Plants of the calcifilic flora exposition of the N.V. Tsitsin Main Botanical Garden of the Russian Academy of Sciences, listed in the regional Red Data Books of Central Russia

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Abstract. The results of conservation of plants of the exposition of the calciphilous flora of the Main Botanical Garden of the Russian Academy of Sciences, listed in the regional Red Data Books of Central Russia, are shown. For 12 years, in the culture of GBS RAS, in the conditions of Moscow, 118 calciphilous species listed in the regional Red Books, represented by 77 genera from 34 families, were studied. Among them, in terms of introduction resistance, resistant ones prevail - 46% and highly resistant - 35.5%, weakly resistant - 13.5%, unstable - 5%. The main groups according to ecological confinement are considered: obligate (25%) and facultative (75%) calciphilic species. The experiment proved the importance of using special agricultural techniques for the successful adaptation of representatives of this group. In total, an average of 70% of calciphilous taxa of regional protected lists were tested. The representation of calciphilic species in the regional Red Data Books of Central Russia is different and is due to the natural features of the distribution of their classical habitats. In the regions of the Chernozem region, this figure ranges from 55% in the Belgorod region to 24% in the Tambov region. In the Non-Chernozem region: Bryansk, Ryazan, Tula regions, calciphilic species in relation to the total number of protected species also represent a significant part - 25%. For Vladimir, Ivanovo, Kaluga, Kostroma, Smolensk, Tver, Yaroslavl regions and the federal city of Moscow, calciphilic taxa represent an average of 9% of protected lists. The share of calciphilous species of categories: 0, 1, 2 in the regional Red Data Books of Central Russia averages 58%, which indicates a high vulnerability of this group and the need for ex situ study

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1 Introduction

The basic principle of conservation of vulnerable taxa of natural flora implies an appeal to the current lists of protected plants in Red Data Books of various ranks. In this regard, using the example of rare calciphilic species preserved in the GBS collections, we decided for the first time to show the role of this ecological group in the regional Red Data Books of Central Russia. Central Russia or the Central Federal District of the Russian Federation, with a population exceeding 40 million hours and a density of more than 62 people. /km² is the most densely populated and developed macro-region of the Russian Federation, located in the southwestern part of the Russian Plain. It covers 17 regions and one city of federal significance, the total area of which is 650,205 km². The northern part of the territory of Central Russia includes the regions of the Non-Black Earth Region: Bryansk, Vladimir, Ivanovo, Kaluga, Kostroma, Moscow, Ryazan, Smolensk, Tver, Tula, Yaroslavl regions and the city of federal significance Moscow, the southern part includes the regions of the Black Earth region: Belgorod, Voronezh, Kursk, Lipetsk, Oryol, Tambov regions. Over the past century, the main threats to floristic diversity have been caused here by a high degree of agricultural and industrial development, which in some regions has led to anthropogenic transformation of more than 80% of the territories. Maintaining Red Data Books in Central Russia is a necessary and most important condition for monitoring the conservation of biodiversity and sustainable development of regions, but often it does not happen simultaneously and not in a timely manner, which requires a more careful attitude to the problem. In this study, the latest editions of Red Data Books and lists of rare species are taken into consideration.

2 Materials and methods

A representative collection of rare calciphilic plants has been formed at the GBS RAS since 2009 and represents, among other things, an extensive group of Red Data Books species of the regions of Central Russia. Within the framework of the GBS RAS program for *ex situ* biodiversity conservation, a number of expeditions were carried out in certain areas of the macroregion: Belgorod, Voronezh, Kursk. To study the group *ex situ* in natural conditions, seed samples of more than 100 species were collected, the collection of samples of living plants was often carried out in protected areas, so the minimum number of samples was taken (no more than 1-2). The main approach in the adaptation of rare plants was the creation of the most favorable growing conditions under the conditions of a special exposition and the use of agricultural techniques appropriate for each individual taxon.

To understand the role of calciphilous taxa in the modern composition of rare plants [1-3], the floristic composition of the regional Red Data Books: Belgorodskaya [4], Bryanskaya [5], Vladimirskaya [6], Voronezhskaya [7], Ivanovoskaya [8], Kaluga [9], Kostroma [10], Kursk [11], Lipetsk [12], Moscow [13], Orel [14], Ryazan [15], Smolensk [16], Tambov [17], Tver [18], Tula [19], Yaroslavl regions [20] and the federal city of Moscow [21]. In a comparative assessment of the rarity of species in the regional Red Data Books, categories critical for understanding the vulnerability of the flora were taken into account: 0 - probably extinct species; 1 – endangered species; 2 - species that are declining in number and (or) distribution.

Ex situ stability was assessed using the N.V. Trulevich (1991), which makes it possible to distinguish: unstable, weakly resistant, resistant, highly resistant taxa [22].

3 Results and Discussion

The 118 calciphilic species of regional Red Data Books of Central Russia studied in the GBS RAS culture represent 77 genera from 34 families [23]. An assessment of their introductory resistant showed the following distribution (Table 1): unstable (us) - 6 (5%), weakly resistant (wr) - 16 (13.5%), resistant (r) - 54 (46%), highly resistant (hr) - 42 (35.5%).

Table 1. Introductory resistance of calciphilic species Red Data Books of Central Russia, tested under conditions in GBS RAS.

Species	Resistant	Species	Resistant	Species	Resistant
Aconitum nemorosum L.	r	*Crambe tataria* Sebeok	r	*Linum flavum* L.	r
Adonis vernalis L.	r	*Daphne cneorum* L.	hr	*Linum hirsutum* L.	r
Adonis wolgensis Stev.	r	*Daphne sophia* Kalen.	hr	*Linum nervosum* Waldst. & Kit.	r
Ajuga chia Schreb.	r	*Dianthus andrzejowskianum* (Zapal.) Kulcz.	r	*Linum perenne* L.	hr
Ajuga laxmannii (L.) Benth.	r	*Dianthus armeria* L.	hr	*Linum ucranicum* Czern.,	r
Allium flavescens Bess.	r	*Dianthus eugeniae* Kleop.	r	*Lithospermum officinale* L.	hr
Allium inaequale Janka	wr	*Dianthus pallens* Sm.	r	*Matthiola fragrans* Bunge.	r
Allium paczoskianum Tuzson	wr	*Diplotaxis cretacea* Kotov	r	*Melica transsilvanica* Schur	hr
Allium sphaerocephalon L.	hr	*Echinops ruthenicus* Bieb.	hr	*Onosma simplicissima* L.	wr
Alyssum tortuosum Waldst. & Kit. ex Willd.	r	*Echium russicum* J. F. Gmel.	r	*Ornithogalum kochii* Parl.	r
Androsace koso-poljanskii Ovcz.	r	*Elytrigia pontica* Soltok.	hr	*Oxytropis pilosa* (L.) DC	r
Anthemis tinctoria L.	hr	*Ephedra distachya* L.	hr	*Paeonia tenuifolia* L.	r
Anthericum ramosum L.	r	*Eremogone micradenia* (P.A. Smirn.) Ikonn	hr	*Pedicularis kaufmanii* Pinzg.	us
Artemisia armeniaca Lam.	wr	*Erucastrum cretaceum* Kotov	r	*Pimpinella tragium* Vill.	r
Artemisia hololeuca Bieb. ex Bess.	r	*Euphorbia seguieriana* Neck.	r	*Polygala sibirica* L.	r
Artemisia nutans Willd.	wr	*Galatella angustissima* (Tausch) Novopokr.	r	*Prunella grandiflora* (L.) Scholl.	hr
Artemisia salsoloides Willd.	r	*Galatella biflora* (L.) Ness	hr	*Psathyrostachys juncea* (Fisch.) Nevski	hr
Artemisia santonica Web.	r	*Galatella linosyris* (L.) Reichenb. fil.	hr	*Pulsatilla patens* (L.) Mill.	r
Artemisia sericea Web. ex Stechm.	r	*Galatella villosa* (L.) Reichenb.	r	*Rosa rubiginosa* L.	r
Asparagus officinalis L.	hr	*Genista tanaitica* P. Smirn.	r	*Salvia nutans* L.	r
Asperula tephrocarpa Czern. ex M. Pop. & Chrshan.	r	*Genista tinctoria* L.	hr	*Salvia vercitillata* L.	hr
Aster amellus L.	hr	*Gentiana cruciata* L.	r	*Schivereckia podolica* Besser. Andrz. ex DC.	r
Astragalus albicaulis DC.	r	*Gypsophila altissima* L.	hr	*Scorzonera hispanica* L.	r
Astragalus ucrainicus M. Pop. & Klok.	wr	*Hedysarum grandiflorum* Pall.	r	*Scrophularia cretacea* Fisch. ex Spreng.	r
Astragalus zingeri Korsh.	hr	*Hedysarum ucrainicum* Kaschm.	r	*Scutellaria supina* L.	hr
Asyneuma canescens (Waldst. & Kit.) Griseb. & Schenk,	us	*Helianthemum canum* (L.) Hornem.	hr	*Serratula radiata* (Waldst. & Kit.) M. Bieb.	hr
Bulbocodium versicolor (Ker-Gawler) Spreng.	r	*Helianthemum nummularium* (L.) *Mill.*	hr	*Silene chlorantha* (Willd.) Ehrh.	wr
Bupleurum falcatum L.	hr	*Helichrysum arenarium* (L.) Moench.	r	*Silene cretacea* Fisch. ex Spreng.	wr
Carex humilis Leyss.	hr	*Helictotrichon desertorum* (Less.) Nevski	r	*Silene supina* Bieb.	hr
Centaurea marschalliana Spreng.	wr	*Hylotelephium maximum* (L.) Holub	hr	*Stipa capillata* L.	hr
Centaurea orientalis L.	hr	*Hyssopus cretaceus* Dubjan.	r	*Stipa dasyphylla* (Lindem.) Trautv.	hr
Centaurea ruthenica Lam.	r	*Iris aphylla* L.	hr	*Stipa lessingiana* Trin.	wr
Cephalanthera rubra (L.) Rich.	us	*Iris pumila* L.	hr	*Stipa pennata* L.	hr
Chamecitisus austriacus (L.)	hr	*Iris arenaria* Waldst. & Kit,	wr	*Stipa pulcherrima* C. Koch	hr
Clausia aprica (Seph.) Korn.-Tr.	hr	*Iris halophila* Pall.	hr	*Thesium arvense* Horvatovszky	wr
Clematis lathyrifolia Bess. ex Reichenb.	wr	*Koeleria talievii* Lavr.	hr	*Thymus cretaceus* Klokov	r
Clematis integrifolia L.	wr	*Krascheninnikovia ceratoides* (L.) Gueldenst.	r	*Verbascum phoeniceum* L.	us
Convolvulus lineatus L.	wr	*Lathyrus lacteus* (M. Bieb.) Wissjul.	r	*Veronica incana* L.	wr
Cotoneaster alaunicus Golitsin	r	*Linaria cretacea* Fisch. ex Spreng.	us	*Veronica spuria* L.	r
Total: 118 taxa				*Vinca herbacea* Waldst. & Kit.	hr

The main groups of life forms: shrubs, semi-shrubs and semi-shrubs - 20%, herbaceous perennials - 60%. Ecological groups of obligate (25%) and facultative (75%) calciphilous species are presented.

The representation of calciphilous species in the regional Red Data Books of Central Russia is different (Figure 1) and is determined by the areas of distribution of suitable habitats. Regions of the Chernozem region: Belgorod, Voronezh, Kursk, Lipetsk, Oryol, Tambov regions as part of the land fund have large areas of those in comparison with the Non-Chernozem region. In the Belgorod and Kursk regions, about half of the protected taxa are calciphilous, in the Voronezh, Lipetsk and Tambov regions, about a third. In the protected lists of the majority of the Non-Chernozem regions adjacent to the Chernozem region: Bryansk, Ryazan, Tula regions, the number of calciphilic species in relation to the total number of protected species is a fourth.

In the composition of rare species of the Vladimir, Ivanovo, Kaluga, Kostroma, Smolensk, Tver, Yaroslavl regions and the federal city of Moscow, calciphilic taxa represent an average of a ninth of the protected lists.

In total, since 2009, an average of 70% of calciphilous species listed in the regional Red Data Books of Central Russia have been tested under the conditions of the GBS RAS.

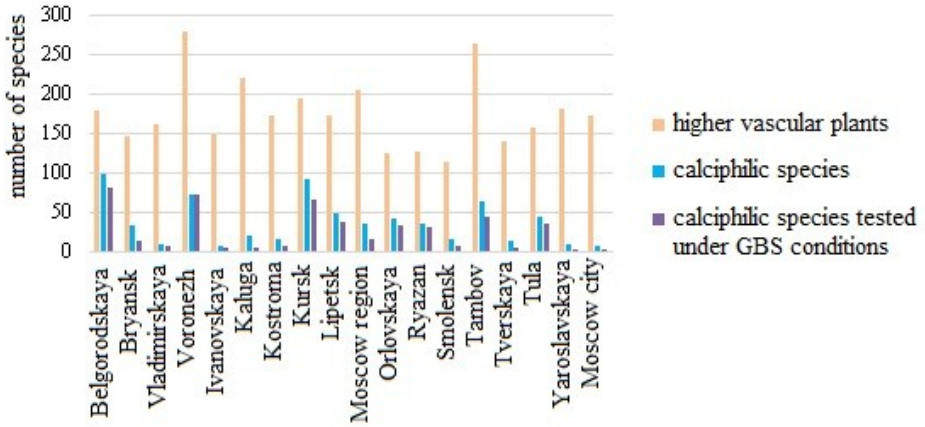

Fig. 1. Representation of calciphilic species in the regional Red Data Books of Central Russia, in relation to those tested under the conditions of the GBS RAS since 2009.

The shares of the most vulnerable categories: 0, 1, 2 in the group of calciphilous species of regional Red Data Books of Central Russia are shown in (Figure 2). Regional differences in their indicators can be due to both natural and anthropogenic factors. In such regions of the Chernozem region as: Belgorod, Voronezh, Kursk, Lipetsk, Oryol, the share of these categories as a whole increases, probably depending on the reduction in habitat areas and the increase in precipitation in these regions and the influence of factors of unfavorable environmental conditions. Significant differences are observed between the Belgorod and Oryol regions - 19 and 98%, respectively. In the Tambov region, with a fairly high representation of calciphilous taxa, the proportion of species of such categories is 26%, which may be due to the favorable environmental situation in the region. In the protected lists of the Non-Chernozem regions adjacent to the Chernozem region: Bryansk, Kaluga, Ryazan, Tula regions, the share of the most threatened categories of calciphilous taxa is significant: from 51% in Ryazan to 100% in Bryansk.

Kostroma, Smolensk, Tver regions - 30%, in Moscow and Yaroslavl regions - 97 and 81%, respectively. In Moscow, despite the insignificant presence of calciphilous species in the region, the share of vulnerable categories exceeds such indicators in most other regions

of the Non-Black Earth Region - 70%. In general, for the macroregion, the average value of the shares of calciphilic species of categories: 0, 1, 2 is 58%.

4 Conclusion

In total, since 2009, 118 calciphilic taxa have been tested under the conditions of the GBS RAS, that is, on average, about 70% of the species included in the regional Red Data Books of Central Russia. According to the introduction resistance, the following distribution was obtained: unstable - 5%, weakly resistant - 13.5%, resistant - 46%, highly resistant - 35.5%. In terms of ecological confinement, the group of facultative species predominates - 75% of calciphilic species, obligate - 25%. An important condition for the successful adaptation of representatives of this group is the observance of the necessary agricultural technology.

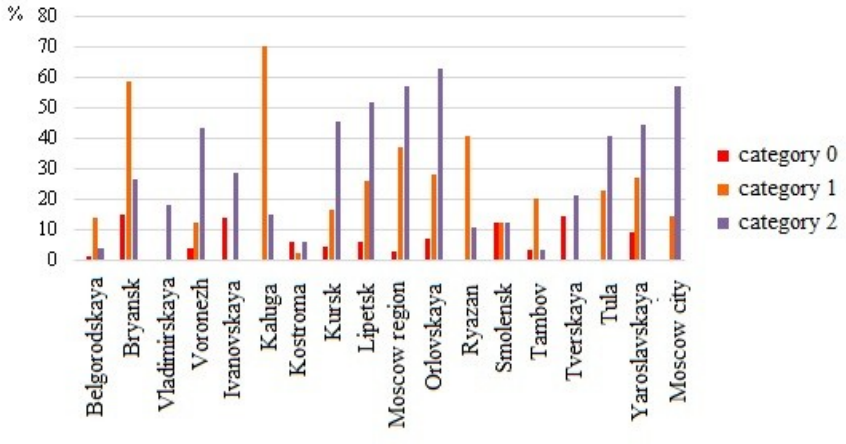

Fig. 2. Shares of the most vulnerable categories in the group of calciphilous species of regional Red Data Books of Central Russia.

The representation of calciphilous species in the regional Red Data Books of Central Russia is primarily due to the natural features of the distribution of calciphilous ecological and floristic complexes. Therefore, the regions of the Chernozem region: Belgorod, Voronezh, Kursk, Lipetsk, Orel, Tambov regions are characterized by a wider distribution of classical habitats of calciphilic species. At the same time, the inclusion in the Red Data Books of these regions of large groups of calciphilous species - an average of 36% of the total number of protected plants indicates a high vulnerability of their habitats.

In the protected lists of the majority of the Non-Chernozem regions adjacent to the Chernozem region: Bryansk, Ryazan, Tula regions, calciphilic species in relation to the total number of protected species also represent a significant part - 25%. For Vladimir, Ivanovo, Kaluga, Kostroma, Smolensk, Tver, Yaroslavl regions and the federal city of Moscow, calciphilic taxa represent an average of 9% of protected lists.

The share of calciphilous species of the most vulnerable categories: 0, 1, 2 in the regional lists of Red Data Books averages 58%.

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