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GENETIC RESOURCES IN THE FORESTRY SECTOR OF MONTENEGRO

SUMMARY

The conservation and the use of forest genetic diversity are the cornerstones in sustainable forest management. Genetic diversity ensures that forest trees can survive, adapt and evolve under the changing environmental conditions. Montenegrin forests possess extremely valuable genetic resources. Given that the obvious richness of forest tree diversity and biodiversity as a whole, it is necessary to make the efforts for conserving it, and also presenting it. It is essential to better familiarise both the professional and the wider public in Montenegro with the abundance and the significance of these forest genetic resources, and the need for conserving them. The forest genetic resources of Montenegro are not presented in the right manner internationally, and it is both necessary urgent to include Montenegro in international initiatives in the field of genetic resource protection.

A partial *in situ* protection of the forest genetic resources in Montenegro is accomplished through a network of protected zones, within national parks and protected zones.

Finding their stronghold within the Law on Planting Material, activities in the protection of genetic diversity of forest trees in Montenegro keep growing. 16 seed objects have been selected, and adequate legislative framework for these activities has been created. Further work on the seeking and selecting of these seed objects has been announced, as well as the establishment of seed orchards for the targeted species of forest trees. However, it is necessary to start the collection of seeds in the seed objects as soon as possible, as well as production of planting material out of seeds of autochthonous origin.

As a specific form of ex situ conservation, it is necessary to establish the forest tree seed bank, for which we can use the current capacities within the Seed bank of agricultural crops in the Biotechnical faculty in Podgorica.

It is necessary to intensify scientific research in the field of Montenegrin forest tree genetics. The genetic characterisation of Montenegrin forest tree populations, according to the available data, has not yet been conducted. However, the genetic characterisation of fungi from Montenegro has already begun.

Fungi constitute an integral part of a forest's ecosystem. A lot has been already been conducted in the field of inventory and the study in the diversity of

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fungi in Montenegro. The Mycological Collection at the Montenegrin Mycological Center, as well as the Collection of Mycelia cultures in the Biotechnical Faculty in Podgorica, are of special value for the conservation of fungi.

Keywords: Forest genetic resources, Montenegro, conservation, genetic characterization, Forest seed bank, fungi.

INTRODUCTION

Forest biodiversity is one of the main components in terrestrial ecosystems. All together, tropical, temperate and boreal forests offer varied habitats for plants, animals, fungi and microorganisms, containing a majority of global terrestrial biodiversity. In terms of the growing awareness regarding human environmental impact and the expected climate changes, the maintenance of the mechanisms generating diversity in forests has become a central issue in determining the stability of terrestrial ecosystems and the sustainability of their resources. It is generally accepted that maintaining or restoring biodiversity, presents the basic precondition to give long-term evolution response to these challenges (Sebastiani et al., 2007). Forest genetic resources represent genetic diversity contained in thousands of forest tree species on Earth (Šijačić and Milovanović, 2007).

Genetic diversity represents a basis for the evolution of forest trees and their ability to adapt to changes. Forest trees are long-lived and extremely diversified. One species may appear in a large number of different habitats, under different ecological conditions. Besides, it should be taken into account that species of forest trees and shrubs have evolved during several geological eras and also under the pressure from several periods of climate change. The past has proven that forest genetic resources have had potential to adapt to environmental changes, which is the reason for considering that their genetic variability would provide the potential for adapting to the incoming environmental changes (FAO, 2009).

Therefore, forest genetic resources stand for a unique and indispensable resource in the future, whose conservation is urgent. The modern concept of a sustainable forest management implies the practice of protecting this genetic diversity in the long run, whereas a potential need for speeding up the adaptation of forest trees due to climate changes through cross breeding and proactive genetic resources management is taken into account. (FAO, 2009)

The aim to manage genetic resources fostering the conditions for the continuous evolution of the species represents a defence mechanism in combating against these environmental changes. The conservation of forest genetic resources constitutes a set of activities and strategies, aiming at ensuring a continuous existence, evolution and availability of these resources for both present and future generations. (Šijačić and Milovanović, 2007).

International efforts for the protection of forest genetic resources

Genetic resources, including forest genetic resources (FGR), are among the highest values a country may have (FAO, 2010).

Basic factors that threaten forest genetic resources in Europe are: habitat destruction, fragmentation, pollution, bad silvicultural practices, the use of low quality reproductive material and the use of inadequate / insufficiently adaptable planting material (Koskelsa et al., 2007).

Factors threatening forest genetic resources know no boundaries. Therefore, different countries are mutually dependent, in terms of forest genetic resources. Under the threat of climate change, the interdependence of forest genetic resources will be even greater in future.

Climate change is recognised as one of the most important challenges that ecosystems and the society on a global level are facing at the same time. According to the Intergovernmental Panel on Climate Change (IPCC), climate change will affect the temperature increase on average by 2-4° C in Europe, over the next 50 years, and will cause significant changes in regional and seasonal models of precipitations. This will change the environmental conditions that European and global forest trees were adapted to and will expose them to new diseases and pests. Therefore, climate change stands for a new challenge in forest management and will have an impact on the economic and social benefits that society and individuals gain from forests, and it will also affect biological diversity of forest ecosystems (Koskelsa et al., 2007).

Due to the awareness of the fact that forest genetic resources are endangered by numerous threats, participants of the First Ministerial Conference on the Protection of Forests in Europe (MCPFE), held in Strasbourg in 1990, drew our attention to the significance of conservation of FGR (Strasbourg Resolution 2). This had happened well before the United Nations Conference on Environment and Development (UNCED), which adopted the global Convention on Biological Diversity (CBD- Rio de Janeiro 1992). Through this Convention on Biological Diversity, UNCED has initiated a new era in international dialogue on forests and has emphasised that countries have sovereign rights over their own genetic resources, but are also responsible for managing these resources in a sustainable manner. The Fourth MCPFE was held in Vienna in 2003 and adopted the Resolution 5, aimed at climate change and sustainable forest management. As a result, the new MCPFE work program includes specific actions for analysing the role of forest genetic diversity in for improving the adaptability of forests and maintaining forest productivity, under the conditions of changing environmental conditions.

For the purposes of enforcing the Strasbourg Resolution 2, the European Forest Genetic Resources Programme (EUFORGEN) was set up in 1994, to promote the protection and the sustainable utilisation of forest genetic resources in Europe. EUFORGEN is also contributing the implementation of Vienna Resolution 4 pertaining to the conservation and improvement of forest biological diversity.

Within the framework of this program, cooperation between the European countries has been generated, aiming at providing efficient protection and sustainable utilisation for forest genetic resources in Europe. Currently, more than 30 countries are supporting and participating in the activities of this program. The program is coordinated by Biodiversity International, which is a technical cooperation with FAO. The Steering Committee of EUFORGEN is composed of the National Coordinators appointed by the member countries, and is funded by the member countries.

EUFORGEN enables the dissemination of information and different initiatives for cooperation. The program is carried out through a network, in which the scientists, managers and politicians jointly analyse the needs, exchange experiences and develop conservation methods for the selected species. The network also contributes to the development of appropriate conservation strategies for eco systems, which the targeted species belong to, and promotes the integration of gene conservation in sustainable forest management.

In the past decades, FAO has recognised the value of forest genetic resources. REFORGEN database was established in 1993 and within the FAO forestry group, containing the information pertaining to the forest tree species and management of their genetic resources. Today, the system holds data for more than 1600 species from 146 different countries. These data in this database are provided by national institutions from each country. In the database, the data on forest tree species and the relevant activities undertaken in the respective country are available[2].

Activities of the FAO program mainly have a wider regional character. The FAO panel of experts for forest genetic resources has identified numerous priority tree species requiring urgent attention and action, at both the national and international level.

The EUFGIS project distinguishes itself among the significant European databases for forest genetic resources by designing an online informational system for inventory of FGR in Europe, with the participation of 41 countries. The project is focused on the improvement of the documentation and the management of units of the dynamic conservation of forest trees for 92 targeted forest tree species. This information system is still maintained and has been further developed as part of EUFORGEN[3]- and contains 2360 conservation units of forest genetic resources.

[2] Information on forest trees in the database include:1. Origin of species, 2. Management of species, 3. Main usage of species,4 Main factors of threatening, if species is threatened,6 In situ conservation activities, 7 *Ex situ* conservation activities, 8. Activities related to the genetic improvement of species and 9. Availability of reproductive material.

[3] EUGIS Project lasted in the period from 2007-2001 and stood for one of the 17 actions supported by the European Commission, under the EC Regulation EC No 870/2004 on genetic resources in agriculture.

International scientific cooperation within the IUFRO (International Union of Forestry Research Organizations) covers the multiple aspects of forest tree genetics. Section 2 (IUFRO Division 2) "Physiology and Genetics" includes studies pertaining to the cross-breeding and genetic resources of conifers and broadleaves, based on the quantitative, biological and population genetics of trees. The studies related to seed physiology and the technology of processing and storing are also conducted within this group. In January 2006, a new group was established within the IUFRO: "Task Force on Forests and Genetically Modified Trees".

However, a global image on the status and the trends of forest genetic resources in the world has not yet been identified. Evaluations on the levels of genetic diversity loss are also missing. This is deemed a serious deficiency. Today we dispose of the reliable general data on forest status and its prevailing trends. The information pertaining to forests mainly refer to forest resources in general, and not to the diversity of forest ecosystems and their variations. The evaluation by FAO experts is that availability of specific information related to the status, and that the forest genetic resource trends on a global scale, are still very low and insufficient.

Aware of the urgency and necessity for conservation and the sustainable utilisation of forest genetic resources, the Commission for Genetic Resources for Food and Agriculture of FAO (CGRFA) has, as supported by the Committee on Forestry, asked for the preparation of the Report on the status of global forest genetic resources and presented it to the Commission in 2013.

Preparation of the Report on the status of global forest genetic resources has been accepted at the 9th meeting of the Conference of member signatories of the Convention on Biological Diversity. It is anticipated that the Report on the status of global forest genetic resources is prepared through the reports of individual countries and thematic studies. The evaluation of global forest genetic resources may be used as a model, and the efforts will be directed to connecting these two processes.

Montenegro has ratified the Convention on Biological Diversity in June 2006, as well as the Resolutions resulting from the MCPFE work: Vienna Resolutions (1-5) 2003, Warsaw Resolutions (1-2) 2007, Oslo resolutions (2011). However, it does not have access to the EUFORGEN and REFORGEN programs yet.

The diversity of forest eco systems in Montenegro

Based on the diversity of its flora and fauna, Montenegro is one of the leading European countries, being rich with all elements of biological diversity. It relates to the diversity at an ecosystemic, taxonomic and genetic level. It is deemed that its mountainous regions, canyons, gorges, virgin forests, wetlands, sands and caves are especially significant, due to their richness in species and biodiversity as a whole, with centres on biodiversity in Prokletije and Durmitor (Stevanović et al., 1995).

The natural potential vegetation of Montenegro consists of a large number of plant communities or vegetation units of a higher rank. In the territory of Montenegro, there are 37 classes, 53 orders, 97 connections and 267 associations that have been selected, more than in the entirety of middle Europe. Plant species from 151 families have been recorded (Blečić and Lakušić, 1976), and according to Stešević i Jovović (2008), there are circa 3600 species and sub-species of vascular flora. It is estimated that Montenegro has 225 endemic plant species and around 250 species of dendroflora.

According to the data from the National Forest Inventory (NFI), implemented in the period from 2009-2011, the forests covered 59,9% of the Montenegrin area and forest land covered 9,8% of the Montenegrin area. The forest coverage of Montenegro is 69,7%, while the diversity of the tree species and forest types that have been estimated during the inventory, emphasises a huge diversity of Montenegrin forests (Dees et al., 2011).

Based on the preliminary data from the NFI of Montenegro, the spatial distribution of Montenegrin forest types indicates a large diversity in Montenegrin forests: 22 broadleaved types, 14 coniferous types and 2 mixed broadleaved and coniferous forest types. In NFI's sample plots the following were recorded in Montenegro: 68 tree species of growing stock, 66 species of trees progeny, 92 species of shrubs and 44 species of herbs, grass and ferns (Dees et al., 2011).

What has been done so far in the field of forest genetic resources protection in Montenegro

A large percentage of forests in Montenegro are under the internationally recognised scheme and network of nature and biodiversity protection. More than 5 % (5.2 %) of all the forests and forest land in Montenegro are in the National Parks, and 11.3 % are part of the Emerald zone category (Dees et al., 2011).

Although these protected areas have not been established with the primary objective of protecting forest genetic resources, it can be considered that an *in situ* conservation is accomplished this way. The preservation of the current gene pool under the specific conditions is a priority, which can be achieved by methods of *in situ* conservation (Šijačić-Nikolić and Milovanović, 2010). In some countries, natural or forest reserves are considered the units of conservation of forest genetic resources. They provide effective genetic conservation, especially when their area is sufficiently large[4] (Šijačić Nikolić and Milovanović, 2007). It should be noted that for the selection of protected areas and zones, this only represents the institutional framework for further work, and that it is necessary to undertake more specific activities in the conservation of forest genetic resources.

[4] Still, we should bear in mind that areas of strict conservation are fully excluded from the forest management practice and that no technical interventions are allowed in them, which also excludes the collection of seeds or other reproductive material (Šijačić Nikolić and Milovanović, 2007).

The recognition of the need for the protection of forest genetic resources in Montenegro has been expressed in documents, such as the National Forest Policy (2008) and the Forest Law (Off. Gazette of the Republic of Montenegro", no. 74/10, 2010).

The majority of European countries consider forest stands for the production of improved seeds as the basic conservation units of forest genetic resources (Šijačić-Nikolić and Milovanović, 2007). Today, the Law on Reproductive Material of Forest Trees ("Official Gazette of the Republic of Montenegro" number 1/09) with selected seed objects and by all means, the recently finalised National Forest inventory in Montenegro, constitute the basis for the protection of forest genetic resources in Montenegro.

Seed stands in Montenegro have been selected for the first time in 1996. After the revaluation of previously selected stands and evaluation of newly appointed ones, the Forest Administration of the Ministry of Agriculture and Rural Development[5] has selected 16 seed stands of conifers and broadleaves, aiming at the production of selected reproductive material. The total area of seed objects is 332 ha, out of which are 277 ha of coniferous and 55 ha of broadleaved seed stands. It is expected that within the seed stands, in the years of full yield, around 1000 kg of seeds would be possible for collection, which would exceed the needs of the Forest Administration of Montenegro.

Based on the Decision number 4627, of 10.08.2010., the Biotechnical Faculty - Center for Forestry is authorised to conduct activities envisaged by the Law on Reproductive Material of Forest Trees.

The process of forest seed production, pursuant to the above Law, shall take place in 5 essential steps: 1. The recognition of seed objects and entry into the Registry, 2. Production control within the seed object, 3. Collection/gathering seeds, 4. Seed processing (if needed), 5. Issuance of the main certificate

1.The recognition of seed objects and entry into the Registry

The general requirements that a seed object will have to meet when speaking about its quality and health status shall be laid down by the Regulation

[5] The Forest Administration of Montenegro is a state administration authority competent in forest management, in accordance with the Forest law ("Off. Gazette of the RMn", no. 74/10), and the Regulation on organizing and the method of work of the state administration ("Off. Gazette of the RMn",no. 7/11 and 40/11). Forest Administration performs administrative and related professional jobs, which to the widest extent, relate to the forests of Montenegro, protecting and improving forest status. Among other jobs, herein we single out the jobs related to genetic resources of forest trees, which are: the selection of seed objects, health examination and control of production of reproductive material of forest trees, supplying seeds and planting material. Then, measures and actions relating to tending, regeneration, planting and forest melioration (biologic reproduction), as well as keeping records and databases for forestry (informational system).

on recognition of the seed objects for the production of forest trees. Professional jobs of recognising seed objects shall be performed by an authorised scientific-research institution. Competent administrative authority shall keep the Registry of forest seeds and issue the decision on entry into the Registry.

In addition to the establishment of seed objects, it is necessary to define the seed categories (based on their origin) and regional seed provenance, which are established only for tree species relevant for forestry of Montenegro.

2. Production control within the seed object

Seed objects are managed on basis of the operational project, as approved by the Forest Administration (Regulation on method of preparation of the operational project for seed objects management "Official Gazette of the RMn, 74/09). The producer submits the application for controlling the production of the seed object to the competent administrative authority, 30 days before collecting the seeds, on the Form 1 of the Regulation on professional control of the production of reproductive material of forest trees "Official Gazette of the Republic of Montenegro, 55/08".

The production control in the seed object is conducted at the authorised institution. It controls whether the object is still meeting the prescribed requirements, and whether it is managed in accordance with the operational plan, then the minutes are then written and one copy is sent to the competent administrative authority (Regulation on professional control of production of reproductive material of forest seeds "Official Gazette of the Republic of Montenegro, 55/08).

3. Collecting/ gathering seeds

Registered companies and entrepreneurs may deal with the production and circulation of reproductive material. Natural persons may produce reproductive material for their own needs, if they have been registered in the Suppliers Registry.

The collection of seeds is controlled by the authorised institution, taking samples of reproductive material for analysis and then identifying the quality and health status, as well as taking the sample of the seed for storage needs. Authorised institutions then issue a report on seed quality, as well as the main certificate.

4. Seed processing

Seed processing is undertaken by a supplier and a registered processor, which meet the prescribed requirements. A shipment of unprocessed seeds, for further processing, is accompanied by the main certificate.

5. Issuance of the main certificate

The procedure of obtaining the main certificate begins by submitting the supplier's application, upon starting the seed collection, to the authorised

institution for the issuance of the main certificate, the application is submitted on Form 5, from the Regulation on content and form of the main certificate for reproductive material of forest trees ("Official Gazette of the RMn 1/09").

The main certificate on reproductive material compatibility (main certificate) is issued to the supplier for each lot of reproductive material produced in the seed object. The main certificate is issued within 15 days from the production date, and in the case of processing outside of Montenegro, 10 days after the completion of production.

The form of this certificate and the procedure for obtaining it are laid down by the Regulation on contents and form of the main certificate for reproductive material of forest trees (" Official Gazette of the RMn, number 1/09).

The procedure for the re-evaluation of seed stands in Montenegro was finalised in 2010, and in 2011, the Forest Administration of Montenegro published the "Registry of Seed Stands in Montenegro", prepared by: Isajev V., Rakonjac Lj., Lavadinović V., Lučić A., Demić Z. and Jakić V., as well as the "Manual for production of forest seed in natural seed objects", prepared by Isajev V., Mataruga M., Lučić A., Rakonjac Lj., Demić Z..

This can be seen as the first significant step in the field of genetic conservation for forest genetic resources in Montenegro. The Forest Administration of Montenegro has announced further work and the application of an increased number of objects to obtain this status[6], as well as the establishment of seed plantations.

After reviewing the most significant forest species in Montenegro, and the potential benefits of planting seed plantations of individual species, it was concluded that it would be necessary to plant seed plantations of Macedonian pine (*molika*), Bosnian pine (*munika*), rare broadleaves and wild fruit trees (Forest administration, 2012.). Likewise, the Forest Administration recognised that for the "finalisation of initiative for planting seed plantations in Montenegro it will be necessary, not only to engage professional staff of the Forest Administration, but also a team of experts in this field, scientific institutions in the country and abroad".

Further activities related to collection of seeds within the seed stands, as well as all the procedures related to its testing and certification, have not yet begun in Montenegro. The Annual Forest Management Program for 2012 states that in 2011, due to a poor seed yield, there were "some cones of Macedonian pine collected in Plav, which will be used for planting a nature park in Kolašin". It was estimated that in 2012, around 1100 kg of seed from the seed objects, 310 kg of conifers and 790 kg broadleaves seed, should be collected (Forest Administration, 2012).

[6] According to the Registry of Forest Administration of the Ministry of Agriculture and Rural Development of the Republic of Serbia, aiming at production of selected reproductive material, 217 seed stands of coniferous and broadleaved species were selected in Serbia. Conifers are represented with 153, and broadleaves with 64 seed objects (Šijačić-Nikolić i Milovanovoić, 2010).

Forest nurseries of the Forest Administration in Montenegro produce 1366000 pieces of seedlings in the Kolašin nursery. In the "Županica'' nursery, the regional unit Rožaje, 500 000 pieces of seedlings are produced, out of which are 300 000 pieces of spruce seedlings and 100 000 broadleaved seedlings. Of the material produced in the Kolašin nursery, 150,640 pieces of seedlings were planned for planting in the fields in 2012, out of which there were around 20 000 broadleaved seedlings. (Forest Administration, 2012). However, the seeds for the nursery production of seedlings are still supplied from importation[7], which is a serious threat to the long-term conservation of genetic structure of the current forests. Besides, issues were also raised on the genetic assumptions of produced planting material and their possibility for successful adaptation to the environmental conditions in the place of their application, and a total degree of seedlings' survival after bringing them out (introducing them) in the field.

Activities pertaining to the selection of seed objects in Montenegro, as well as the related legal regulations in this field, were supported by international FODEMO[8] project, funded by the Government of the Grand Duchy of Luxembourg.

Gene bank and seed storage for forest genetic resources in Montenegro

On the basis of the existing legislation in the field of reproductive material in Montenegro, the Law on Reproductive Material of forest trees ("Official Gazette of the Republic of Montenegro, number 1/09) stipulates that the preparation of the "Regulation on the method of establishment of seed storage and seed banks in relation to the forest trees species, regional provenance, categories and quantities, as well as the storage and utilisation of seed material in the seed storage and seed bank". However, the issue of the forest tree gene bank and seed storage in Montenegro has not yet been resolved.

The forest seed gene banks have been established in Bulgaria, Czech Republic, Latvia, Poland, Slovakia and Slovenia, while it is known that the forest trees gene bank in Lithuania were established within the gene bank of agricultural seed (Šijačić-Nikolić and Milovanović, 2007).

At the Biotechnical Faculty in Podgorica, the gene bank of agricultural seeds (Montenegrin plant gene bank, MGB) was established in 2004, with financial support from the SEEDNet project. The entire activities (inventory, collection, characterisation, conservation, regeneration, evaluation, documentation and the exchange of genetic resources) in the Montenegrin plant

[7] In recent years, the seed of conifers, and to a smaller extent, of broadleaves were supplied from Slovenia and Bosnia and Herzegovina.

[8] FODEMO Project (Forestry Development in Montenegro) Contract No: YUG/012 09 211, Subject: Forest seed Supply Advisory Team

gene bank were performed in accordance with the IPGRI procedures and standards. The Montenegrin plant gene bank has all the necessary equipment for the cleaning, drying, and packaging of seeds, determination of moisture, cleanliness and health of seeds and labelling of samples. Additionally, it is equipped for the long-term storage of seeds (-20°C) and active collections storage (4°C).

The seed gene bank of the Biotechnical Faculty has a significant capacity for the storing and the keeping of seeds from different plant species. This fact is opening up possibilities, through new projects and through the cooperation with the Forest Administration and the Ministry of Agriculture and Rural Development, to establish the forest trees gene bank within the existing gene bank. That would create possibilities for additional building of the BTF's institutional capacities, as institution of national significance.

The setting up and the establishment of the national gene bank within the BTF also implies setting up a close cooperation with the Ministry of Sustainable Development and Tourism, whose competence is in the passing legal acts and the by laws related to this area.

Types of Montenegrin growing stock significant from the point of view of genetic conservation

In order to define the program of conservation and sustainable utilisation of forest genetic resources in Montenegro in the future, it will be necessary to prepare an overview of the species potentially valuable for conservation for the gene fund. "The list of tree species of growing stock (measured trees) evaluated on sample plots in the NFI" was used as the basis of analysis. From this list containing 71 tree species (67 species from the list + 4 additional species[9]) we have selected rare, endangered, endemic and relict tree species, as well as the species with marginal distribution and diffuse/interrupted areals. We have used the IUCN categorisation for determining the category of species, FAO lists of endangered species for the areas of the Mediterranean and Northern Europe. We have also consulted a database of forest genetic resources REFORGEN, as well as the web portal EUFORGEN, in order to define the conservation status of these species in Europe as properly as possible.

[9] It should be noted that not all of the species were recorded on the sample plots of the NFI (nor lower taxonomic units) that are known as being present in Montenegro. Some "missed" tree species were inserted in Table 1 (marked with *). For any further additions, specific field and phytocoenological investigations would be necessary.

Table 1. Forest trees in Montenegro, character of their populations in Montenegro, vulnerability and conservation status in Europe

	Forest tree species	Seed objects in MNE	Species in Montenegro	Status of species according to			
				IUCN	EUFORGEN	FAO	REFORGEN
	1	2	3	4	5	6	7
Conifers							
1	*Abies alba* Mill.	3	M	LR/LC	+	NE(2);M (2)	13
2	*Cedrus atlantica* (Endl.) Manetti ex Carrière*	1	Al	LR/LC		M (1)	3
3	*Cupressus sempervirens* L.	/	/	ne		M (1)	5
4	*Larix decidua* Mill.	/	Al	LR/LC	+	/	13
5	*Picea abies* (L.) Karsten	3	M	LR/LC	+	NE (2)	22
6	*Pinus halepensis* Mill.	/	/	LR/LC	+	M (2)	7
7	*Pinus heldreichii* Christ	1	sE	LR/LC	+	/	1
8	*Pinus mugo* Turra	/	M	LR/LC	/	/	7
9	*Pinus nigra* Arnold	2		LR/LC	/	M	17
10	*Pinus peuce* Griseb.	1	E	LR/NT	+	/	8
11	*Pinus pinea* L.	/	Al	LR/LC	+	/	4
12	*Pinus pinaster* Aiton	/	Al	LR/LC	+	M (1,2)	6
13	*Pinus silvestris* L.	1	M	LR/LC	+	NE (2)	26
14	*Taxus baccata* L.	/	R	ne	+	M(1) NE(1)	10
BROADLEAVES							
15	*Acer campestre* L.	/	/	ne	+	/	2
16	*Acer heldreichii* Orph	1	E	ne	/	/	/
17	*Acer hyrcanum* Fisch. & Mey.	/	E/M	ne	/	/	/
18	*Acer monspessulanum* L.	/	/	ne	/	/	BI
19	*Acer obtusatum* Waldst. & Kit. ex Willd.	/	sE	ne	/	/	/
20	*Acer platanoides* L.	/	/	ne	/	NE (2)	8
21	*Acer pseudoplatanus* L.	1	/	ne	+	NE (2)	9
22	*Acer tataricum* L.	/	/	ne	/	/	/
23	*Ailanthus glandulosa* Desf.	/	I	ne	+	/	(I)11
24	*Alnus glutinosa* (L.) Gaertn.	/	/	LC	/	/	14
25	*Alnus incana* (L.) Moench	/	/	/	/	/	3
26	*Betula verucosa* Ehrh.	/	/	ne	+	/	12
27	*Castanea sativa* Mill	/	IZ	ne	+	M (1,2)	7
28	*Carpinus betullus* L.	/	M, IZ	ne	+	/	6
29	*Carpinus orientalis* Mill.	/	/	ne	/	/	me
30	*Celtis australis* L.	/	E	ne	/	/	me
31	*Ceratonia siliqua* L.*	/	/	ne	/	M (1)	1+me
32	*Coryllus colurna* L.	/	R	ne	/	/	2
33	*Fagus moesiaca**(Maly) Czeczott	2	(R)	ne	/	/	/
34	*Fraxinus excelsior* L.	1	M, IZ	ne	+	NE (1)	18
35	*Fraxinus ornus* L.	/	/	ne	/	/	2
36	*Fraxinus angustifolia* Vahl.	/	IZ	ne	/	/	2
37	*Juglans regia* L.	/	R	NT	+	NE (3)	8
38	*Malus sylvestris* Mill.	/	/	DD	+	/	7

39	*Morus alba* L.	/	/	ne	/	/	A
40	*Olea europea* (Wall. ex G. Don) Cif.	/	/	ne	/	/	A
41	*Ostrya carpinifolia* Scop.	/	R	ne	/	/	1
42	*Populus alba* L.	/	/	ne	+	/	6
43	*Populus nigra* L.	/	/	LC	+	M(1),NE(2)	7
44	*Populus tremula* L.	/	/	ne	+	/	8
45	*Prunus avium* (L.)L.	/	/	ne	+	NE (2)	11
46	*Prunus mahaleb* L.	/	/	ne	/	/	2
47	*Prunus padus* L.	/	/	ne	/	/	/
48	*Pyrus communis* L.	/	/	ne	+	/	3
49	*Pyrus amygdaliformis* Vill.	/	/	ne	/	/	me
50	*Quercus cerris* L.	/	/	ne	+	M	5
51	*Qurecus coccifera* L.	/	IZ	ne		M (1)	me
52	*Quercus frainetto* Tenore	/		ne	+		1
53	*Quercus ilex* Laur.	/	IZ	ne		M (1)	5
54	*Quercus petraea* (Mat.)Lieblen	/	/	/	+	/	11
55	*Quercus pubescens* Willd.	/	/	ne	+	M (1)	4
56	*Quercus robur* L.	/	M, I	LC	+	/	15
57	*Quercus trojana* Webb.	/	IZ	ne	/	Q (M 1)	/
58	*Robinia pseudoacacia* L.	/	I	LC	/	/	10 (7I)
59	*Saliix alba* L.	/	/	ne	/	/	2
60	*Salix fragilis* L.	/	/	ne	/	/	W
61	*Sorbius aria* (L.) Crantz	/	/	ne	/	NE	1
62	*Sorbuis aucuparia* L.	/	/	ne	/	NE	4
63	*Sorbus austriaca* (Beck.) Hedl	/	/	ne	/	NE	/
64	*Sorbus domestica* L.	/	/	ne	+	NE (2)	/
65	*Sorbus torminalis* (L.) Crantz	/	/	ne	+	NE (2)	3
66	*Tilia argentea* DC	/	/	ne	/	/	/
67	*Tilia cordata* Mill.*	1	/	ne	/	NE (2)	9
68	*Tilia grandifolia* Ehrh.	/	/	ne	/	/	/
69	*Tilia parvifolia* Ehrh.	/	/	ne	/	/	/
70	*Ulmus glabra* Hunds.	1	/	ne	/	NE, M (1)	6
71	*Ulmus leavis* Pallas*	/	/	ne	/	NE (1)	5

Legend of symbols used:

1. Forest tree species (*species not found in the NFI list, but evidently present in Montenegrin forests)
2. Number of seed objects in Montenegro
3. Character of populations of this species in Montenegro: Endemits and sub-endemits (E, sE), tertiary relicts (R), marginal populations (M), isolated populations, populations of interrupted areas (IZ), invasive species (I), foreign species present in populations of other species individually or in smaller groups (Al), globally endangered by pathogens (P)
4. IUCN category: NT- near threatened, LC- last concern, DD-without enough data, ne- not evaluated
5. According to EUFORGEN, species of interest for conservation of forest genetic resources (+),
6. FAO: Species identified as high global, regional or national priority in Northern European countries (NE) or Mediterranean (M) (1-high priority for action, 2-recommended fast action, 3, significant but not as much as 1 and 2)
7. REFORGEN- a number of European countries undertaking genetic conservation and/or other activities with this species, also the Mediterranean-countries of the Middle East (they were mentioned only for Mediterranean species and if there were no data about the species for European countries).

This list enables the creation of a general image on the richness of genetic diversity of forest trees[10] in Montenegro, and the necessity for its protection.

It should be taken into account that populations of endemic and relict species, as well marginal and isolated populations of cosmopolite species (populations of interrupted areals), all hold a special value in Montenegro.

As a unique part of Global Gene Fund, endemic species deserve extreme attention and active protection in terms of their spreading and deeper studying, as well as rational utilisation of their resources (Šilić, 1984). Endemic implies living systems (populations, sub-species, species, genus, etc.), naturally inhabiting a restricted, larger or smaller area. Because of the geographic position of Montenegro and direction of the mountain ranges, the numerous plants of subtropical and moderate range that used to live in the area in Tertiary, have managed to survive the ice age, along the warm southern and south-western slopes of mountains, in protected places. These are Tertiary relicts. At the same time, and together with other relicts, they constitute conservative or old relicts endemics (paleoendems). In earlier geological eras, these species used to have a larger range, but today their range is brought down to a narrow area (Šilić, 1984). Opposite the conservative endema, we distinguish progressive, young endema (neoendema) of a younger origin, representing the young species that indicate that the flora of the Balkan Peninsula is under full development. These species here replace the related species from the surrounding areas, and in a phytogenetic sense, they are young sprouts of separate polymorphic species under full development, under specific regional conditions creating different, but directly related forms, such as the so called *vikar* species (Šilić, 1984).

From the point of view of the protection of the gene pool for certain species, marginal populations have special significance, close or on the limit of distribution, at high altitudes and generally in unfavourable, ecological conditions, as well as in mixed forests. In the absence of data on genetic variability distribution, the more or less uniform distribution of conservation areas within a natural species distribution may be applied, including all extreme, disjunctive and characteristic populations (Ledig, 1986). Marginal and isolated populations may contain genes that are important as the basis of the resistance to drought, cold, pests, and diseases, which will ensure the future survival under the climate change processes. These genes may be important for the adaptation under the conditions of global warming, so that appropriate measures have to be undertaken in order to protect these species. (Koskela et al., 2007).

It is obvious that Montenegro has a large number of tree species whose populations should be protected as a priority.

Here, we will give a short commentary about conifers, whose numbers are less than 1/4 of the entire tree species recorded in Montenegro. Macedonian pine

[10] Shrub species recorded during the NFI have not been analysed in details. Among them, there are a large number of species, which, from the point of view of genetic conservation, should be paid attention to. This especially refers to the shrubs of the Mediterranean region.

(*P. peuce*) and Bosnian pine (*P. heldreichii*) are endemic and relict species. For the marginal populations among conifers in Montenegro we can consider the populations of spruce *Picea abies*, fir *Abies alba*, mugho pine *Pinus mugo*, and partially the Austrian pine *Pinus sylvestris*. Populations of *Pinus nigra* are an isolated and discontinued range, which is considered as a species of special significance for the area of southern and south-eastern Europe.

The Mediterranean coniferous species of Atlas cedar and cypress (*Cupressus sempervirens*) deserve special attention. The protection of the Atlas cedar gene pool is a priority in some Mediterranean countries, where it is an indigenous species, as well as the cypress, whose survival is endangered by pathogen appearance, which has led to the intensification of research on a selection of resistant clones. Among the coniferous species of interest for protection in the Mediterranean area, the following are mentioned: *Abies* spp., *Picea abies, Pinus pinaster*, *Taxus baccata, Pinus nigra*, *Pinus pinea*, *Pinus halepensis*, *Pinus peuce*, *Pinus heldreichii*, *Cupressus* spp., *Cedrus* spp., *Juniperus* spp.

The protection of the yew gene pool (*Taxus baccata*) is a priority in the countries of northern Europe and the Mediterranean. Based on the NFI data in Montenegro, it is observed that on sample plots, this species has only been recorded in progeny. In the future, it will be necessary to pay more attention to it and to identify its sites in Montenegro.

Sustainable forest management requires a better understanding of the specific features of forest trees and their genetic diversity. So far, we have not found any results of finalised genetic studies for trees in Montenegro. Such studies will be needed and should be a priority in the future. It is necessary to start research projects on the characterisation of genetic resources in Montenegro, but also characterisation of genetic diversity of other living organisms in forests.

Activities and research on BTF- Forestry Center

Scientific research in the field of forestry that has been performed at the Biotechnical faculty of the University of Montenegro for the past ten years, referred to the forests and forest ecosystems in the protected areas (National Park Durmitor, NP Biogradska Gora, NP Skadarsko jezero) including *Picea abies*, *Abies alba*, *Pinus mugo*, *Fagus moesiaca*, *Castanea sativa* etc., then forests of endemic and relict tree species (*P. heldreichii*), also as to the forests of endangered species (*Castanea sativa*). They have included numerous and important tree species and have covered a notable part of Montenegrin territory, and can therefore be considered a good starting point for further scientific research work on the conservation of these species. Research in forest objects such as, for example, those in the NP Biogradska gora, in addition to familiarising with the biological and ecological characteristics of tree species, also have a huge significance from the point of view of finding an optimal method of management under similar ecological conditions, and contributes to recommendations for *in situ* conservation. (The Project “Basis of natural

valuation of forests in the NP Biogradska Gora, was executed in the period from 2008-2011, Ćurović et al, 2011a, Ćurović et al., 2011b.) Complex research has also been performed on forest of the NP Durmitor, including both the range of boreal forests of spruce and fir (Project: *Endangerment and protection of coniferous forests in Northern forest area of Montenegro, implemented in the period 2004-2008.*; Čurović and Spalević, 2011; Čurović and Spalević, 2012; Lazarević 2004a, Lazarević 2005), and communities of mountainous pine in the range of high mountainous vegetation above the upper forest border (Lazarević, 2001; Lazarević 2004, Lazarević et al., 2009). Studies were also directed to the populations of the species whose survival had been endangered due to the appearance of pathogen fungi, such as *Castanea sativa* (Dubak, 2001). In sub-endemic forests, *P. heldreichii* fungi communities were studied (Lazarević, 2010a; Lazarević, 2010b), with emphasis on the ectomycorrhizal species and the possibilities of using them in the production of planting material.

Genetic resources of fungi in Montenegro

Fungi constitute an integral part of forest eco systems. The diversity of fungi is very important for forest ecosystem functioning (Brundert, 2009).

Systematic mycological research of macromycetes in Montenegro has started 20 years ago (Perić i Perić 1997, 2004.) The results obtained so far have shown a large richness in fungal diversity in Montenegrin forests. More than 1000 fungal taxa have been recorded. Species from more than 60 genera of Ascomycota have been recorded, as well as around 220 genera of Basidiomycota. Bearing in mind that the diversity of plant communities in the territory of Montenegro is higher than in the rest of middle Europe, here one should expect excessive fungal diversity (Perić and Perić 2004). A preliminary red list of macromycetes of Montenegro has been prepared, serving as a professional basis for the passing of the legal acts related to fungi protection not only here, but also in Europe.

In recent years, the trend of giving away the principle of wide-inclusive recording of these species and their distribution, used to be prominent during the first decade of mycological studies, has been observed in Montenegrin mycology. The tendency of specialisation and referring to the individual taxonomic groups is increasingly present (Boletales, Pezizales) (Lazarević et al., 2011). Among the results of mycological studies, herein we would especially emphasise species, new for the science, *Alpova komoviana* B. Perić & P.-A. Moreau, sp. nov. (Mycobank Accession Number: MB564288), found on the site of Opasanica (Komovi) in the community with *Alnus incana* (Moreau et al., 2012).

The mycological collection of Montenegrin Mycological Center is of special value. The collection is unique, according to the number and diversity of dried fungi specimens in the region of South-Eastern Europe. The findings of fungi-dried fungal sporocarps were stored and accompanied by ample photo documentation of the fruit bodies (sporocarps) on the field, as well as by microphotographs and drawings of taxonomically important details.

Also, within the Laboratory for forestry research in BTF there is also a mycoteque containing more than 50 cultures of ectomycorrhizal fungi of Montenegro[11]. These current cultures are used for testing the physiological characteristics of mycorrhizal fungi and possibilities of their utilisation in the mycorrhisation of seedlings (Lazarević, 2008; 2010a; 2010b, 2010c). Besides, their genetic characterisation has been undertaken for 22 fungi cultures (20 species) so far (Lazarević et al., 2012). ITS sequences were deposited into the gene bank of the American National Center for Biotechnological Information (NCBI GenBank) under the Accession numbers JQ685712 to JQ685733.

Thus, and for the first time, fungi from 11 ectomycorrhizal genus and one saprobe genus from the region of south-eastern Europe have been genetically characterised.

The mentioned mycological collections constitute the method of *ex situ* conservation, significant for the conservation and studying of these species.

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Jelena LAZAREVIĆ

GENETIČKI RESURSI U SEKTORU ŠUMARSTVA U CRNOJ GORI

SAŽETAK

Konzervacija i održivo korišćenje šumskih genetičkih resursa predstavlja osnovu održivog gazdovanja šumama. Genetička raznovrsnost obezbeđuje opstanak šumskog drveća, njegovu adaptibilnost i voluciju pod promenjenim uslovima spoljašnje sredine. Šume Crne Gore poseduju izuzetno vredne genetičke resurse. S obzirom na evidentno bogatstvo diverziteta šumskog drveća i biodiverziteta u celini, neophodno je da se preduzmu napori radi njegove konzervacije, kao i prezentacije. Neophodno je bolje upoznavanje stručne i šire javnosti u Crnoj Gori sa bogatstvom i značajem šumskih genetičkih resursa ipotrebom njihove konzervacije. Šumski genetički resursi Crne Gore nisu predstavljeni na međunarodnom na odgovarajući način, pa je potrebno što hitnije uključivanje Crne Gore u međunarodne inicijative na polju zaštite genetičkih resursa.

Delimična *in situ* zaštita šumskih genetičkih resursa u Crnoj Gori ostvaruje se kroz mrežu zaštićenih zona u nacionalnim parkovima izaštićenim zonama.

Nalazeći uporište u Zakonu o sadnom materijalu, aktivnosti na zaštiti genetičkog diverziteta šumskog drveća u Crnoj Gori uzimaju sve više maha. Izdvojeno je 16 semenskih objekata i stvoren adekvatan zakonski okvir za ove aktivnosti. Najavljen je dalji rad na kandidovanju i izdvajanju semenskih objekata, kao i osnivanje semenskih plantaža za pojedine vrste šumskog drveća. Međutim, potrebno je što pre započeti sakupljanje semena u semenskim objektima i proizvodnju sadnog materijala od semena autohtonog porekla.

Kao specifičan oblik *ex situ* konzervacije, potrebno je uspostaviti banku semena šumskog drveća, za šta se mogu iskoristiti postojeći kapaciteti u okviru Banke semena poljoprivrednih kultura na BTF u Podgorici.

Naučna istraživanja iz oblasti genetike šumskog drveća u Crnoj Gori je neophodno intenzivirati. Genetička karakterizacija populacija šumskog drveća u Crnoj Gori, prema raspoloživim podacima, do sada nije rađena. Započeta je, međutim, genetička karakterizacija gljiva iz Crne Gore.

Gljive predstavljaju integralni deo šumskih ekosistema. Na polju intventarizacije i proučavanja bogatstva diverziteta gljiva u Crnoj Gori urađeno je dosta. Posebnu vrednost imaju Mikološka kolekcija Crnogorskog mikološkog centra, kao i kolekcija micelijalnih kultura na Biotehničkom fakultetu u Podgorici.

Ključne reči: Crna Gora, šumski genetički resursi, konzervacija, genetska karakterizacija, banka šumskog semena, gljive