Conservation *ex situ* of bryophytes in the Botanic Garden of Tver State University (Middle part of European Russia)

Uliana Spirina

Abstract

The problem of growing endangered bryophytes *ex situ* is poorly studied. At the same time some phytocenotic groups of these plants are rather vulnerable. Experimental research leading to the conservation of bryophytes *ex situ* is urgent and important. In 1998 we started research on the introduction of bryophytes in the Botanic Garden of Tver State University. The objective of the research is to evaluate the potential of conservation of rare bryophytes *ex situ*. At present the collection numbers 27 species. Alongside rare and endangered bryophytes, we also study common species representing vulnerable ecological complexes. This approach enables us to single out suitable model species that have the same ecological preferences as the rare ones, and to choose the best cultivation techniques. Bryophytes of the basiphil-epiphytic complex, *calciphilous* species, ground mosses of dry pinewoods are quite stable in culture. It is possible to propagate and use such species in decorative plant growing to promote biodiversity conservation of wild populations *ex situ*.

Keywords

Bryophytes, conservation *ex situ*, introduction

The problem of growing endangered bryophytes *ex situ* in Russia is poorly studied. The need for special experimental research in this field is underestimated. Even the authors of Red Data Books attach no importance to the cultivation of rare bryophytes. At the same time some phytocenotic groups of these plants are rather vulnerable. For example, in many regions of Central Russia the basiphil-epiphytic complex are rapidly degrading as their components are very sensitive to acid air pollution. The species composition of bryophytes in mynerotrophic marshes has seriously deteriorated; the area of distribution of this group of plants is dwindling. Unfortunately in most cases this deterioration is connected with destruction of natural habitats or the global processes of antropic dynamics in the atmosphere and landscape. In the latter case it is difficult to suggest any effective strategy to mitigate the impact of the limiting factors. The vegetation cover is degrading so rapidly that in many cases it is impossible to control the negative dynamics of different components of the phytocenosises. In this connection, experimental research providing the opportunity of conserving rare and vulnerable species of bryophytes *ex situ* becomes very important.

The Tver region is situated in Middle Russia, near the border with North-Western Russia. The territory has one of the biggest hydrosystems in Europe. It is the starting point of the Volga river, West Dvina river, the rivers of the Neva basin, and the Dnieper (closer to the south border of the territory). The complex lake system of Holocene origin and high geomorphologic diversity make this region especially interesting. The region is situated at the intersection of important ecological zones and is notable for its diverse vegetation cover and rich and heterogeneous flora.

The upper reaches of the Volga are of special conservation importance. Within the upper reaches of the Volga river there are several unique nature complexes. The most important of them is Rzev-Staritsa Povolzhye. The relief of the area can be described as vast valley complexes with carbonate outcrops. The longest of the valleys (20 km) is called “The Gateway to Staritsa”. The vegetation cover of the steep riverbanks is as diverse as the relief of the area. Here you can find fragments of coniferous, small-leaved, and mixed forests with occasional broad-leaved trees, pine and birch forests with steppe elements, meadows with moss synusias, fragments of mineratrophic and oligotrophic marshes. The typical ecology and phytocoenosis of the region is determined by the rich biodiversity of plants and other living organisms in the area. The area boasts of the richest species composition compared to other areas of the Tver oblast.

Unfortunately much of the territory faces multiple pressures from agriculture (overgrazing, invasive weeds, agrochemical misuse), timber felling, quarrying and mining, industrial and domestic building and uncontrolled tourism. Most potentially serious of all are plans to increase exploitations of the Volga basin water resources. The territory has no protection status necessary for the implementation of effective conservation measures.

In 1998 Tver Botanic Garden started the research on introduction of bryophytes. The objective of the research is to evaluate the potential of conservation of rare species *ex situ*. The research was carried out on the basis of the bryophytes collection held at the garden. The collection materials were collected during floristic expeditions. At present the collection numbers 27 species (25 mosses and 2 liverworts). 8 bryophytes are listed in the Red Data Book of Tver Region. As far as we know all the bryophytes have never been introduced into culture in Russia before. Alongside with rare and endangered plants we study common species representing vulnerable ecological complexes. This approach enables us to single out suitable model species that have the same ecological preferences as the rare ones, and to choose the best cultivation techniques. At the moment the following plants groups are studied:

1) Bryophytes of the basiphil-epiphytic complex
2) Species of minerotrophic marshes
3) Calciphilous bryophytes
4) Plants that favour habitats with discontinuous vegetation
5) Ground mosses of forests and meadows.

The preliminary stage of the experiment was the study of the species in their natural habitats in order to define their ecological, phytocoenotical and biological characteristics. Next we defined the habitats allowing the collection of plants for the experiment without endangering the population of rare bryophytes. Alongside the experiments in the nursery and at the collection sites we conducted a number of field researches to study plant populations in the wild.

It is not always possible to use the experience of growing seed plants when dealing with bryophytes. It is necessary to take into account the specific features of their biological and life cycles, their dependence and confinement to local microhabitats. Special difficulties are caused by the fact that bryophytes have no root system. The plant material should be taken from natural habitats in large fragments or you should chose the substrate corresponding to the natural one in all its ecological characteristics. The plant material taken from the natural habitats is planted out in the experimental site into the soil or the substrate corresponding to the ecological preferences of the species. When planted into rich soil the accompanying plants become more vigorous and start to suppress the growth of rare vulnerable species. For this reason the substrate with mosses is isolated from the ground with the layer of sand. This technique of growing has proved its efficiency.

As a research result we created and applied an 18-point estimation scale of bryophytes introduction stability (Table 1). First, in this scale we take into account the possibility of artificial vegetative reproduction by tuft fragmentation. Success of this process essentially affects further introduction results because all material comes in a collection as living plants. Second, we deal with the change of a vital condition in culture. One of bryophytes features is their low competitive capacity in comparison with vascular plants. Therefore during cultivation special value is placed on an estimation of character of mutual relations between mosses and vascular plants and between different species of mosses. Next in our scale we consider the degree of cultivation laboriousness and ability for vegetative proliferation in accordance with similar criteria for vascular plants. Finally we notice sporophyte production possibility in culture. The complexity of phenological spectra studying for bryophytes lies in irregular sporophyte production in many (especially pleurocarpous) species. We have estimated the results of introduction for all 27 bryophytes species (Table 2).

The experiment has proved that some bryophytes of the basiphil-epiphyllous complex can be planted out on limestone substrate. For example, *Anomodon longifolius* grows well on limestone powder. It is possible to continue the experiment and try planting other species of this complex on carbonate substrate. Among the species of mineratrophic marshes, *Philonotis fontana* has proved to be more stable in culture, and to have broader ecological amplitude compared with other species of this complex. Such species as *Anomodon longifolius*, *A. viticulosus*, *Philonotis fontana*, *Encalypta streptocarpa* are quite stable in culture. The specimens of *E. streptocarpa* propagated in culture have been used in decorative planting. In the future it may be possible to propagate and use such species in decorative plant growing to promote biodiversity conservation of wild population *ex situ*.

In 2000 we started the development of living plant displays and exhibitions devoted to the unique natural complexes of the region. The displays imitate the most interesting fragments of these complexes. The display “the Gateway to Staritsa” demonstrates the most interesting fragments of the Volga Valley with the large outcrops of the maternal stratum. The flora of this region, as mentioned earlier, is very rich and heterogeneous and includes different botanical and ecological plant groups. The display contains 25 vascular species and 10 species of bryophytes taken from their natural populations. The display “the Flora of Minerotrophic Marshes” demonstrates the rare hygro- and hydrophytes taken from the different districts of the region (*Eleocharis quinqueflora, Herminium monorchis, Sonchus palustris, Juncus inflexus, Bryum schleicheri*). The display “Secretive Garden” is especially dedicated to vascular spore plants and bryophytes. Here visitors can get a closer acquaintance with plants that do not produce flowers and fruits, and can reflect upon the fact, that not everything in plants, as well as in the life of human beings, is ostentatious aimed at outshining and providing a visual impression.

In our work we place emphasis on regional biodiversity conservation research and educational work with different groups of the visitors as well. At the garden people can get acquainted with common species of bryophytes which are found in our territory, and also see vulnerable species. Special lessons on bryology are conducted for university students on the basis of the botanic garden bryophytes collection. Students study features of mosses morphology, life cycle, taxonomy and ecological varieties, and learn about the value of these plants in nature and human life.

The collection is going to be augmented and enriched with the species of other ecological groups with the aim of continuing the experiments. We are inviting other botanic gardens to join us in our research.

Table 1. Estimation scale of bryophytes introduction stability

Criteria	Estimation scale
Artificial vegetative reproduction	1 - badly transplanted species, in most cases perishes at this stage; 2 - well transplanted species (to 50 % of cases and more); 3 - always well transplanted species
Vital condition in culture	1 - condition in culture goes down; 2 - condition in culture is stable also does not change; 3 - condition in culture raises
Competitive capacity in culture	1 - accompanying plants substantially oppress the moss; 2 - character of competitive mutual relations is the same, as in natural communities; 3 - activity of the moss becomes more than in natural communities
Agrotechnics	1 - cultivation demands creation of a specific mode and the constant control of conditions; 2 - cultivation does not require creation of a specific mode, but the regular control of conditions is necessary; 3 - cultivation does not require use of special agrotechnics
Vegetative prolifiration	1 - vegetative proliferation is not observed; 2 - insignificant vegetative proliferation; 3 - active vegetative proliferation
Sporophyte production	1 - sporophytes are not formed in culture; 2 - sporophytes form sometimes in culture; 3 - sporophytes form regularly in culture
Total estimation	1-7 - species in culture is not steady; 8-13 - species in culture is steady; 14-18 - species in culture is very steady

Table 2. Bryophytes introduction stability

Species	Total estimation
Abietinella abietina (Hedw.) Fleisch.	14
Anomodon longifolius (Brid.) Hartm.	13
A. viticulosus (Hedw.) Hook. et Tayl.	15
Bryum schleicheri Schwaegr.	8
Campylium stellatum (Hedw.) C. Jens.	10
Cratoneuron filicinum (Hedw.) Spruce	14
Ditrichum flexicaule (Schwaegr.) Hampe	9
Drepanocladus aduncus (Hedw.) Warnst.	10
Encalypta streptocarpa Hedw.	13
Fissidens taxifolius Hedw.	9
Hylocomium splendens (Hedw.) B.S.G.	10
Limprichtia cossonii (Schimp.) Anderson, Crum & Buck	9
Paludella squarrosa (Hedw.) Brid.	9
Philonotis fontana (Hedw.) Brid.	12
Plagiochila porelloides (Torrey ex Nees) Shust.	9
Plagiomnium undulatum (Hedw.) T.Kop.	11
Pogonatum dentatum (Brid.) Brid.	16
Polytrichum strictum Brid.	16
Preissia quadrata (Scop.) Nees	12
Pseudocalliergon trifarium (Web. et Mohr) Loeske	9
Racomitrium canescens (Hedw.) Brid.	10
Rhytidiadelphus squarrosus (Hedw.) Warnst.	10
Rh. triquetrus (Hedw.) Warnst.	13
Scorpidium scorpioides (Hedw.) Limpr.	9
Seligeria campylopoda Kindb.	13
Thuidium philibertii Limpr.	12
Tomentypnum nitens (Hedw.) Loeske	9