THE CREATION OF BIOTECHNOLOGICAL PLANT COLLECTIONS IN THE BOTANICAL GARDENS OF RUSSIA AS ONE OF THE PROMISING DIRECTIONS FOR THE CONSERVATION OF THE BIOLOGICAL DIVERSITY OF LIVING SYSTEMS

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ABSTRACT

In recent decades, many countries have show more interest in biotechnological collections of plant objects. The main goal of creating such collections is a comprehensive study and conservation of the genetic resources of the natural flora, especially rare and endangered plant species, endemic, medicinal, as well as economically important plants.

In the large collections of the big botanical gardens of the Russian Academy of Sciences there are present a wide range of plants from different taxonomic groups. In the majority of biotechnological laboratories of regional botanical gardens of Russia, mainly specific rare and endemic groups of plants as well as economically significant for different regions of Russia are propagated and preserved. Some plant collections are formed within the framework of scientific and regional projects, which gives specificity of species and varietal composition to the gene banks created in botanical gardens.

Keywords: Biological diversity; botanical gardens; gene pool conservation; collections of living plants *in vitro*; clonal micropropagation.

INTRODUCTION

The most effective and reliable method of conservation of plant resources is the protection of plant species in nature and natural habitats, as this ensures optimal development and renewal of plants. However, the current rate of growth of anthropogenic environmental impacts hinders from protecting bio resources exclusively in natural conditions [1].

Creating plant collections in botanical gardens is the most effective way to conserve and sustainably use biological diversity. Currently, Russia accounts for more than 100 botanical gardens and other introduction centers responsible for creating special plant collections in order to preserve biological diversity and enrich the plant world. The methodological approaches to the formation of such collections are based on the principle of maximum representativeness of genetic diversity, including wild species and introduced plants [1,2,3,4,5].

The traditional conservation strategy for biodiversity in the *ex situ* collection funds of botanical gardens has recently been successfully supplemented by modern biotechnology methods by creating and preserving collections of living plants *in vitro*. Biotechnological methods offer possibilities for creating an in vitro crop bank with a long storage period for the plant gene pool. Of particular importance is the preservation by this method of plant species that poorly or slowly renew under natural conditions, as well as rare (endemic) plants. The preservation of the gene pool as a whole largely depends on the sustainability of the reproduction of such crop [6,7, 8].

The development of effective methods of plant reproduction in vitro is the basis of many works on the conservation of the gene pool. Plants of different taxa differ in totipotency of cells and regenerative potential. This necessitates a differentiated approach to the development of clonal micropropagation techniques. The choice of the *in vitro* conservation strategy for each taxon needs to consider its biological characteristics and also minimize the risk of somaclonal variations [9].

In this work, *in vitro* biotechnological plant collections in the botanical gardens of Russia as the leading centre in biological diversity conservation of the Living systems is represented.

MATERIALS AND METHODS

To date, the method of clonal micropropagation is commonly used in the production of healthy planting stock [10]. This method is especially relevant for plants that are difficult to traditionally breed or root. Most of such crops are representatives of woody and shrub plants. Plants obtained by clonal micropropagation have multiple valuable features such as enhanced formation of flower buds, plentiful bushiness, high yield, low level of fungal, bacterial, and viral infections [11,12,13].

RESULTS AND DISCUSSION

About 10% of the botanical gardens of Russia have formed and supported plant genetic banks *in vitro* [14]. N. V. Tsitsin Main Botanical Garden, the Russian Academy of Sciences (Moscow), has been forming an *in vitro* plant genetic bank since 1996 and is currently the most representative in Russia. It contains 153 species, 1157 varieties and selected forms of 183 genera and 61 families. About 70% of the *in vitro* collection belongs to phytoresource species. Most fully represented families in the collection are Actinidiaceae, Asteraceae, Caprifoliaceae, Ericaceae, Liliaceae, Oleaceae and Rosaceae. The Laboratory of Plant Biotechnology, GBS RAS focuses on the study of rare and endangered plant species, which *in vitro* collection is represented by more than 80 taxa. The laboratory develops technologies for clonal micropropagation of many medicinal and economically important plants. Improvement of the methods of long-term deposition of cultures *in vitro* is an essential part of the research activities of the laboratory [8,9].

The Central Siberian Botanical Garden of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk) has created a collection of rare and useful plants of the flora of Siberia and the Far East, preserved as meristem cultures. Long-term *in vitro* preservation not only contributes to the deposition of valuable genotypes, but also is the basis for studying the processes of morphogenesis and regeneration in tissue culture and studying the processes of microclone adaptation to *ex situ* conditions. As of 2008, 16 microclones of rare and endemic species from 6 families and 185 microclones of useful species, varieties, hybrids, and forms from 11 families were cultivated in the *in vitro* collection of the biotechnology laboratory of the Central Siberian Botanical Garden [15,16].

For more than 10 years, the Research Institute of the Botanical Garden of Nizhny Novgorod State University have been conducting research on introducing into culture *in vitro* and maintaining a collection of rare and endangered wild species of the Orchidaceae family. In 2014, the collection consisted of 13 natural species (18 forms and variations of these species) and 12 varieties of European selection. Most of these plants cannot be grown in open ground, since their natural habitats are tropical and subtropical zones. Species and forms of orchids that grow on the territory of Russia are the most stable, which allows to conduct active work to identify new natural forms, as well as selective work on hybridization. This should stimulate the introduction of the data of rare and endangered plant species into the widespread crop production practice [17,18,19].

The botanical garden of N. G. Chernyshevskii Saratov National Research State University has created an *in vitro* collection of economically important perennial crops. The researchers work actively to create a collection of rare and endangered plant species in the Saratov region [20]. Currently, the *in vitro* collection fund contains 107 samples of 60 species of 48 genera belonging to 26 families of angiosperms, of which 26 species of 21 genera of 14 families are protected species of the Saratov region ([21], Aminov, et al. 2020). Influence of constricts on the body of a medical leech on their reproductive ability.

Since 2017, the laboratory of plant biotechnology of the Botanical Garden Scientific and Educational Center of the Belgorod State National Research University (NRU "BelSU") has been working on the creation of an *in vitro* collection of decorative and berry crops. Currently, it contains 48 species, 237 varieties belonging to 37 genera and 21 families. The most fully represented families are: Rosaceae, Oleaceae Saxifragaceae, Caprifoliaceae, Hydrangeaceae, and Actinidiaceae (Fig. 1).

The collection contains herbaceous plants (Saxifragaceae, Orchidaceae, Asparagaceae, Asteraceae), shrubs (Oleaceae, Crossulariaceae, Hudrangeaceae, Celastraceae, Ericaceae, Caprifoliaceae, Rosaceae), lianas (Aristolochiaceae, Vitaeae, Apaeaceae, Apaeaceae, Vitaeaeae, Vitaeaeae Caprifoliaceae), and trees (Rosaceae, Adoxaceae, Salicaceae, Cupressaceae, Fabaceae).

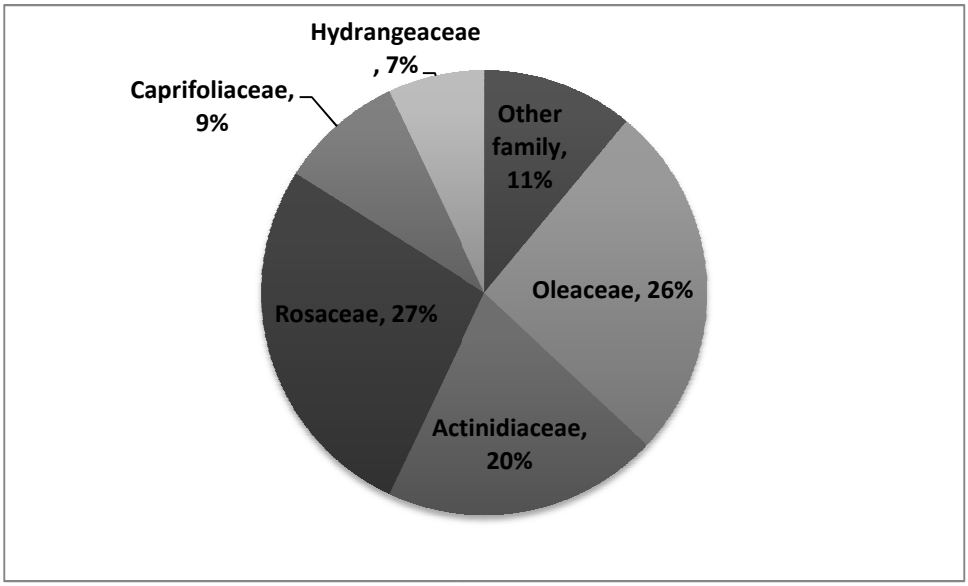

Fig. 1. The quantitative composition of the most representative families in the *in vitro* genetic bank of the plant biotechnology laboratory of the REC "Botanical Garden of the National Research University "BelSU"

The collection is mostly represented by the Rosaceae family of 13 species, 65 cultivated varieties belonging to 9 genera (*Aronia, Potentilla, Sorbus, Cotoneaster, Amelanchier, Rosa, Prunus, Rubus, Fragaria*). At the same time, the genus *Rubus* has the largest varietal composition - 29 varieties of raspberries and blackberries.

The collection of cultivated varieties of the genus *Syringa* is the most numerous, which has over 70 varieties of lilacs, including the latest varieties of the Russian Lilac breeding creative group — Den Pobedy, Marshal Malinovsky, Federico Garcia Lorca, Mikhailo Lomonosov, Olia, Tatiana Poliakova, Antoine de Saint-Exupery, etc [22].

The laboratory is actively working on the creation of a collection of lianas used for vertical gardening of various places in urban space. Most lianas belong to the genera *Actinidia, Clematis, Aristolochia, Vitis, Periploca, Lonicera,* and *Wisteria*.

The *in vitro* collection also includes promising varieties of rare berry and fruit crops that are used as starting material for the development of microclonal propagation technologies and the further cultivation of these plants in nurseries. Conditions for accelerated reproduction and adaptation to *ex vitro* conditions have been already selected for species and varieties of actinidia, raspberries, honeysuckle, blackberry.

Table 1. *In vitro* collection of plants in various botanical gardens

Name of Centre	Type of plants	Number of species, varieties, genera, families and ….	Most fully represented families
N.V. Tsitsin Main Botanical Garden, the Russian Academy of Sciences	*in vitro* plant	153 species, 1157 varieties and selected forms of 183 genera and 61 families.	Actinidiaceae, Asteraceae, Caprifoliaceae, Ericaceae, Liliaceae, Oleaceae and Rosaceae.
The Laboratory of Plant Biotechnology, GBS RAS	rare and endangered plant species.	which *in vitro* collection is represented by more than 80 taxa	
The Central Siberian Botanical Garden of the Siberian Branch of the Russian Academy of Sciences (Novosibirsk)	rare and useful plants of the flora of Siberia and the Far East	16 microclones of rare and endemic species from 6 families and 185 microclones of useful species, varieties, hybrids, and forms from 11 families were cultivated in the in vitro collection	
the Research Institute of the Botanical Garden of Nizhny Novgorod State University	*in vitro* and maintaining a collection of rare and endangered wild species of the Orchidaceae family	13 natural species (18 forms and variations of these species) and 12 varieties of European selection	
The botanical garden of N.G. Chernyshevskii Saratov National Research State University	*in vitro* collection of economically important perennial crops	fund contains 107 samples of 60 species of 48 genera belonging to 26 families of angiosperms, of which 26 species of 21 genera of 14 families are protected species of the Saratov region	
the laboratory of plant biotechnology of the Botanical Garden Scientific and Educational Center of the Belgorod State National Research University (NRU "BelSU")	*in vitro* collection of decorative and berry crops	contains 48 species, 237 varieties belonging to 37 genera and 21 families	Rosaceae, Oleaceae Saxifragaceae, Caprifoliaceae, Hydrangeaceae, and Actinidiaceae

The work has been started on introducing *in vitro* culture and creating a collection of rare, endangered and endemic plant species.
One of the applied areas of the plant biotechnology laboratory is the production of high-quality healthy planting material for decorative and berry crops using modern biotechnological methods. The created gene pool of *in vitro* cultures allows nursery enterprises engaged in year-round production of miniature plants by clonal micropropagation to promptly fill orders.

In summary, Table 1 depicts the purposed information.

CONCLUSION

In the large collections of the big botanical gardens of the Russian Academy of Sciences there are present a wide range of plants from different taxonomic groups. In the majority of biotechnological laboratories of regional botanical gardens of Russia, mainly specific rare and endemic groups of plants as well as economically significant for different regions of Russia are propagated and preserved. Some plant collections are formed within the framework of scientific and regional projects, which gives specificity of species and varietal composition to the gene banks created in botanical gardens.

The creation of an *in vitro* gene bank of crops in the botanical gardens of Russia not only contributes to the development of research on the conservation of plant biodiversity, but also forms the basis for studying the fundamental issues of plant physiology, biochemistry, genetic selection work, etc. The exchange of information and material *in vitro* between the biotechnological laboratories of botanical gardens and other research centers is a crucial step in the successful implementation of plant biodiversity conservation programs.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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