right-hand spectrum; 0.28 with two-vertex spectrum on the cape Nemnianda; and 0.22 with two-vertex spectrum in the valley of the river Bolshaya. Thus, the cenopopulation in the valley of the river Southern Birikan is characterized as “teenage”, while the other two are young (the color scale is given for visibility).

The total number of individuals in cenopopulation of *C. macranthon* is 10. Under sufficient moistening and illumination level and no competition from other plants in the herbaceous layer the favorable conditions for development of young plants are being created. (Fig. 4). The age index of *Cypripedium guttatum* in the valley of the river Southern Birikan is 0.18. The type of its population is growing up with left-hand age spectrum.

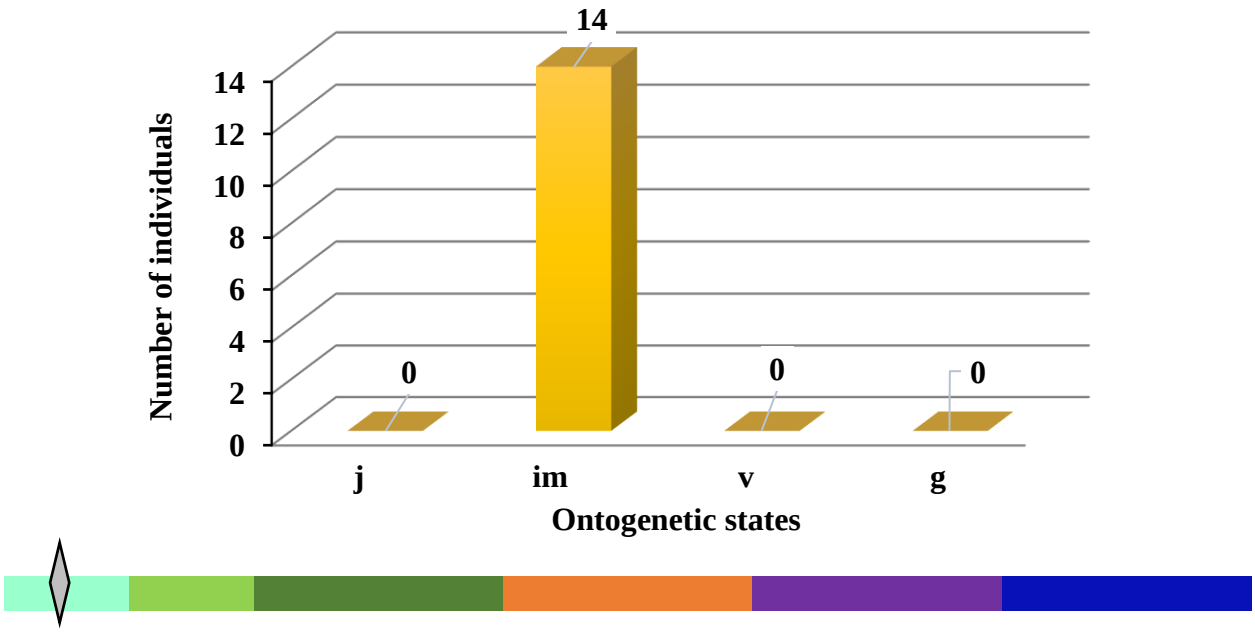

Fig. 4. Ontogenetic spectrum of *Cypripedium guttatum* cenopopulation (valley of the river Southern Birican) in 2020. At the bottom of the picture hereinafter the badge shows the population age weighted average (Table 1).

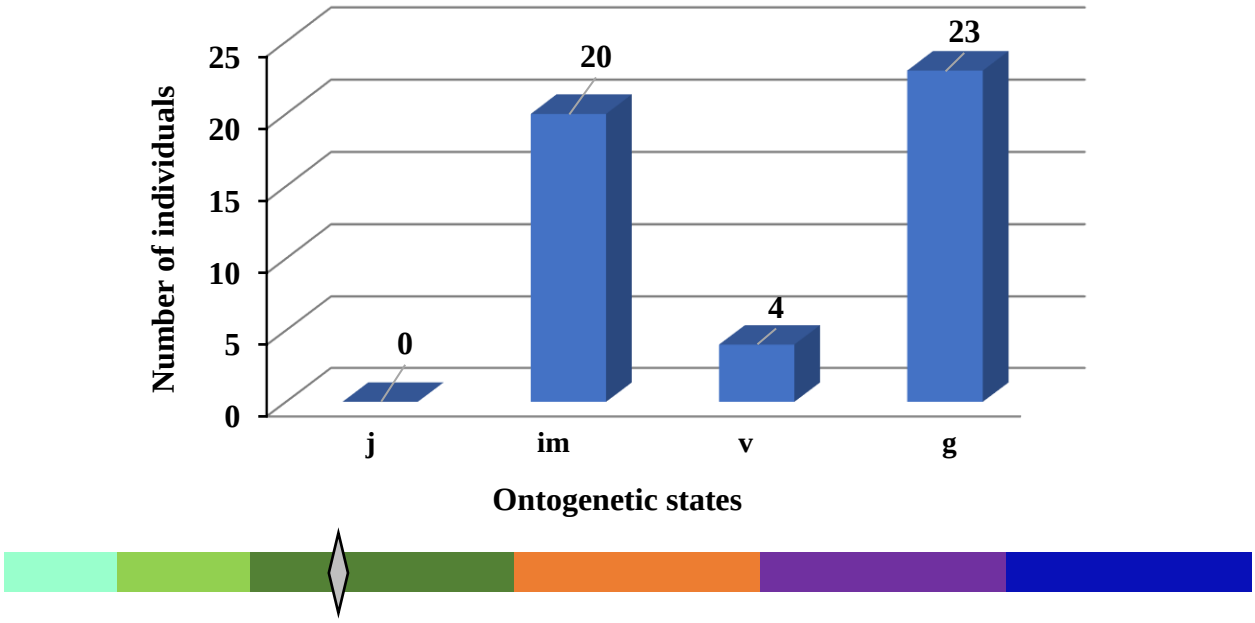

Fig. 5. Ontogenetic spectrum of *Cypripedium guttatum* cenopopulation (cape Nemnianda) in 2020.

The population size of *C. calceolus* is very high and composes of 6 individuals. In the onthogenetic spectrum the virginal individuals prevail (Fig. 8). The age index of *C. calceolus* in the valley of the river Southern Birikan is 0.16, which is typical for growing up cenopopulation. Cenopopulation is with right-hand age spectrum.

Thus, basing on the age index in Barguzinsky reserve, the growing up and young individuals in the cenopopulations of *Cypripedium* prevail. Meanwhile, in all cenopopulations we can see the age inequality of individuals. The individuals of plants in one age or one age state make up an age group. Distribution of individuals in the age groups promotes to stability of species in the

phytocenoses because for each group the individual ecological niche is typical and their own specific links with the habitat conditions.

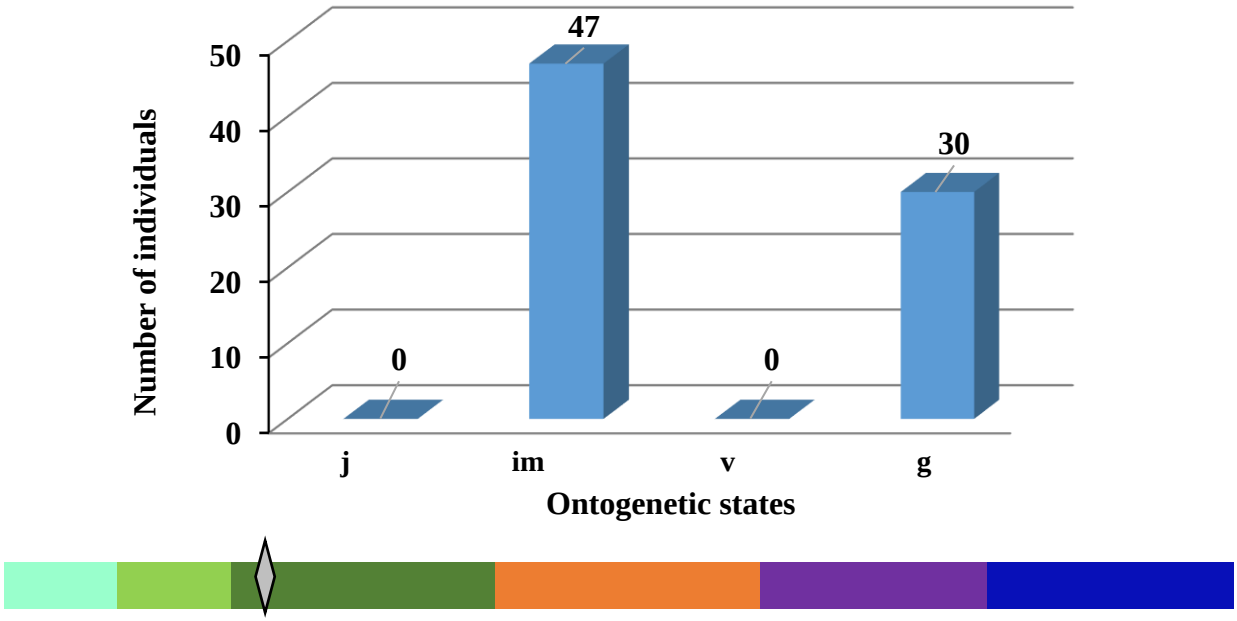

Fig. 6. Ontogenetic spectrum of *Cypripedium guttatum f. albiflora* cenopopulation (valley of the river Bolshaya) in 2020.

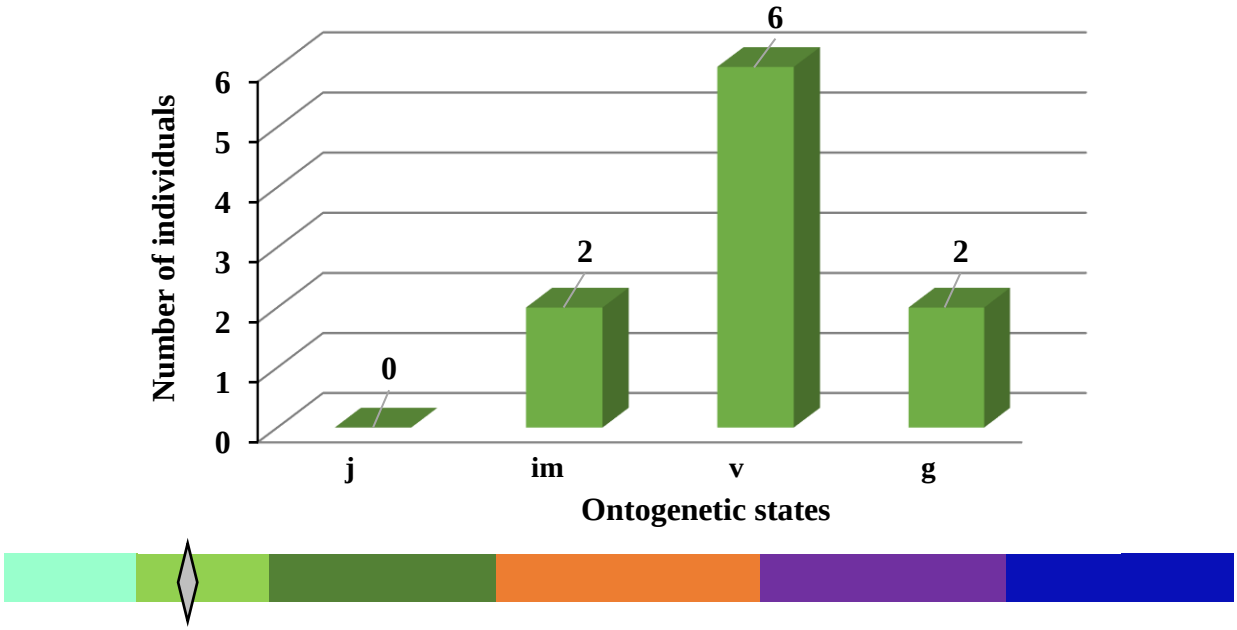

Fig. 7. Ontogenetic spectrum of *Cypripedium macranthon* cenopopulation (valley of the river Southern Birican) in 2020.

Among onthogenetic spectra (ratio of plants of different age groups) the most frequent are right-hand and two-vertex spectra which shows that almost all cenopopulations have the majority of mature individuals (v,g) than young (j, im).

In Dzherginsky reserve we studied only one cenopopulation of *Cypripedium guttatum*, in the

valley of lower current of the Jerga river in the mixed herbaceous forest (larch-birch forest with pine tree and aspen), orchids-strawberry-sedge-herbaceous phytocenosis (Kazazaeva, 2009).

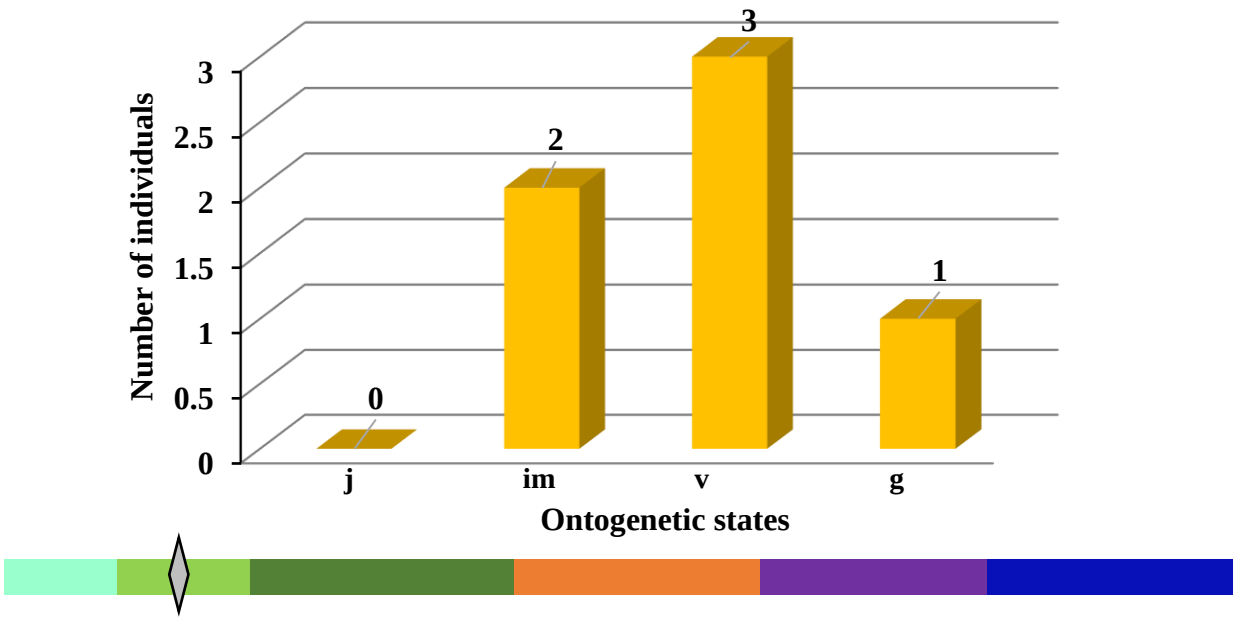

Fig. 8. Ontogenetic spectrum of *Cypripedium calceolus* cenopopulation (valley of the river Southern Birican) in 2020.

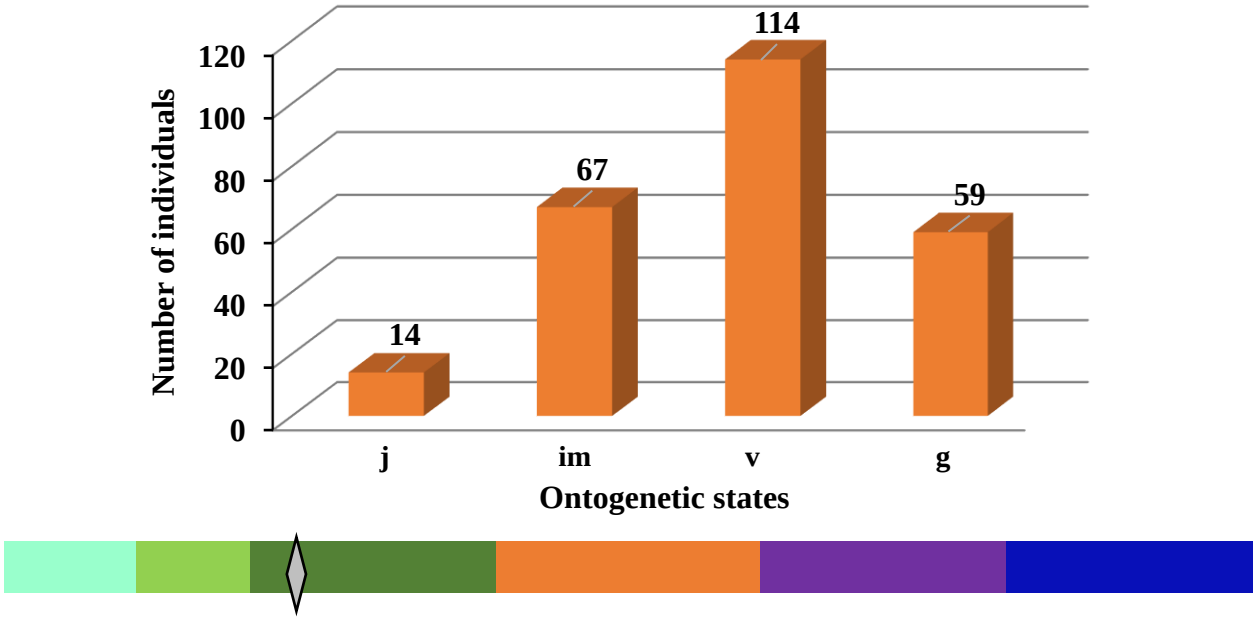

Fig. 9. Ontogenetic spectrum of *Cypripedium guttatum* cenopopulation (valley of the river Jirga) in 2020.

The total number of individuals in cenopopulation is 254. The average density is 2.54 individuals per 1 m^2. The territory of cenopopulation is 8.75 m^2. Cenopopulation has right-hand spectrum (Fig 9), maximum belongs to virginal individuals. Age index is 0.23. So it could be characterized as young, but the mature individuals prevail in it.

Thus, the cenopopulation has right-hand spectrum with domination of virginal and generative individuals. This type of the age spectrum is considered to be optimal for orchids (Tatarenko, 1996).

Table 6. Morphometric parameters of the age studies of orchids from *Cypripedium* genera in the Barguzinsky Reserve.

Latin names of species	Age state	Plant height, cm	Leaf width, cm	Leaf length, cm	Number of ribs	Flower (yes/no)
Cypripedium macranthon	im	10-12	1.8-2.1	4.8-7	4-7	-
	v	21-26	5-6	9.5-12	7	-
	g	31-35	6-7	10-14	9-11	+
Cypripedium guttatum	im	1.8-5.7	2-5.5	4.7-9	5-7	-
	g	7-24	3.9-6.5	7.3-12	8-9	+
Cypripedium calceolus	im	1.3-2.2	1.8-3.5	7-8	5-7	-
	v	2.5-3.1	3-5.8	8-9.5	6-10	-
	g	5-10	5.6-14	8.8-11	9-12	+

In Baikal reserve we mentioned only one from two species of orchids that grow here- *Cypripedium guttatum* (other species we did not search specially and did not find accidentally). We mentioned three localities of this species on the southern slope of Khamar-Daban ridge; two of them were at the foot of the ridge in the Temnik river valley, on the river terraces in the light-coniferous-birch herbaceous forests with *Rhododendron dauricum* (850-900 m), and the third one was in the loach belt on the border of tundra belt (1700 m). In all cases the cenopopulations are small in territory. The first one has 100 individuals on the territory of 2 m^2, and about 10 flowering individuals (according to observations of N.S. Gamova in 2013). The number of individuals in the second cenopopulation in the valley of the Temnik river – about 80 plants, 3 of them are flowering, territory is 1 km^2 (according to observations of N.S. Gamova in 2019). The number of individuals in the third cenopopulation in the loach belt is about 10 plants on the territory of 3 m^2, 2 of them are faded (according to observations of N.S. Gamova in 2015). There is no information about the age state.

The data received indicate a successful state and development of almost all studied populations of *Cypripedium* genus on the territory of reserves, conditioned by their biological features and special species strategy. Species of *Cypripedium* genus are characterized by intensive vegetative reproduction that conditions the stable life of their cenopopulations (Tatarenko, 1996). The exception is population of *Cypripedium calceolus* on the territory of Brguzinskiy reserve: the low vitality of individuals and low population density say about vulnerability of species on the Barguzinsky ridge (Bukharova, 2011).

Summingup the above the studying of orchids cenopopulations on the territory of the specially protected natural areas gives the real idea of life and state of studied species because of absence of anthropogenic load. The study of cenopopulations can be used as “model forms” for further study of biology and ecology of species.

Morphometric features reflect the dimensional characteristics of individuals that changes in time and space (in different ecological-geographical conditions and under different regime of communities’ exploitation; Bichenko, 1999). That is why comparison of morphological parameters of different regions is useful because it gives the chance to find the ecological optimum of species (Table 7).

In this table we compared the morphological features of Transbaikalia orchids with the same features of orchids in European Russia – Arkhangelskaya (Puchnina, 2017) and Moskovskaya regions (Chronicles of nature, 2017), and also with Cheliabinskaya region (Lesina, 2011).

For excluding of anthropogenic impact during comparison we took the data form other regions from reservoirs as well: Pinegskiy (Arkhangelskaya region), Prioksko-Terrasniy (Moscow region) and Ilmenskiy (Chelyabinskiy region).

Table 7. Comparison of morphological features of some orchid species in different regions of Russia.

Latin names of species	Feature	European part of Russia (Chronicles of Nature, 2017; Puchnina, 2017				Chelyabinsk region (Lesina, 2011)				Transbaikalia			
		Age groups											
		j	im	v	g	j	im	v	g	j	im	v	g
C. calceolus	Shoot height, cm	1.4-5.2	7-10.3	17-20.1	28-43	3.9-4.1	9.8-10.2	26.4-27.6	43	–	1.3-2.2	2.5-3.1	5-10
	Leaf length, cm	4.9-6.5	7.2-11	7-11	10-16	3.1-3.3	6.3-6.7	9.6-10.3	13.8	–	7-8	8-9.5	8.8-11
	Leaf width, cm	2.9-4.7	4.9-6.3	4.6-6.3	6-9	0.9-1.1	2.9-3.1	5.5-5.9	7.4	–	1.8-3.5	3-5.8	5.6-14
	Number of ribs	4	5-6	10-11	12-13	3	6	12	15	–	5-7	6-10	9-12
C. guttatum	Shoot height, cm	–	–	–	–	3.1-3.3	6.8-7.2	8.6-9.4	24	–	1.8-5.7	–	7-24
	Leaf length, cm	–	–	–	–	2.7-2.9	4.2-4.4	9.6-10.3	10.5	–	4.7-9	–	7.3-12
	Leaf width, cm	–	–	–	–	1.1-1.3	2.4-2.6	5.8-6.2	6.5	–	2-5.5	–	3.9-6.5
	Number of ribs	–	–	–	–	3	7	15	16	–	5-7	–	8-9
C. macranthon	Shoot height, cm	–	–	–	–	3.9-4.1	8.9-9.1	30.6-31.4	36	–	10-12	21-26	31-35
	Leaf length, cm	–	–	–	–	2.7-2.9	5.8-6.4	8.8-9.4	17	–	4.8-7	9.5-12	10-14
	Leaf width, cm	–	–	–	–	1.1-1.3	3.1-3.3	6.1-6.5	9.5	–	1.8-2.1	5-6	6-7
	Number of ribs	–	–	–	–	3	7	12	15	–	4-7	7	9-11

For comparison of morphological features we took into consideration the natural-climatic conditions of the regions. As could be seen in the Table 4, the morphological features of model orchid species differ from the same features in other regions of Russian Federation. Similarity is mentioned for the number of leaves veins while difference – the length and width of leaves and the height of generative shoot.

Table 7 continuation.

Latin names of species	Feature	European part of Russia (Chronicles of Nature, 2017; Puchnina, 2017				Chelyabinsk region (Lesina, 2011)				Transbaikalia			
		Age groups											
		j	im	v	g	j	im	v	g	j	im	v	g
Platanthera bifolia	Shoot height, cm	–	–	–	–	2.6-2.8	4.1-4.3	11.8-12.2	34	–	–	–	32-32.6
	Leaf length, cm	5-6	8-10	8-12	8-12	2.5-2.9	4.1-4.3	11.9-12.1	10.7	–	6.2-10.4	6.6-12.3	9.2-10.3
	Leaf width, cm	0.3-0.6	1-1.5	2-2.5	2.5-3.5	0.3-0.5	1.5-1.7	3.7-3.9	4.2	–	1.2-2.4	1.8-3.5	1.3-3.1
	Number of ribs	–	6	9-11	12	3	5	9	12	–	7	8-14	7-11
Calypso bulbosa	Shoot height, cm	–	–	–	13.9-14.1	–	–	–	–	–	–	–	6.5-16.1
	Leaf length, cm	0.9-2.1	1.9-2.3	3.1-4.1	4-4.2	–	–	–	–	–	2.2-2.5	2.2-4.1	2.2-4.2
	Leaf width, cm	0.4-0.8	0.9-1.2	1.6-2.3	2.1-2.5	–	–	–	–	–	1-1.4	1.3-2.7	1.1-2.8
	Number of ribs	–	–	–	–	–	–	–	–	–	4	5-7	5-8

Comparing the data of cenopopulation of orchids in Republic of Altay and Irkutsk Region, we mentioned the similarity of morphometric parameters that could be connected with the similar climatic conditions of those territories.

Analyzing the age groups in the regions (Table 8) we can say that onthogenetic structure of cenopopulations under consideration correlates with the basic age spectra typical for other parts of the species areas. Everywhere the mature individuals of plants prevail (v-g) while juvenile are almost absent.

Taking into consideration other data on the orchid cenopopulations in Altay Republic (Gerasimovich, 2004) and Irkutsk region (Vinogradova, 1991) we can mention the similarity of morphometric parameters that can be explained by similar natural-climatic conditions on those territories.

Presumably the species of *Cypripedium* genera have their ecological optimum in the region of South Siberia mountains (in Altay in particular) where they have the high number of individuals optimal ratio of the age groups for population development and prefer the deciduous and mixed forests and river valleys.

In the Urals and in Siberia meet the areas of western, mostly European species and Asian species. Besides here the relict patches of areas of some species survived which do not have the continuous areas in European Russia.

Analysis of distribution of orchid species on the territory and of inventory maps (Fig. 10-12) shows that orchid species on the territory of Transbaikalia reserves could be met almost everywhere

along the river valleys with sufficient moistening; some of them could be met on the slopes of Hamar-Daban (altitude above sea level of the Baltic system up to 1,744 m).

Table 8. Distribution of cenopopulations in different regions of Russia, according to onthogenetic groups.

Latin names of species	Cenopopulation in Arkhangelsk region, 2016 (j/im/v/g)	Cenopopulation in Moscow region, 2017 (j/im/v/g)	Cenopopulation in Chelyabinsk region (j/im/v/g)	Cenopopulation in Transbaikalia region (j/im/v/g)
C. calceolus	0/2/63/137 (v-g)	0/1/1/6 (g)	1/17/5/34 (v-g)	0/2/3/1 (v)
	9/78/16/48 (im-v)	0/2/7/5 (v-g)		
C. guttatum	–	–	0/10/124/64 (v-g)	0/14/0/0 (im)
			0/12/72/87 (v-g)	0/20/4/23 (v-g)
			0/1/17/15 (v-g)	0/47/0/30 (im.g)
				14/67/114/59 (v-g)
C. macranthon	–	–	0/2/3/6 (v-g)	0/2/6/2
Platanthera bifolia	–	0/1/2/2 (v-g)	0/0/3/3 (v-g)	0/4/6/2 (v-g)
Calypso bulbosa	1/13/20/24 (v-g)	–	–	0/2/38/11 (v-g)

The distribution of orchids is attached to the places with high moistening (valleys of streams and rivers). Ecological- phytocenological features of orchids also play important role in their distribution. There is the group of species which occupy the wide spectrum of ecotopes *(Cypripedium guttatum, Corallorhiza trifida, Malaxis monophyllos)*, that shows their good competitiveness in contrast to the species attached to narrow spectrum of ecotopes *(Listera cordata, L. ovata, Epipogium aphyllum)*, with weak competitiveness. It is possible that such variety of orchids (22 species) in the reserves of Transbaikalia corresponds to the differences in the territory ecology that promoted to the distribution of stenobionts as well as eurybionts.

It should be noted that the places of maximum density of orchids are characterized by the high differentiation of habitat conditions favorable for their growing which is also one of the reason of the orchids biodiversity (Tolmachev, 1974).

Here we present the sketch maps of the specie included in the Red Data Book distribution in each of three reserves (Fig. 10-12). We showed the populations of species as points on the map but sometimes we showed the separate findings of species. For example, in the protection zone of Baikal reserve (out of the main boundary of reserve) in the surroundings of visit center in 2020 the flowering individual of *Orchis militaris* has been found which is shown on the map. *Neottianthe cucullata* close to the eastern boundary of Baikal reserve is represented by one individual as well. In other reserves there are no such separate findings of species, only populations: very small (7-10 individuals) or numerous (up to 250 individuals).

In Barguzinsky reserve the sites with species *Platanthera bifolia, Calypso bulbosa, Cypripedium calceolus, C. guttatum* and *C. macranthon* coincide with the areas of their monitoring.

After analyzing of these sketch maps we selected the following groups of the species included in the Red Data Book (Table 9).

As we mentioned above the majority of species are attached to the river valleys and it refers not only to the piedmont group, but to all groups in the mountains.

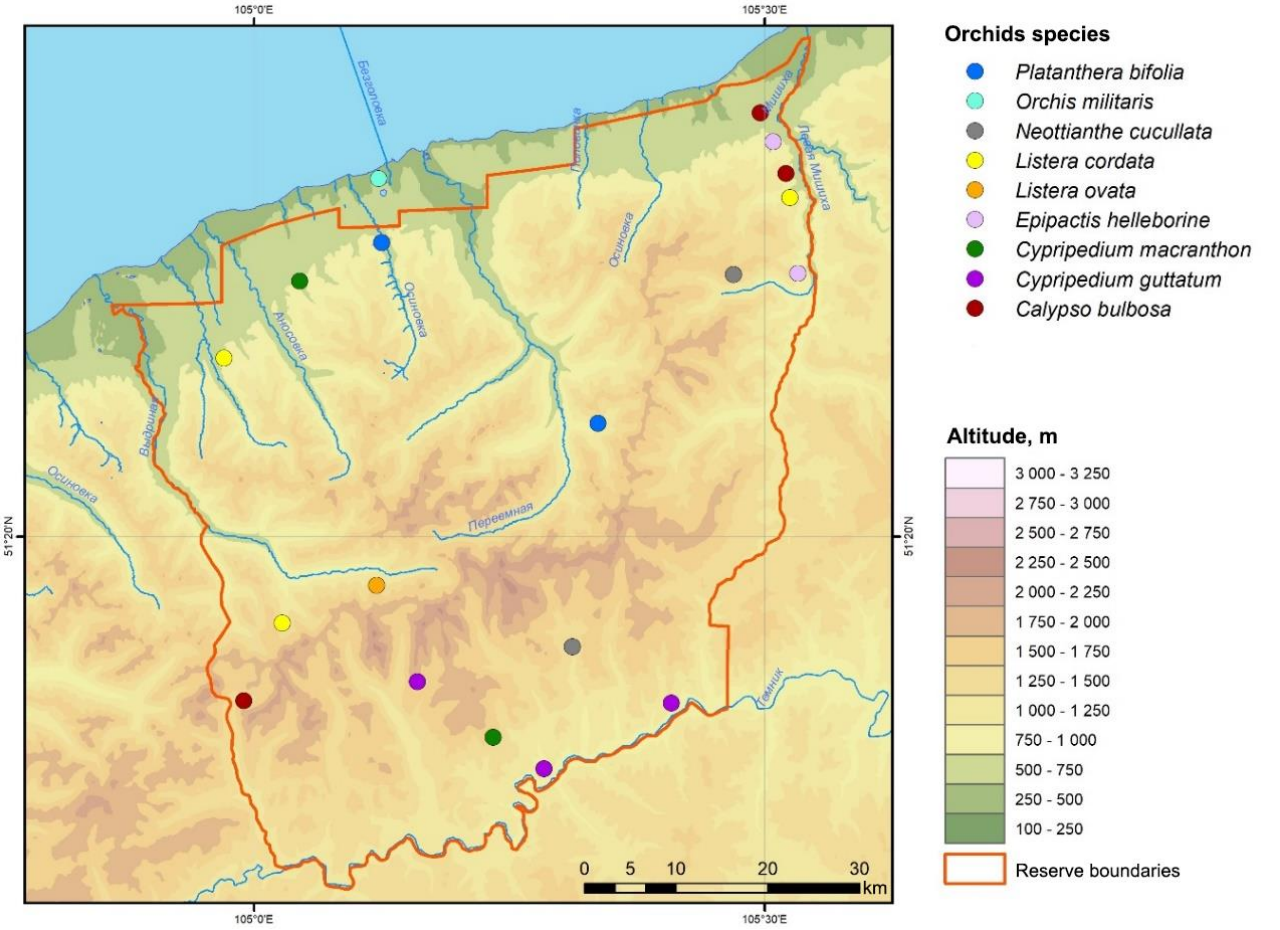

Fig. 10. Schematic map of the protected orchid species findings distribution on the territory of Baikal reserve, compiled on the basis of numerous works (Abramova, Volkova, 2011; Gamova, Krasnopevtseva, 2013; Gamova, Dudov, 2018; Kitaev et al., 2019; Chronicles of Nature, 2017).

In the Baikal reserve several species are not attached to the river valleys and are attached to the slopes of Hamar-Daban (*Cypripedium guttatum*, *C. macranthon*, *Neottianthe cucullata*), where orchids grow in the upper belt of the dark coniferous forest (1100-1700 m altitude above sea level of the Baltic System).

The species of *Dactylorhiza* genera (*D. fuchsii*, *D. incarnata* and *D. cruenta*) could be met higher than the upper border of the forest on the subalpine meadows as well as on the wetlands of the river terraces of the northern and southern macro-slopes. *Gymnadenia conopsea* is also distributed on the subalpine and alpine meadows of the northern macro-slope. The rest species could be met on the river terraces – in the light coniferous forests, in the valley poplar-tree forests, on the wetland riparian meadows on the elevations of 1200-1400 m altitude above sea level of the Baltic system.

In Bargusinskiy and Dzherginsky reserves all species are attached to big rivers. In the first one they were found in the dark spruce and fir tree forests, as well as on the herbaceous meadows along the river banks; in the second one they inhabited the light coniferous (fir and pine tree) and mixed forests. It is possible that *Cypripedium guttatum*, *Listera cordata*, *Epipactis helleborine* and species of *Dactylorhiza* genera can be found in the alpine meadows higher in the mountains.

To clarify the distribution of these and other species, the additional researches are required to be carried out in the reserves, including the monitoring of the population of orchid species.

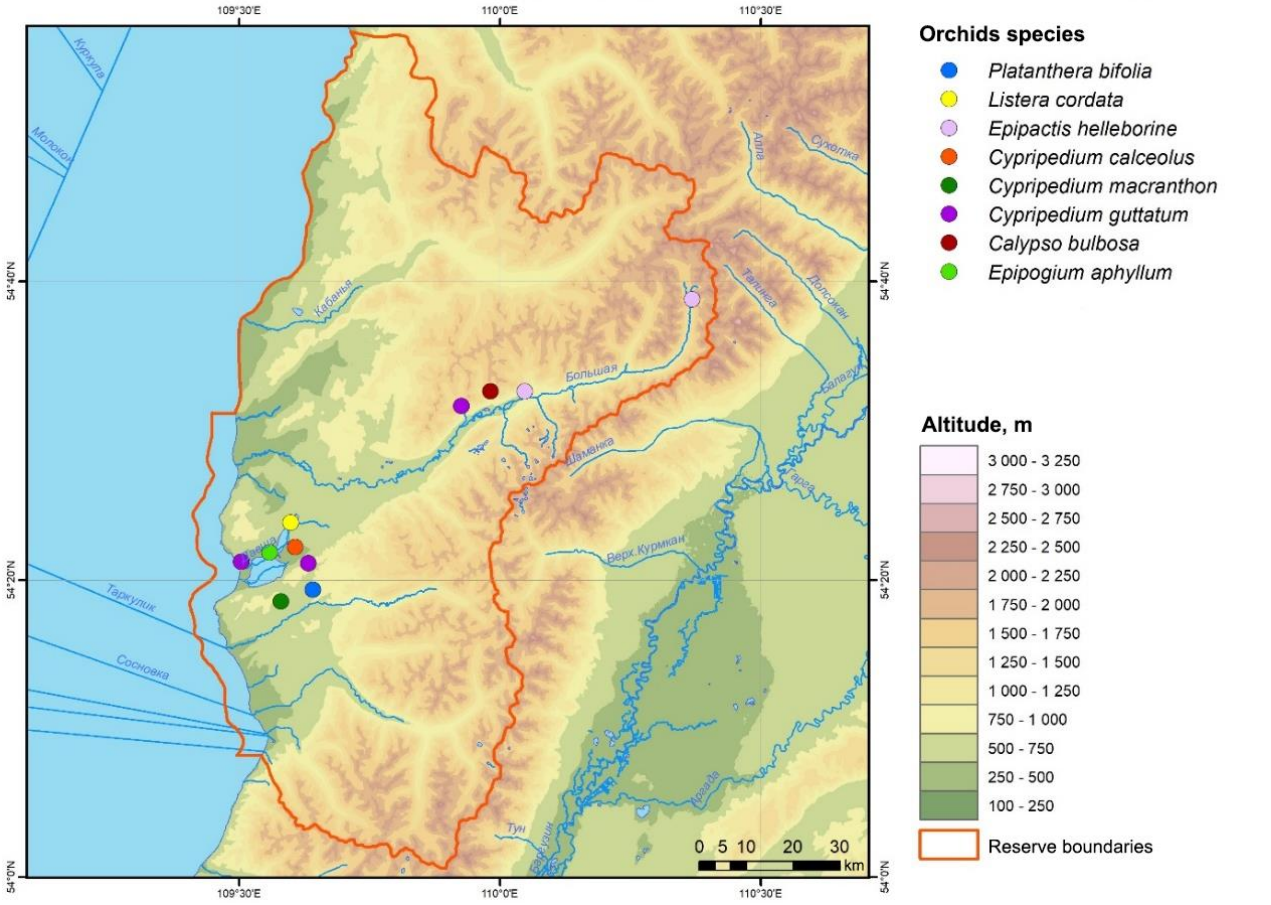

Fig. 11. Schematic map of the protected orchid species findings distribution on the territory of Bargusinskiy reserve, compiled on the basis of numerous works (Ananin, Ananina, 2018; Chronicles of Nature, 2017; Buharova, 2011; Troitskaya, Fedorova, 1989).

Conclusions

1. By now we found 22 species of orchids on the territory of reserves in Transbaikalia that belong to 17 genera: 19 species in Baikal Reserve, 12 species in Barguzinsky Reserve, and 10 species in Dzherginsky Reserve. Most of them are included into the regional and federal Red Data Books.

2. Considering areographic spectrum, we found out that Eurasian, Holarctic and Eurasian-Siberian groups prevail. In phytocenotic groups we selected 5 groups: forest (13 species), forest-tundra (1 species), meadow (2 species), meadow-forest (4 species) and meadow-wetland (2 species).

3. The state of 6 cenopopulations of *Cypripedium* genera under consideration proves their successful development. It is supported by prevalence of virginal and generative individuals and, as a consequence, their right-handed onthogenetic spectra. The exception is the population of *Cypripedium calceolus* in Barguzinsky Reserve, which features are low number of individuals and low density. This shows the vulnerability of this species on the Barguzinsky Ridge.

4. Morphometric features of the model species of orchids differ from those in the other regions of Russian Federation. Similar is the number of plant veins, and different are the length and width of leaves blades and the height of plants. When analyzing the age spectra of orchids in the other regions we marked the correspondence of cenopopulations in Transbaikalia to the age spectra typical for the other parts of areas: everywhere the mature individuals prevail (v, g) while juvenile

individuals are not met.

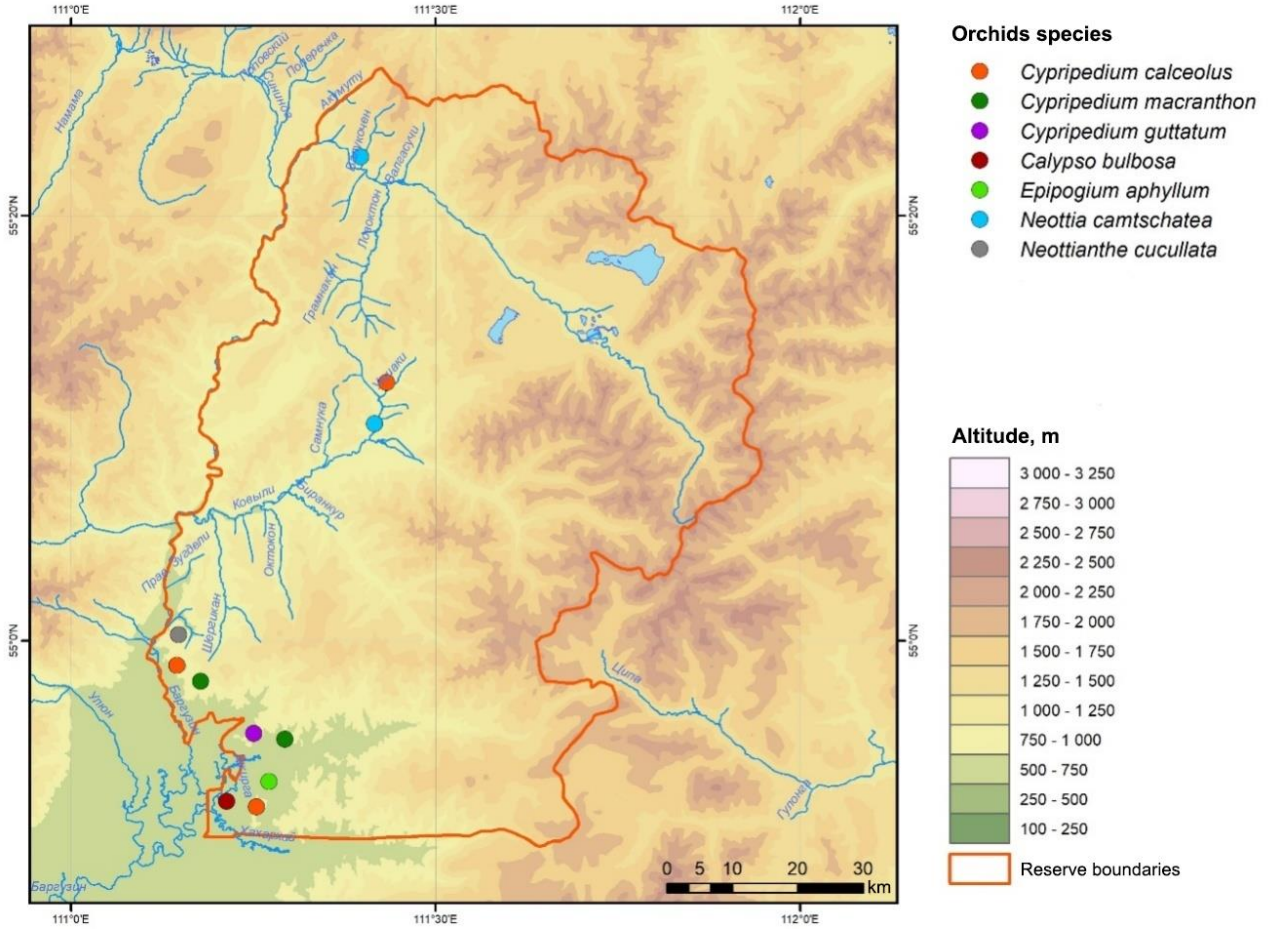

Fig. 12. Schematic map of the protected orchid species findings distribution on the territory of Dzherginsky reserve, compiled on the basis of numerous works (Budaeva, 2020; Chronicles of Nature, 2017; Elaev et al., 2020).

Table 9. Altitudinal groups of protected orchid species.

No.	Altitudinal range (m, above sea level of the Baltic System)	Species met within certain range	Number of sites on the map
1	450-800	*Cypripedium macranthon, C. guttatum, C. calceolus. Listera cordata, Calypso bulbosa, Platanthera bifolia, Epipactis helleborine, Orchis militaris, Epipogium aphyllum, Neottianthe cucullata*	24
2	810-1130	*Listera cordata, Cypripedium guttatum, C. calceolus, Neottianthe cucullata, Calypso bulbosa, Epipactis helleborine, Neottia camtschatea*	9
3	1140-1800	*Calypso bulbosa, Cypripedium macranthon, C. guttatum, Listera ovata, L. cordata, Neottianthe cucullate, Platanthera bifolia, Epipactis helleborine*	9

5. Analysis of sketch maps of the species included in the Red Data Book findings distribution

on the territory of Transbaikalia shows the attachment of the most part of species to the big rivers with sufficient moistening. According to the altitudinal levels the species are distributed into 3 groups, but most of them (*Cypripedium guttatum, Calypso bulbosa, Listera cordata, Epipactis helleborine, Neottia thecucullata*) could be met in all altitudinal groups.

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ЭКОЛОГО-БИОЛОГИЧЕСКИЕ ОСОБЕННОСТИ И РАСПРОСТРАНЕНИЕ ОРХИДНЫХ (*ORCHIDACEAE*) В ЗАПОВЕДНИКАХ ЗАБАЙКАЛЬЯ

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В статье анализируются основные черты ценопопуляций и особенностей распространения видов сем. *Orchidaceae* в Забайкалье. Выявлено видовое разнообразие орхидных и их фитоценотическая приуроченность в заповедниках Забайкалья. Дана характеристика ценопопуляций (на примере рода *Cypripedium*). Состояние шести исследованных ценопопуляций башмачков говорит об их успешном развитии, чему свидетельствует преобладание виргинильных и генеративных особей и, как следствие, правосторонних онтогенетических спектров. Составлены картосхемы высотного распространения орхидных для исследуемой территории. Анализ картосхем распространения видов, занесенных в Красную книгу, по территории заповедников Забайкалья говорит о приуроченности большей части видов к крупным рекам, где имеется достаточное увлажнение.

Ключевые слова: ценопопуляция, фитоценотическая приуроченность, Забайкалье, *Orchidaceae,* высотное распространение.

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