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SADRŽAJ CONTENTS
TOM 61-62

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SUSTAINABLE FORESTRY **ODRŽIVO ŠUMARSTVO**
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Original scientific paper

THE POSSIBILITY OF USING SOME CONIFEROUS SPECIES FOR THE IMPROVEMENT OF THE CHARACTERISTICS OF MINE SOILS

Zoran MILETIĆ[1]

Abstract: *On the reclaimed mine soils of the lignite mine "Kolubara" the influence of forest plantations of Japanese larch, Douglas fir and Austrian pine on the revitalization of the soils formed by waste-rock deposition was researched. The total yield of litterfall which is annually transported to the soil surface and the percent of nitrogen, phosphorous and potassium in the litterfall was determined. The following soil characteristics were dertermined: reaction of soil solution, the total amount of humus and nitrogen, as well as the forms of phosphorous and potassium which are available to the plants. It was concluded that the Douglas fir plantations had the most favourable effect on the revitalization of soils, whereas the Austrian pine and Japanese larch plantantions had the significantly less favourable effect on it.*

Key words: mine soils, forest plantations, litterfall, humus, nitrogen, phosphorous, potassium

1. INTRODUCTION

The soils formed by waster-rock deposition from the open pits of lignite mines in Kolubarski basin are poor in the content of forms of nutrients which are available to the plants. Phosphorous and potassium are present in the overburden above the coal layer, out of which the tailing dumps are formed, but they are not found in the water-soluble forms that are available to the plants. The recently deposed waste-rock is devoid of the nutrients and humus, and, thereby, of the organic nitrogen, which is the source of the forms that are available to the plants

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(Stojanović et al 1977; Antonović et al 1978; Antonović et al 1984; Veselinović et al 1984; Šmit, Veselinović 1997; Šmit, Miletić 1997, Dražić, 1997; Miletić 2004, Miletić, Radulović 2005.).

By establishing the forest plantations on the deposited tailing dumps and forming the canopy of the vegetation cover the protective forest functions are established. Along with the main-protective function of the forests on mine soils, anthropogenic forest ecosystems should serve the meliorative function, i.e. improve the soil characteristics, its fertility and productive potential by the dead organic residues.

Humus is the stable and long-lasting source of the nutrients for the forest trees. The formation of higher quanties of humus under the plantations would enable the harmonized release of the nutrients over the whole growing season. Humus has the positive effect on other soil characteristics as well, mainly on the structure, since it fixes soil particles in the structural aggregates. In this way it indirectly accelerate the water infiltration, aeration of soil solum, and the ratio of some categories of pores in the differential soil porosity. The presence of humus increases the soil resistance to the eroding agents.

This paper is aimed at the study of the influences of some forest plantations of the creation of humus in the soil and biological accumulation of nitrogen, phosphorous and potassium.

2. METHODS

On three sample plots on the mine soils of lignite mines under the forest plantations of Douglas fir (*Pseudotsuga menziesii* /Mirb./ Franco), Japanese larch (*Larix leptolepis* Siebold et Zucc.) and Austrian pine (*Pinus nigra* Arn.) the annual yield of the litterfall on the soil surface was measured, the soil profiles were opened, and the samples of the soils were taken for the laboratory studies. The researches were done on the mine soils of lignite mine "Kolubara". The sites characterized by the mine soils of the heavier texture were selected, i.e. all observed mine soils belong to the textural class of clays and clay loams.

The following aspects were studied in the laboratory conditions:

- Determination of the quantity of macroelements in the litterfall by the ash analysis after the dry combustion in the following ways: potassium was determined flame-photometrically, phosphorous was determined colour-metrically, and calcium and magnesium complex-metrically. The quantity of nitrogen in the leaflitter was determined by using Kjeldahl's method.
- The soil analyses referred to: determination of the active and substitional acidity electrometrically, the forms of phosphorous and potassium which are available to the plants by AL method according to Egner-Rihm, of nitrogen by using Kjeldah's method, and the total quantity of humus by using Turin's method.

3. RESULTS

The litterfall of the observed species greatly differs, in both total amount which is transported to the soil during one year, and in chemical characteristics, i.e. content of the macroelements of nutrition (Table 1). The highest quantities of the litterfall during the year are transported to the soil surface under the Austrian pine plantations. In spite of the fact that Japanese larch is a broadleaf species, which in autumn reject all assimilation organs, it transports the significanly lower quantities of litterfall to the soil surface than the Austrian pine. Douglas fir produces almost half quantity of the litterfall in comparison with Japanese larch. Litterfall is the most significant source of the nutrients for the soil organic layer in the forest ecosystem, and, thereby, the main source of the organic carbon around which the humus is formed (Родин, Базилевич, 1965; Nordén, U. 1994). It implies that the highest quantities of the organic carbon are produced by the Austrian pine plantations, followed by the larch plantations, and the lowest quantities are produced by the Douglas fir plantations. Along with the litterfall of the species which were used for the reforestation, the part of the dead organic residues are produced by the native species which spontaneously inhabit the plantations. Japanese larch is the heliophilic species with the open crown, which enables the penetration of light to the soil surface and the occurrence of the native species in all layers of the larch plantations. As a result, the production of nutrient out of which the humus is formed by the native species is the highest under the Japanese larch plantation. Under the Austrian pine plantation the production of the dead organic resideus by the native species is significantly lower than under the larch plantation, where, along with the less favourable light conditions, the spontaneous occurrence of the native species is prevented by a very powerful horizon of the soil organic layer. Under the Douglas fir plantation, due to the dense canopy and strong shade which is formed by this sciophilic species, there is almost no production of the organic residues by the native species.

Out of all observed plantations, the litterfall of the Japanese larch is the richest in the ash. Significantly high quantities of ashes were also reported in Douglas fir litterfall, and the lowest quanties in the Austrian pine litterfall. The highest percent of nitrogen was reported in the Japanese larch litterfall, which was followed by the Douglas fir litterfall, and the lowest percent in the Austrian pine litterfall.

By contrast to the nitrogen, the percent of phosphorous, as well as potassium, is the highest in the Douglas fir litterfall, considerably lower in black locust litterfall, and the lowest in the Austrian pine litterfall.

Table 1. *Characteristics of litterfall*

Plantation	Litterfall	Nutrient	Ash	N	P	K
	t/ha	%	%	%	%	%
Japanese larch	1044.00	90.54	9.46	0.83	0.005	0.757
Douglas fir	548.80	93.38	6.62	0.78	0.048	2.431
Austrian pine	1447.50	97.69	2.31	0.40	0.003	1.154

The forest plantations established on the tailings of the mining basin “Kolubara” by the production of litterfall on the soil surface provided the energy

material for saprophytic microorganisms and initiated microbial processes of decomposition of the dead organic residues (Miletić 2004, Miletić, Radulović 2005). The microbial processes affect the pedogenetic processes, mainly humification, the creation of humus-accumulative horizon and biological accumulation of nutrients in the surface soil layers.

In the mine soils under the observed plantations, the highest quantities of humus were reported under the Douglas fir plantation (Table 2). The yield of the organic residues out of which the humus is formed under the Douglas fir plantations is the lowest in all observed species, because along with the lowest production of litterfall there are no native species. The conditions for microbial activity under the observed plantation are unfavourable because Douglas fir is the sciophilic species which forms the dense canopy and casts the strong shade on the soil surface. It implies the unfavourable light conditions to the activity of saprophytic microorganisms which decompose the nutrients. By contrast to the soil under the larch plantation, where the native flora had the significant influence on the total production of the dead organic residues out of which the humus is formed, under the Douglas fir plantation there is almost no yield of the organic residues of other species to the soil. The Douglas fir litterfall is almost the only source of nutrients for the soil organic layer and for the soil.

The decelerated decomposition of the nutrient under the Douglas fir plantation enables the mutual connection of the intermediate products of the decomposition and the synthesis of the humus substances which are resistant to the further decomposition.

As the result of the multi-annual yield of the high quantities of the litterfall rich in potassium, under the Douglas fir plantations the surface layer of the mine soils was well-supplied with the forms of this element which are available to the plants. The content of the available forms of potassium is the highest in the surface layers of the soil, whereas it decreases with the increasing depth of the solum. In the deeper layers the content of the available potassium is within the limit of the mean availability, based on the threshold values for AL method.

By the contrast to potassium, the quantity of the forms of phosphorous which are available to the plants is lower under the Douglas fir plantations than under the Japanese larch and Austrian pine plantations. The fallen Douglas fir needles have the higher percent of phosphorous than other observed species. However, the total quantity of litterfall is very low, so the yield of phosphorous per a unit of area of the soil under the Douglas fir is even lower than under other plantations. The highest quantities of the forms of phosphorous which are able to the plants were reported under the Japanese larch plantation, the litterfall of which is richer in phosphorous and where the native plants significantly affect the cycle of this element in the artificially established ecosystem.

Under the Japanese larch plantation the twofold higher amount of the litterfall is transported to the soil surface, and the content of the total humus is half as much as under the Douglas fir plantation. It implies that the larch needles are to a lesser extent transformed into the humus, owning to which there is no higher biological accumulation of nitrogen. The quantities of the forms of phosphorous which are available to the plants are higher than under the Douglas fir plantations, but in this instance they are also within the limits of poor availability, whereas the

quantities of the forms of potassium which are available to the plants are somewhat lower than under the Douglas fir.

Table 2. *The characteristics of the mine soils under the different plantations*

Plantation	Dubina	pH H_2O	pH KCl	pH $CaCl_2$	N	Humus	P_2O_5	K_2O
Japanese larch	0 – 2	6.4	5.2	5.6	0.099	1.24	7.10	20.32
	2 – 7	5.8	4.6	5.1	0.071	0.58	4.00	19.10
	7 – 17	5.4	3.6	4.2	0.068	0.29	18.50	18.52
	17 –100	6.7	5.4	6.3	0.089	0.27	4.50	13.71
Douglas fir	0 – 2	5.2	3.9	4.7	0.216	2.26	0.40	23.80
	2 – 7	5.3	3.9	4.9	0.097	1.24	0.20	17.80
	7 – 17	5.7	3.8	5.2	0.062	0.43	0.30	16.20
	17 –100	6.8	4.6	5.8	0.041	0.27	0.30	13.30
Austrian pine	0 – 2	6.4	5.1	6.0	0.123	1.96	0.70	29.30
	2 – 7	6.7	5.1	6.3	0.070	1.01	3.80	20.30
	7 – 17	7.8	6.5	7.5	0.020	0.71	6.00	14.40
	17 –100	8.0	6.8	7.6	0.016	0.28	5.20	17.67

Under the Austrian pine plantation the considerably higher quantity of the nutrient is transported to the mine soils than under the Douglas fir plantations. In spite of this fact, under the Austrian pine plantation the lower quantity of humus was reported than under the Douglas fir plantation. The Austrian pine litterfall is characterized by the unfavourable chemical properties. The content of all observed macroelements of nutrition is lower than in Douglas fir and larch. The low content of nitrogen in the litterfall implies the wide ratio of carbon and nitrogen. It results in the decelerated decomposition of the nutrient and in its accumulation in the horizon of the soil organic layer. Due to the lack of nitrogen in the litterfall, the processes of fermentation of the soil organic layer produce the organic acids and aggressive fulvic acids which do not contain nitrogen.

The Austrian pine plantations on all sites in Serbia acidify the soil (Knežević 1994). The production of the acidified products of the decomposition of the soil organic layer under the observed plantation on the mine soil also led to the visible acidification of the soil.

In the surface layers of soil under the Austrian pine plantation the higher content of the forms of phosphorous and potassium which are available to the plants than in the deeper layers of the soil was reported, which implies that under this plantation potassium is biologically accumulated.

4. CONCLUSION

The established forest plantations of Douglas fir, Japanese larch and Austrian pine, along with the protective and productive functions on the observed mine soils, have the meliorative role. The litterfall and products of its decomposition to a lesser or greater extent meliorate the soil characteristics in comparison with the recently deposited waste-rock. Out of the observed tree species, the Douglas fir plantation has the most favourable effect on the soil characteristics. Under the influence of the Douglas fir plantation, the significant increase of the content of humus and nutrient in the soil and biological

accumulation of nitrogen, and biological accumulation of nitrogen occur, as well as the transformation of phosphorous and potassium from the unavailable forms to the water-soluble forms which are available to the plants.

Austrian pine transports the highest quantity of the organic residues, out of which the humus is formed, to the soil surface. However, this plantation had the less favourable effect on the revitalization of the soil than Douglas fir. Owning to the wide ratio of carbon and nitrogen, the Austrian pine needles are decomposed very slowly and accumulated in the soil organic layer. The low quantities of humus are formed, which implies the low biological accumulation of nitrogen. The products of decomposition have acid reaction. Under the influence of the aggressive products of the decomposition of the nutrient, the soil is acidified. The higher quantities of the available forms of phosphorous and potassium in comparison with the mine soils under the Douglas fir are not the result of the accumulation via the litterfall, but of their mobility from the crystal structure of the mineral and transformation from the unavailable forms to the water-soluble forms under the influence of the aggressive organic acids (fulvic acids 1a).

The larch plantation had the least favourable effects on the revitalization of the mine soils. Under this plantation the lowest quantities of the humus and nitrogen were reported, and, at the same time, the lowest quantities of the forms of potassium which were available to the plants.

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THE POSSIBILITY OF USING SOME CONIFEROUS SPECIES FOR THE IMPROVEMENT OF THE CHARACTERISTICS OF MINE SOILS

Zoran MILETIĆ

Summary

On the reclaimed mine soils of lignite mine "Kolubara" under the influence of the litterfall of forest plantations and products of their decomposition the revitalization of soil occurs, i.e. the soil regains its natural characteristics, fertility and productive ability. It was concluded that the Douglas fir plantations, which produced the lowest quantity of the litterfall to the soil surface, had the most favourable effect on the revitalization of soil. Under the Douglas fir plantations the significant increase of the content of the total humus and nitrogen in the soil occurs, as well as the transformation of potassium from the water-insoluble forms to the forms which are available to the plants. The Japanese larch and Austrian pine plantations have significantly less favourable influence on the revitalization of the soil.

Reviewer: **Ph. D. Dragana Dražić**

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Original scientific paper

THE SITE CHARACTERISTICS, FLORISTIC COMPOSITION AND STRUCTURE OF THE SPRUCE FOREST (ASS. *PICEETUM EXCELSAE MONTANUM SERBICUM* GREBENŠČIKOV 1950.) IN PESHTER PLATEAU

Ljubinko RAKONJAC[1], Zagorka TOMIC[2], Aleksandar VASILJEVIC[3], Mihailo RATKNIC[1], Milorad VESELINOVIC[1]

Abstract: *This paper presents the results of the research of the remains of sprouce forests in Peshter Plateau, i.e. on the mountain branches which extend well into Peshter area. The position, range, site conditions, floristic composition and structure, layers, etc. were determined in the observed area. The biological spectrum of the association and the spectrum of the floral elements are presented within the floristic composition.*

Key words: site, spruce forests, Peshter, floristic composition

1. INTRODUCTION

Spruce forests of Peshter Plateau are the remains of the previous coniferous forests of Giljeva, Ozren and the remains of the forests of the branches of Golija and Javor which extend well into the plateau itself. In almost all higher mountains in Serbia the spruce forests, which are preserved to a greater or lesser extent, and described by Grebenshchikov (G r e b e n s h c h i k o v, O., 1950) as the unique complex of spruce forests in Serbia under the name *Piceetum excelsae serbicum*. The montane types of spruce forests were marked by Blechic and Tatic (B l e c h i c, V., T a t i c, B., 1962) as *Picetum montanum.* The climate-regional zone at the altitudes ranging from 1,500 to 1,700 meters is made of the mono-dominant spruce

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forests. The zone is particularly well-developed in Kopaonik, Golija, Zlatar and Stara planina. The spruce forest is the dominant type of forests in Zlatar and is the climate-regional association (Obratov, D., 1992). It spread in a mosaic pattern, alternating with the other forest types at the altitudes ranging from 1,290 to 1,790, mainly on the limestone at the different exposures and slopes. By its population size and crown cover, the spruce is absolutely dominant in the forest layer, so all spruce forests are of mono-dominant character. It is very similar to the spruce forest in Golija. According to Blechic and Tatic (Blechic, V., Tatic, B., 1962), spruce forest in Golija is by its floristic composition more similar to the spruce forests of Montenegro and Croatia than to the spruce forests which have been described in Serbia. According to Obratov (Obratov, D., 1992), the same observation holds true to the spruce forests in Zlatar, which by their characteristics are similar to the spruce forest in Golija.

2. METHODS

The recent forest vegetation was studied by using the principles and methodology of the French-Swiss school by Braun-Blanquet (1928, 1921), which is usual and generally accepted in the phytocoenological researches in this country. As the starting point for the study of the phytocoenological characteristics of spruce forests, the collection of the phytocoenological records, which encompassed the basic characteristics of stands, floristic composition and construction and site conditions, was used. The spectra of the floral elements (percent of the groups of floral elements and the percent of the individual floral elements) per associations were made in accord with the systematization of the plant-geographical elements of Gajic (1984). The biological spectra (percent of some life forms) of the plants were made by using the results obtained by Kojic et al. (1994), based on the classification of the types of the life forms by Raunkiaer's method.

3. THE IMPORTANCE AND AIM OF THE RESEARCH

The ultimate aim of the study of the forest vegetation and spruce forests, as well as the suitable sites, is helping the regeneration and re-estastablishment of the forest cover in this devasted and to a great extent deforested plateaus, mainly in order to regenerate spruce in this optimal site of it, where it used to be considerably more present.

The current condition of forests and forest sites in Peshter Plateau is the result of its natural development over the previous periods.Its current condition is one of the important keys to solving the problem regarding the origin, succession, and degradation of forest vegetation of this area. The natural spruce forests in the form of the remains of the previous poly-dominant associations occupy only small areas.These associations, which are similar by the type of the micro-climate area or the mountain zone, by the site and floristic composition, and which originate from the same association, composes one ecological-floristic historic series, which implies that in such similar conditions, the indicators of which are the ecological-

vegetation-historic series, the forest vegetation can be efficiently re-established on the site on which it has been previously destroyed.

4. RESULTS

4.1. Position and distribution in the observed area

This tree species, which used to be well-spread, is not in the favourable position according to its range. It is limited to small forest preserves, scarce canopies and individual trees. Krstic (Krstic, O., 1956) reported that in the 1950s he was not able to find as three spruce in the same place, let alone spruce forests. He found only about twenty trees which sprouted from common hazel and common juniper scrubs at Zilindar, at the altitudes ranging from 1,460 to 1,600 meters above the sea level, above the very Potkrsh spring. In Bare the spruce association is in its range at the altitudes ranging from 1,200 to 1,400 meters, from the left bank of Dubochica to the meeting place of Babov Do and Crvachka Gorge. In this area its stands with the dense crowns were scattered. The last preserved forests burnt in 1947, between Treshnjevica and Vishnjevo. The previous spruce forest is quickly replaced by beeches and different sprouts, weak pastures, common hazelnuts, aspens and birches.The villagers still grow it in the forest preserves, but there is an increasing presence of the beech, apsen and Scots pine in them. The spruce in the Bare is in the regression. The third site is Karishici (from 1,200 to 1,400 meters above the sea level), in the forest preserves of the scattered pasture canopy. It is not found on the serpentinite although Krstic reported that it was present at the bend between Ozren and Jadovnik, but the sites reported by him did not have the serpentinite as the bedrock. On the slopes of Jadovnik it occurs individually on the limestone, in the complete regression. The distribution of the spruce on the surrounding area can be divided into two units. One of them spreads from Miloshev do to Uvac, and the second one from Uvac to Bojev do in Golija. On the first site it is found only in the small groups in the forest preserves in Gorachici, but the spruce also disappears on these sites. From Zlatarsko brdo to Derventa the spruce has been suppressed to the border line of Zlatar. Its best sites are now occupied by the common hazel bushes. With the little attention and tending, it could have been saved from the final destruction, at least in the form of the pasture forests and groves, so typical forms of the Stari Vlah forest-pasture landscape. It occurs in the vicinity of Sugubin and Papic, on the silicate terrains, between the massive limestones of Zlatar and Javor. In these places it is found in the preserved forest preserves, such as Papica gaj and Omar. From Omar, Papica gaj, towards Javor, via Radevska River towards its flat crest, the every trace of the spruce seems to lose in the huge range of deciduous forests of the foot of the Javor mountain (Krstic, 1956). It has preserved in the form of several small groups above Prashovici in the recent meeting places in Studenichka reka, below Ogorijevac and around Jevik, in the very vicinity of village, on the barren limestone karst (Krstic, 1956). At the western side of Leskovac (at 1,326 meters above the sea level) only one spruce, in the privately-owned forest preserve has been preserved. It has not been found on the slopes of Javor towards Golija in Sjenica area any more. The

scattered spruce crests are found on the dacite in Bojevo brdo, where its highest site is located at Peshter-Sjenicka Plateau. From Bojevo brdo via all Golija in the Ljutska reka gravity, there are no whole spruce stands, except for the individual trees in the beech forest Crvena Voda and in Srchanski Buh.

Regarding the characteristics of spruce stands, their conditions have not altered since Krstic described their sites up to the present, due to the permanent zoo-anthropogenic influences, so the progression is not visible. The spruce is the basic conifer tree of the open karst areas of the mountains of Dinaric type, and the Peshter-Sjenicka Plateau is also like this. In Sjenichka Ravine it is found only in the form of artificial plantations. From the above statements it is seen that the spruce has preserved only in the peripherous plots of the plateau in the forms of last remains.

4.2. Site charateristics

On three sites in the observed area the spruce association is found on the different bedrocks. In the foot of the mountain Javor in the valley of the Radevska River, where the spruce remained in the low-lying areas, the bedrock of the valley are limestone and marly limestone.The spruce is here found in the inversion, in the river ravine, where they descend and keep the cold air masses for a long time, as well as the snowdrifts which melt slowly, owning to which the spruce descended the lower positions. In Aljinovici, on the slopes of Zlatar, the spruce is found on the multi-layer limestone with cherts. In two stands in Bara, the spruce is found on spilite. Regarding the altitudes, the remains of these spruce stands are found at the altitudes ranging from 1,100 to 1,380 meters, at western, west-southwestern, eastern, north-northeastern exposures. The slopes of the terrains on which these spruce stands are located ranging from 15° in Bare, to 40° in the Radevska River. On the limestone of the Radevska River the limestone chernozem and brown limestone soil are developed, and on the cliff metting place the marly limestone and eutric cambisol occur. On the multi-layered limestone with chert at the branches of Zlatar, on the eutric cambisol in Aljinovici one spruce stand was found. In Bare, on the spilite, luvisol occurs in the stands with the dense crowns. The limestone chernozem is 37 cm deep, and by the texture characteristics it belongs to the powdery clay. The soil reaction is alkaline and pH value in water is 7.1, and in KCl it is 6.4. Regarding humus, the soil is rich (6.63%), as well as regarding the total nitrogen (0.65%). The soil is not well-provided with the available forms of phosphorous (0.7 mg/100 g soil), whereas it is well-provided with potassium (30.01 mg/100 g soil). The brown limestone soil is 55 cm deep, and regarding the texture characteristics it ranges from powdery clayey-loam to the powdery clay. The pH value is harmonized along the whole depth of profile and accounts for about 5.0. In the upper layers of the profile the soil is rich in humus and nitrogen, whereas in the lower ones it is poor (0.43%). Regarding the available forms of phosphorous, the soil is poor (0.1–0.3 mg/100 g soil), and regarding the available forms of potassium it ranges from poor-provided to well-provided (from 8.72 to 21.29 mg/100 g soil). Luvisols are deep for the conditions of Peshter, i.e.they are 70 cm deep, and regarding the texture characteristics in the upper parts

loams are present, and in the lower ones clays. In Bare the pH value of luvisols is about 5, and in KCl it is 4.3. The humus-accumulative horizon in this type of soil is rich in humus and nitrogen. Regarding the available forms of phosphorous, the soil is poor, whereas regarding the available forms of potassium it ranges from poor-provided to mid-provided.

4.3. Floristic composition and structure

Floristic composition and structure are presented by the phytocoenologic table 1, which contains 6 records. The phytocoenologic table contains 117 plant species: in the first layer ***Picea abies*** is dominant, and in one record the *Betula pendula, Fagus moesiaca, Pinus nigra* and *Populus tremula* are present. In the second layer more ligneous and bushy species are presented , the total of 22, and 102 species, respectively, occur in the layer of ground flora. Out of the species in the layer of ground flora, two species belong to fens and 100 species to the flowering plants. Individually, phytocoenological records contain very different number of species, from 14 (14b) to 55 plant species (S14), in average 34 species.The majority of records contains more than 30 plant species. The considerable number of plant species is found in only one phytocoenological record (71).

Spectrum of life forms – biological spectrum

The biological spectrum of association is presented in the Table 1. There is a high percent of spruce associations in chemi-cryptophytes (51%), which is much higher than in beech forests, and in beech and fir forests, which points to the cold conditions in it. Phanerophytes account for 20% (10% phanerophytes and 10 nanophanerophytes), which is more than in the spruce association in Zlatar that represents the monodominant association. There is a considerable percent of geophytes, which can be marked as mainly forest plants, i.e. they account for14 %. There is a low percent of the chamaephytes, which are the indicators of the unfavourable site conditions (herbaceous and ligneous chamaephytes, respectively, account for 2%). Terophytes, whose population size is mainly influenced by the Mediterranean, account for only 2%. For their development a lot of light and warmth are necessary, in which the spruce association is poor. Terophytes/chamaephytes account for 4%. Regarding the spectrum of life forms, this association is chemi-cryptophytic-phanerophytic

Table 1. *The spectrum of life forms of plants in Piceetum excelsae montanum serbicum Grebenshchikov 1950 association (sin. Picetum abietis serbicum (Rud. 47) Mish. et Pop. 1980)*

Životni oblici							
Phanerophytes	Nanophanerophytes	Ligneous chamaephytes	Herbaceous chamaephytes	Chemi-cryptophytes	Geophytes	Terophytes	Terophytes/ chamaephytes
p	np	lc	hc	c	g	t	tc
10%	10%	4%	4%	51%	14%	2%	4%
20%		8%					

Spectrum of floral elements

The spectrum of floral elements of the association is presented in the Table 2. The high percent of the individual range types is not visible, particularly regarding the Sub-Mediterranean floral elements, i.e. Balkan and Balkan-Apennine floral elements regarding some other associations of this area. The most dominant total range types are Mid-European floral elements (accounting for 27%), and the second most frequently found are Eurasian floral elements (accounting for 25%). The same ratio of the range types is found in the beech association. There is a low percent of the Sub-Meditteranean floral elements, which account for only 4%. There is a considerable percent of Pontic-Central Asian floral elements (accounting for 12%). The very important group of floral elements of the cold areas are made of frigophilic floral elements of the northen regions (accounting for 7%) and cosmopolitan floral elements (accounting for 11%)

Table 2. *Spectrum of floral elements of Piceetum excelsae montanum serbicum Grebenshchikov 1950. (sin. Picetum abietis serbicum (Rud.47), Mish.. et Pop. 1980) association*

Group of floral elements	Number of plants	Percent		Floral elements	Number of plants
FLORAL ELEMENTS OF NORTHERN REGIONS	5	7%	7%	Boreal European	1
				Sub-Boreal -Eurasian	1
				Sub-Boreal-Sub-Eurasian	1
				Sub-Boreal-Circumpolar	2
MID-EUROPEAN	18	27%	27%	Mid-European	6
				Sub-Mid-European	11
				Alpine-Carpathian	1
SUB-ATLANTIC	5	7%	7%	Sub-Atlantic-Sub-Mediterranean	5
SUB-MEDITERRANEAN	3	4%	11%	Sub-Mediterranean	3
Eastern-Sub-Mediterranean	2	3%		Eastern-Sub-Mediterranean	2
Balkan and Balkan-Apennine	3	4%		Moesian	1
				Sub-Illyrian	2
PONTIC-CENTRAL ASIAN	1	1%	12%	Sub-Pontic-Central Asian	1
Pontic	8	11%		Sub-Pontic	2
				Pontic-Sub-Mediterranean	4
				Pontic-Eastern-Sub-Mediterranean	1
				Sub-Pontic-Sub-Mediterranean	1
EURASIAN FLORAL ELEMENTS	17	25%	25%	Sub-South Siberian	4
				Eurasian	10
				Sub-Eurasian	3
CIRCUMPOLAR AND COSMOPOLITES	7	11%	11%	Circumpolar	5
				Cosmopolites	2
TOTAL:	69	100%	100%	TOTAL:	126

Mesophilic plants (of the Mid-European and Sub-Altantic floral elements) account for 34%, and the plants of the xerophilic character (Pontic, Sub-Mediterranean, Balkan floral elements, and the floral elements of the desert areas) account for 23%, whereas there is a high percent of the plants of the wide ecological amplitude (Eurasian and cosmopolitan floral elements), accounting for 28%. Frigophilic plants account for 14%.

The most dominant individual range types are Sub-Mid-European (11), Eurasian (10), Mid-Europan (6), circumpolar (5), etc. The spectrum of floral

elements of the spruce association in the observed area is very similar to the spruce association in Zlatar.

4.4. Layers

In the vertical structure of this association the following layers are present: trees, bushes and ground flora. It is a mono-dominant species; in the layers of trees and bushes the spruce is dominant. The degree of crown cover in the **first layer** is different and ranges from 0.5 to 0.9, but mainly it exceeds 0.7. The height of the trees is different, depending on the age of the stands, degree of the preservation of the stand range from 20 to 30m, and mainly it is 22 m. The mean diameter of the trees of the first layer of the observed stands is very similar and ranges from 30 to 35 cm, except for in one record (s31), where there is a wide range of volumes, from 12 to 35 cm. The highest values are reported at the western slope and in the valley of the Radevska River, where the significant dimensions, regarding the diameter and height, are reported, i.e. the diameter of the trees is up to 50 cm, and trees are taller than 25 m. It can be said that the distances between the trees are typical for such a condition of the spruce stands and range from 1 to 5 meters. The assessments of the spruce regarding the population size, crown cover and closure range from 3.3 to 5. 5, which leads to the conclusion that the stands are highly homogenous, since they mainly got the mark 4.4.

In the canopy of **bush layer** there are many species, even 22, in spite of the fact that the stands with the favourable canopy closure are found in the first layer. Regarding the degree of presence, *Picea abies* is dominant, but there are also significant percent of *Corylus avellana, Juniperus communis, Rosa arvensis*. The **layer of ground flora** is not abundant and the degree of land cover ranges from 0.15 to 0.4. The lower degree of land cover is reported in the stands with the dense canopy and found on the steep slopes, so the ground flora is not well-rooted. In the third layer the most frequently found are the following species: *Aremonia agrimonioides, Anemone nemorosa, Vaccinium myrtillus*, whereas *Brachypodium silvaticum, Fragaria vesca* are less frequent. In considerable part of the stands of this association the following species occur: *Daphne blagayana, Deschampsia flexuosa, Festuca ovina, Glechoma hirsuta,* and *Veronica officinalis*.

Table 3. *Phytocoenologic table – Association Piceetum exelsae montanum serbicum Grebenshchikov 1950*

Cardinal number of the record	**1**	**2**	**3**	**4**	**5**	**6**	**Degree of presence**
Number of record (field code)	s29	s29A	s31	A6	s14	14b	
Date of record	24.6.96	24.6.96	24.6.96	19.7.97	19.6.96	2.7.96	
Site	Radevska River			Aljinovići	Bare		
Area (m2)	900						
Altitude (m)	1190	1170	1100	1340	1370	1380	
Exposure	Z		S-SI	Z-JZ	I		
Slope(°)	40	25	20	15			
Bedrock	Limestones and marly limestones			Marly limestones with cherts	spilites		
Soil	Limestone chernozem	Brown limestone	Eutric cambisol		luvisol		

Cardinal number of the record	1	2	3	4	5	6	Degree of presence
I LAYER							
Canopy	**0.6**	**0.7**	**0.9**	**0.5**	**0.8**	**0.8**	
Height- mean (m)	**28**	**30**	**20**	**20**	**22**	**25**	
Diameter -mean (cm)	**38**	**35**	**12-35**	**30**	**30**	**35**	
Distance – mean (m)	**1-5**	**4**	**4**	**1-5**	**3-5**	**1-3**	
Picea abies	4.4	4.4	5.5	3.3	4.4	4.4	V
Betula pendula		+.1					I
Fagus moesiaca					+1		I
Pinus nigra				+.1			I
Populus tremula			+.1				I
II LAYER							
Canopy	**0.3**	**0.2**	**0.1**	**0.2**	**0.2**	**0.3**	
Mean height (m)	**1.5**	**1.5**	**1.5**	**1**	**1.5**	**1.5**	
Picea abies	1.2	2.1	1.1	1.1	+.1	3.3	V
Corylus avellana	1.2			+.1	+.1		III
Juniperus communis	+.1			+.1	+.1		III
Rosa arvensis	+.1		+.1		+.1		III
Rubus idaeus		+.1	+.1		1.1		III
Betula pendula		+.1	+.1				II
Populus tremula		1.1	1.1				II
Clematis vitalba	+.1						I
Cotoneaster tomentosus		+.1					I
Crataegus monogyna	1.1						I
Daphne laureola		+.1					I
Daphne mezereum					+.1		I
Lonicera nigra						+.1	I
Lonicera xylosteum	+.1						I
Prunus spinosa	+.1						I
Pyrus pyraster	+.1						I
Rhamnus catharticus	+.1						I
Rosa agrestis					+.1		I
Rosa canina	+.1						I
Salix capreae					+.1		I
Sorbus austriacus				+.1			I
Viburnum lantana	+.1						I
III LAYER							
Land cover	**0.3**	**0.4**	**0.15**	**0.3**	**0.3**	**0.4**	
Anemone nemorosa	+.1	2.2	1.2		+.1	1.2	V
Aremonia agrimonoides	+.1	+.1		+.1	+.1	+.1	V
Vaccinium myrtillus		+.1	+.2	2.2	3.3	3.3	V
Brachypodium silvaticum	+.1		1.2	+.1	2.2		IV
Fragaria vesca	+.1	+.1		+.1	+.1		IV
Daphne blagayana	+.1				+.1	+.1	III
Deschampsia flexuosa			1.1	1.1	+.1		III
Festuca ovina	+.1			+.1	+.1		III
Glechoma hirsuta	+.1	+.1				+.1	III
Potentilla heptaphylla		1.1		+.1	1.1		III
Veronica officinalis		+.1		+.1	+.1		III
Ajuga reptans					+.1	+.1	II
Asarum europaeum	+.1	+.1					II
Campanula persicifolia		+.1			+.1		II
Chamaecytisus hirsutus				+.1	1.1		II
Dactylis glomerata	1.2	1.1					II
Epilobium montanum		+.1	+.1				II
Euphorbia amygdaloides					+.1	+.1	II

Cardinal number of the record	1	2	3	4	5	6	Degree of presence
Festuca vallesiaca				1.1	2.2		II
Gentiana asclepiadea			1.1		+.1		II
Hypericum montanum			+.1		1.1		II
Luzula campestris		+.1		+.1			II
Melica nutans		1.2		+.1			II
Oxalis acetosella	+.1					+.1	II
Plantago media	+.1				+.1		II
Polygonatum verticillatum			+.1	+.1			II
Pteridium aquilinum	+.1				+.1		II
Stachys officinalis		+.1		+.1			II
Teucrium chamaedrys	+.1	+.1					II
Trifolium montanum	+.1			+.1			II
Viola sylvestris					1.1	+.1	II
Drvenaste u III spratu							
Picea abies	+.1	+.1	+.1		+.1		IV

The following species were reported in one phytocoenological record:
Agrimonia eupatoria +.1 (s29A), Alchemilla vulgaris +.1 (s29A), Astrantia major +.1 (A6), Ballota nigra +.1 (s29A), Bellis perennis +.1 (s29A), Campanula patula +.1 (s29A), Carduus personata +.1 (s29), Carex hirta +.1 (A6), Carex montana +.1 (A6), Centaurea montana +.1 (s29A), Centaurea nyssana +.1 (s14), Cephalanthera alba +.1 (s29), Chamaespartium sagittale +.1 (A6), Chamenerion angustifolium +.1 (s31), Crepis conyzifolia +.1 (A6), Cynosurus cristatus +.1 (s29A), Cytisus procumbens +.1 (s14), Dentaria bulbifera +.1 (14b), Digitalis ambigua +.1 (s14), Digitalis lanata +.1 (s29), Dryopteris filix-mas 1.1 (s14), Festuca pratensis +.1 (s14), Festuca rubra +.1 (s14), Filipendula hexapetala +.1 (s14), Galium aparine +.1 (s31), Galium corrudifolium +.1 (s14), Galium cruciata +.1 (A6), Galium mollugo +.1 (s29A), Galium silvaticum +.1 (s14), Galium uliginosum +.1 (s29A), Geum urbanum +.1 (s29A), Helianthemum nummularium +.1 (s14), Helleborus odorus +.1 (s29), Hieracium bauhini +.1 (A6), Hieracium cymosum 1.1 (s14), Hieracium guthnicianum +.1 (s31), Hieracium murorum 1.1 (s14), Hieracium pilosella +.1 (s14), Hypericum maculatum +.1 (s29A), Knautia magnifica +.1 (s14), Lamium galeobdolon +.1 (s29), Leontodon crispus +.1 (s29A), Leontodon hispidus +.1 (s31), Luzula luzulina 1.1 (s14), Luzula luzuloides 1.2 (s31), Luzula pilosa 1.1 (s29A), Majanthemum bifolium +.1 (s31), Melampyrum silvaticum +.1 (A6), Melittis melissophyllum +.1 (s29), Musco sp. 4.4 (14b), Nardus stricta 1.1 (A6), Pastinaca hirsuta 1.2 (14b), Plantago lanceolata +.1 (s14), Poa violacea 1.1 (s29A), Polygala comosa +.1 (s14), Polygala major 1.1 (s29A), Potentilla erecta +.1 (s14), Prenanthes purpurea +.1 (14b), Primula acaulis +.1 (s14), Prunella vulgaris +.1 (s29A), Prunus avium +.1 (A6), Sanguisorba minor +.1 (s14), Sanicula europaea +.1 (s14), Silene armeria +.1 (s14), Silene vulgaris +.1 (s14), Solanum dulcamara +.1 (s29), Stellaria graminea +.1 (s31), Thelypteris palustris +.1 (A6), Thymus serpyllum 1.2 (s14), Trifolium hybridum +.1 (s14), Veratrum nigrum +.1 (s31), Viburnum lantana +.1 (s29).

5. CONCLUSIONS

1. **Mono-dominant spruce forest - *Piceetum excelsae montanum serbicum* Greb. 1950, is found only in the peripheral parts of the region, occupying small areas or in the form of the small groups and individual trees. The association is preserved on the low-lying areas on the limestone and marly limestone, on the multi-layered limestone with cherts and spilities. The spruce stands are found at the altitudes ranging from 1,100 to 1,380 meters, at the western, western-southwestern, eastern, northern-northeastern exposures on the slopes of terrains ranging from 15 to 40°. The soils reported in the spruce forests are limestone chernozem, brown limestone, eutric cambisol and luvisol.**
2. **he spruce association contains 117 plant species: in the first layer *Picea abies* is dominant, and in one record *Betula pendula, Fagus moesiaca, Pinus nigra* and *Populus tremula* are present. In the second layer more ligneous and bushy species are present, the total of 22 and 102 species, respectively, occur in the layer of ground flora.**
3. **In the spruce association a high percent of chemi-cryptophytes (accounting for 51%) is reported, which is considerably higher than in the beech and fir forests, which points up to the cold conditions in it. Phanerophyte account for 20% (phanerophytes and nanophanerophytes account for 10%, respectively), more than in the spruce association in Zlatar, which is a mono-dominant association.**
4. **The association does not have many individual range types, particularly regarding the Sub-Mediterranean floral elements, i.e. Balkan and Balkan-Apennine, regarding some other associations of this area. The most frequently found total range types are Mid-European floral elements (accounting for 27%).**

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THE SITE CHARACTERISTICS, FLORISTIC COMPOSITION AND STRUCTURE OF SPRUCE FOREST (ASS. *PICEETUM EXCELSAE MONTANUM SERBICUM* GREBENŠČIKOV 1950.) IN PESHTER PLATEAU

Ljubinko RAKONJAC, Zagorka TOMIC, Aleksandar VASILJEVIC, Mihailo RATKNIC, Milorad VESELINOVIC

Summary

Mono-dominant spruce forest - *Piceetum excelsae montanum serbicum* Greb. 1950, is found only in the peripheral parts of the region, occupying small areas or in the form of the small groups and individual trees. The association is preserved on the low-lying soils on the limestone and marly limestone, on the multi-layered limestone with cherts and spilities. The spruce stands are found at the altitudes ranging from 1,100 to 1,380 meters, at the western, western-southwestern, eastern, northern-northeastern exposures on the slopes of terrains ranging from 15 to 40°. The soils reported in the spruce forests are limestone chernozem, brown limestone, eutric cambisol and luvisol.

The spruce association contains 117 plant species: in the first layer *Picea abies* is dominant, and in one record *Betula pendula*, *Fagus moesiaca*, *Pinus nigra* and *Populus tremula* are present. In the second layer more ligneous and bushy species are present, the total of 22 and 102 species, respectively, occur in the layer of ground flora.

In the spruce association a high percent of chemi-cryptophytes (accounting for 51%) is reported, which is considerably higher than in the beech and fir forests, which points up to the cold conditions in it. Phanerophyte account for 20% (phanerophytes nanophanerophytes account for 10%, respectively), more than in the spruce association in Zlatar which is a mono-dominant association.

The association does not have many individual range types, particularly regarding the Sub-Mediterranean floral elements, i.e. Balkan and Balkan-Apennine, regarding some other associations of this area. The most frequently found total range types are Mid-European floral elements (accounting for 27%).

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SESSILE OAK AND HORNBEAM FOREST RESOURCES IN PESHTER PLATEAU

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Abstract: *Sessile oak and hornbeam is the relict association (G1.A1A) reported on the limestone chernozem and dystric cambisol. The total of 138 plants, out of which 16 tree species, 15 bush species and 107 ground flora species, were registered. The mean value of the ecological indices for humidity is 2.54, of the chemical reaction of soil 3.24, of the nutrients 2.48, of the light 3.19, and of the temperature 3.36. Out of total number of the registered plants, there are 56 medicinal plants, i.e. 40.1%: 10 of them belongs to the first, 5 to the second, 12 to the fourth, and 15 species to the fifth healing classes. Due to the high degree of degradation, the sessile oak and hornbeam forests are not rich in the forest fruit trees. The total of 58 honey plants, out of which 8 ligneous, 18 bushy and 32 herbaceous species, was reported in the sessile oak and European hornbeam forests. The mean honey yield of the association is 3.00. The number of the honey plants in blossom is the highest in May, June and July, which enables the long-lasting honey-bee harvesting during the summer months. The beech forest occupy 412.85 hectares of the territory . The coppice stands account for 22.16%, and 5.4%, subsequently, whereas in other parts it occurs in the form of thick scrubs, with the trees thinner than 10 cm. In the aim of site regeneration, the main, accompanying and secondary tree species were defined.*

Key words: sessile oak and hornbeam forests, G1.A1A, sustainable use, natural resources

1. INTRODUCION

The disapperance of forests, which accounts for 10 million hectares annually, points out to the seriousness of problem and requires the urgent measures

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aimed at the inhibition of degradation and devastation of the current forest ecosystems. In the concept of ecocentric (or biocentric) use of the resources, the ecosystem is the complex of the living organisms and has its value by itself, which refers to the assessment of the human needs and their relation to nature in another way. The way in which nature creates and maintains the ecosystems is respected. The ecocentric concept protects, preserves and regenerates the functions of the natural ecosystems by the simultaneous use of all goods and services, which implies satisfying the human needs at the stable and permanent bases. The ecological processes in the ecosystems, which implies satisfying the economic needs of the society, but not the industrial use, are favoured. The integral part of this approach is the treatment of soil, water, biodiversity and biomass. The meeting of these goals is based on the ecological, socio-demographic and economic criteria. The concept is based on the Concept of the sustainable development and focused on the smaller territorial units (areas).

The sessile oak and hornbeam is the relict association. In Serbia sessile oak and hornbeam forests are orographically and edaphically determined, i.e. they occur as the extrazonal vegetation, and the association is not present in the classical form, which means that sessile oak and hornbeam do not occur in the tree layer (Gajic, M., 1970), but as the different combinations of several oak species with European hornbeam. The first "real" *Querceto-Carpinetum*, i.e. variant in which sessile oak and hornbeam is dominant in tree layer, has been first described by Rudski (1949).

This association is the extension of the association from the southeastern parts of Bosnia and Croatia, where the sessile oak and hornbeam forest is the climatogenic association. The association is of the mesophilic character and occurs at the higher altitudes. It also spreads in the spatially separated ranges within the area of climatogenic Hungarian and Turkey oak forest (Stefanovic, 1977), on the shaded slopes, fresh valleys of the brooks, on the lessive soil and pseudogley. Sessile oak and hornbeam forests were reported in Rudnik (Gajic, 1961), Avala (Borisavljevic, et al., 1955), Frushka gora (Jankovic et Mishic, 1960), Majdanpechka domena (Jovanovic, 1948) and Suva planina (Jovanovic, 1955), which means that in Serbia sessile oak and hornbeam association is clearly differentiated.

In the forests located in the lower hilly zone of Kopaonik, sessile oak and hornbeam forests are extremely disturbed, by the massive occurrence of oriental hornbeam (*Carpinus orientalis*) in the second layer (Rajevski et Borisavljevic, 1956). Sessile oak and hornbeam forest in Bosnia, where it is regionally extended in the moderate continental-humid climate, narrow their range in the southeast direction towards the area of Serbia and Montenegro. On the werferian sediments, as well as on the sediments from the Tertiary and Paleozolic formation, sessile oak and hornbeam forest (*Querco-Carpinetum iliricum*) in the border area of Hungarian and Turkey oak forest, occupy the most favourable sites, whereas the sessile oak forests are found on the less favourable sites (Stefanovic, 1964). In the virgin forest reserve Perucica, sessile oak and hornbeam forests were registered at the altitudes around 800 meters above the sea level as the thermophilic variants of sessile oak and hornbeam forest (Fukareket Stefanovic, 1958; Ratknic, 2004.).

2. MATERIAL AND METHOD

The research was conducted in sessile oak and hornbeam forest in the Peshter Plateau (southwestern Serbia). The soil characteristics were also studied based on the soil profiles, and the soil types were determined based on the soil classification (Shkoric, et all. 1985), as well as by using FAO classification. The sites were classified based on EUNIS classification. For the determination of the species "Flora of Social Republic of Serbia"(1970–1986), Ikonographie der flora des südöstlichen Mitteleuropa" (Jávorka, S., Csapody, V., 1979), "Flora and vegetation of Golija and Javor" (Gajic, M., 1989), "Flora of Tara National Park " (Gajic, 1988) were used. The biological spectra of plants were processed by using the method devised by Kojic et al. (Kojic, et al., 1994). The types of the life forms were classified by using Rankiaer's method (Diklic, 1984). The area covered by forests and forest stands, classification of area based on the types of stands, wood volume and volume increment, were analyzed. The percent of the trees in the total volume, thinner than 30 cm, was separately analyzed.

3. RESULTS

The adequate biodiversity protection at the spatial and genetic levels is not possible without the adequate site protection. The site becomes the central unit of protection in the concept of the biodiversity protection. The site is defined as the "association of plants and animals" (as well as other members of biocoenosis), which along with the abiotic factors (soil, climate, amount and quality of water, etc.) is the unique functional unit (Davies et Moss, 2002). The system of site classification in Serbia is based on the EUNIS system of classification. The sites which are within the EUNIS system kept the same names and codes, whereas the sites which are not found in the EUNIS system got the new names and codes, thereby mainly based on the *EUNIS* logics of naming. The new codes are integrated in EUNIS system of classification. Each site also got the suitable new code, relevant to the national system of classification (Lakushic, et all, 2005). The site classification is the integral part of EUNIS system (European information system) and was created in the aim of providing universal and inclusive site classification for Europe.

In order to satisfy the needs of EUNIS classification, the term "site" was defined in the following way: "place inhabited by plant and animal species, which is mainly characterized by the physical characteristics (topography, plant or animal physionomy, soil characteristics, climate, water quality, etc.), as well as by the plant or animal species which live there".

EUNIS classification is the data base which provides the comprehensive typology of European sites: from natural to artificial ones, from water to terrestrial ones. The sites were classified in a hierarchal way, at the certain levels and marked by alphanumeric codes. Based on these criteria, sessile oak and hornbeam forests would have the following hierarchal codes (Lakušić, et all, 2005).

G FOREST AND FOREST SITES AND OTHER REFORESTATED AREA
G1 Broadleaf deciduous forests
G1.A Meso- and eutrophic forests with <*Quercus*>, <*Carpinus*>, <*Fraxinus*>, <A*cer*>, <*Tilia*>, <*Ulmus*> and related forests
G1.A1 Oak forests <*Quercus*> - ash <*Fraxinus*> and hornbeam <*Carpinus betulus*> on eutrophic and mesotrophic soils
G1.A1A – Illyrian oak-hornbeam <*Quercus*> -<*Carpinus betulus*> forest
Equivalent association: *Querco-Carpinetum illyricum*

In the Peshter Plateau, sessile oak and hornbeam are completely devastated. These forests have disappeared due to the multi-century destruction, and have been preserved only as the low-lying bushes in Djetanica. Although the hornbeam is resistant to the adverse effects, these forests have not been preserved on the limestone terrains. The sessile oak, which did not managed to preserve in the conditions which are unfavourable to its development, disappeared from these forests. Such conditions were reflected in the shallow skeletal soil. Nowadays in Peshter Plateau they occur on the northen slopes of the valley of the Trijebinska River (silicate bedrock) and in the Uvac River valley, below the limestone cliffs of Uvacka Gorge. These forest do not have the preserved canopy, on the slopes of the cliffs the common hazel is dominant, and between the common hazelnut groups the short oriental hornbeam and hop-hornbeam are located. Due to the incomplete canopy the species of the surrounding forest and grass associations are present.

In Trijebina in the first layer aspen, birch, juniper tree are present, and in Chedovo and Uvac *Corylus avellana, Cornus mas, Juniperus communis, Viburnum lantana, Pyrus pyraster, Viburnum opulus, Crataegus monogyna, Cotoneaster intergerrimus,* etc. Although the terrains on which this association occurs are steep, and characterized by the shallow soil, humid air masses converge along the valley, so in the parts in the direction to Bare it occurs in the different site conditions than the ones in Uvac area. Owning to the vicinity of the rural settlements, the forests are destroyed, and not regenerated. Although the hornbeam is the biologically stronger edificator (which is able to multiply in vegetative and generative ways), it did not succeed in regenerating and preserving. The sessile oak has been, as the technically more valuable species, completely removed from these stands.

The association have two geographically-ecologically range of distribution. The first one is located below the limestone cliffs of the Uvacka Gorge, on its lateral slopes, on the limestone chernozem and occupy smaller areas of the brown limestone soil in the altitudinal zone ranging from 1,000 to 1,100 m, at all exposures, on the slopes ranging from 30 to 40^0 degrees, as well as in the valley itself (on the gentler slopes and deeper soils). The fragments of the previous stands are better preserved in the parts which are closer to the river. In the upper, flattened parts, limestone chernozem are from 10 to 30 cm deep, and has only managed to uproot and survive. In the past the soil was deeper, but by the process of forest destruction and occurrence of erosion its ability has been considerably reduced. The main site characteristics are analyzed in the Table 1.

On the diabase-chert formation, on the dystric cambisol, the better preserved stand of this association, which occurred as the result of the reduced anthropogenic influence over the last years, was reported. The remain of this

association was also studied in some parts of Trijebine village, on sands and clay, on dystric cambisol. Out of the remains of the previous forests only one hornbeam has remained, whereas aspen and birch are increasingly present.

Table 1. *Characteristics of the site of sessile oak and hornbeam forest*

The number of record	Parent rock	Soil	Altitude (m)	EExposure	NSlope $_0$
1	Limestone	Limestone chernozem	1010	N-W	40
2	Limestone	Limestone chernozem	1010	S	30
3	Limestone	Limestone chernozem	1090	W	30
4	Sandstones, shales and hornstones	Dystric cambisol	1010	N	30
5	Peskovi i gline	Dystric cambisol	1250	N-W	20

Floristic composition of sessile oak and hornbeam forests – In sessile oak and hornbeam association the total of 138 plants, 16 tree species, 15 bushy species, and 107 species occurring in the ground flora layer were reported (*Acer campestre, Achillea millefolium, Achnatherum calamagrostis, Aegopodium podagraria, Agrimonia eupatoria, Alchemila vulgaris, Anemone silvestris, Aremonia agrimonoides, Arrhenatterum elatius, Asarum europaeum, Asperula cynanchica, Asperula taurina, Avena planiculmis, Betula pendula, Brachypodium silvaticum, Briza media, Bupleurum sibthorpianum, Calamintha vulgaris, Campanula persicifolia, Campanula rotundifolia, Carpinus betulus, Carum carvi, Centaurea atropurpurea, Chaerophyllum aromaticum, Chaerophyllum hirsutum, Chamaespartium sagittale, Cirsium pannonicum, Convolvulus arvensis, Cornus mas, Coronilla coronate, Corylus avelanna, Cotoneaster integerrimus, Crataegus calycina, Crataegus monogyna, Dactylis glomerata, Danaa cornubiensis, Danthonia provincialis, Daphne mezereum, Deschampsia flexuosa, Dianthus petraeus, Doronicum columnae, Dorycnium herbaceum, Euphorbia amygdaloides, Evonymus verrucosus, Fagus silvatica, Festuca amethystine, Festuca heterophylla, Filipendula hexapetala, Fragaria vesca, Galium boreale, Galium corrudifolium, Galium mollugo, Galium purpureum, Galium silvaticum, Genista ovate, Glechoma hirsute, Helianthemum nummularium, Helleborus odorus, Hepatica nobilis, Heracleum sphondylium, Hypericum hirsutum, Hypericum perforatum, Inula helenium, Juniperus communis, Knautia sarajevensis, Lathyrus venetus, Leontodon crispus, Leucanthemum vulgare, Lonicera alpigena, Lonicera xylosteum, Luzula luzuloides, Luzula pilosa, Lysimachia nummularia, Medicago falcate, Medicago orbicularis, Melampyrum pretense, Melica nutans, Mercurialis perennis, Minuartia hybrid, Myrrhis odorata, Ostrya carpinifolia, Pedicularis comosa, Peucedanum officinale, Phyteuma spicatum, Picea abies, Pimpinella saxifrage, Pirus piraster, Plantago lanceolata, Plantago major, Poa nemoralis, Poa pumila, Polygala comosa, Polygonatum verticillatum, Populus tremula, Potentila erecta, Primula acaulis, Prunela vulgaris, Prunus spinosa, Pulmonaria officinalis, Quercus petraea, Ranunculus repens, Rhamnus catharticus, Rhamnus saxatilis, Ribes grossularia, Rosa agrestis, Rosa pendulina, Rubus idaeus, Salix capreae, Salix pentandra, Sanguisorba minor, Sanicula europaea, Scabiosa columbaria,*

Silene escapa var. balcanica, Silene roemeri subsp. sendtneri, Silene viridiflora, Solidago virga-aurea, Stachys officinalis, Stellaria graminea, Stellaria holostea, Succisa pratensis, Tanacetum corymbosum, Teucrium chamaedrys, Tilia cordata, Trifolium alpestre, Trifolium diffusum, Trifolium montanum, Trifolium pignantii, Trifolium pretense, Trifolium repens, Vaccinium myrtillis, Veratrum album, Veronica chamaedrys, Viburnum lantana, Viburnum opulus, Vicia cracca, Vicia incana, Viola hirta, Viola silvestris).

The spectrum of life forms – In the spectrum of life forms the high percent of chemicryptophytes (56.52%) was reported. The percent of geophytes (9.42%) points out to the relatively favourable pedological conditions of the stands in the vicinity of watercourses where the relative air humidity is high. Due to the open canopies and absorption of the high quantity of light, the particularly favourable conditions for the development of nano-phanerophytes (10.87%) are created. Phanerophytes and nano-phanerophytes account for 22.46%. Chamaephytes account for 8.69%, out of which there are 3.62% ligneous and 5.07% herbaceous species. Terophytes account for 2.17%, and terophytic/chamaephytes for 0.72% (Table 2.).

Table 2. *Life form spectrum of plants in sessile oak and hornbeam forests*

Life forms (%)							
Phanerophytes	Nano-phanerophytes	Ligneous chamaephytes	Herbaceous chamaephytes	Chemi-cryptophytes	Geophytes	Terophytes	Terophytes/ Chamaephytes
p	np	dc	zc	h	g	t	th
11.59	10.87	3.62	5.07	56.52	9.42	2.17	0.72
22.46		8.69					

Spectrum of floral elements – The Eurasian floral elements are most dominant in the spectrum of floral elements, accounting for 31.11%. Although the Eurasian elements are most dominant individual types in this range, Sub-Eurasian and Sub-South Siberian are also very frequently found. There is also a high percent of the group of Mid-European floral elements (23.70%), out of which Mid-European and Sub-Mid-European ones are the most frequently found individual range types. Sub-Mediterranean floral elements account for 17.04%, which points out to the more expressive influence of the Sub-Mediterranean climate. Pontic-Central Asian floral elements account for 13.33%, which is the result of the climate conditions in the Uvac and Vapa valley. Sub-Atlantic floral elements account for only 3.70%. Floral elements of the north regions and circumpolar ones account for 3.70%, and circumpolar and cosmopolites for 7.41% (Table 3.).

Table 3. *Spectrum of floral elements in sessile oak and hornbeam forests*

Name of the group of the floral elements	Floral element	Percent %	
1 FLORAL ELEMENTS OF NORTHEN REGIONS			
Arctic floral elements			
Boreal floral elements	Boreal-circumpolar	22.22	
	Sub-boreal-European –West-Siberian	00.74	
	Boreal-Eurasian	00.74	33.70

Name of the group of the floral elements	Floral element	Percent %	
2 MID-EUROPEAN FLORAL ELEMENTS			
Mid-European	Mid-European	11.11	
and European	Sub-Mid-European	11.85	
	Alpine- Carpathian	00.74	223.70
3 SUB-ATLANTIC FLORAL ELEMENTS			
Sub-Atlantic and Atlantic	Sub- Atlantic- Sub-Mediterranean	33.70	33.70
4 SUB-MEDITERRANEAN FLORAL ELEMENTS			
Sub-Mediterranean	Sub-Mediterranean	110.37	
East-Sub-Mediterranean	East-Sub-Mediterranean	11.48	
Balkan and	Sub-Moesian	00.74	
Balkan-Apennine	Scardo-Pindic	00.74	
	Mid-Balkan	11.48	
	Sub-Mid-Balkan	00.74	
	Mid-Balkan –Central-South-Apennine	00.74	
	Sub-Balkan-Apennine	00.74	117.04
5 PONTIC-CENTRAL ASIAN FLORAL ELEMENTS			
	Sub-Pontic-Central Asian	22.96	
	Sub-Pontic- Cenral Asian – Sub-Mediterranean	00.74	
Pontic	Pontic	00.74	
	Sub-Pontic	22.96	
	Pontic-Sub-Mediterranean	22.22	
	Pontic-East-Sub-Mediterranean	11.48	
	Sub-Pontic-Sub-Mediterranean	00.74	
	Sub-Pontic-Sub-Pannonian	11.48	113.33
6 EURASIAN FLORAL ELEMENTS			
	Sub-South Siberian	55.93	
	Eurasian	117.04	
	Eurafrican	00.74	
	Sub-Eurasian	77.41	331.11
7 CIRCUPOLAR COSMOPOLITAN FLORAL ELEMENTS			
	Circumpolar	66.67	
	Cosmopolites	00.74	77.41

Ecological indices of sessile oak and hornbeam forests – In sessile oak and hornbeam forests the ecological indices of humidity, chemical soil reaction, nutrients, light and temperature were determined.

The mean value of the ecological indices of humidity is 2.54 (depending on the record, the values ranges from 2.47 to 2.77). Sub-mesophilic plants, which favour more mesophilic sites, but can be also found in xerophilic conditions, are most dominant on these sites.

The mean value of the ecological indices of the chemical soil reaction is 3.24 (from 3.15 to 3.36) and mainly points out to the neutrophilic plants, which are found on the neutral and low acidified soil.

The mean value of the ecological indices of nutrients (amount of nitrogen in the soil) is 2.48 (from 2.31 to 2.59), which points out that the plants that are intermediate between oligotrophic and mesotrophic ones are most frequently found.

The mean value of ecological indices of the light is 3.19 (from 2.83 to 3.39), which means that half-sciophytes are most frequently found in birch forests.

The mean value of ecological indices of the temperature is 3.36 (from 2.06 to 3.46) and points out to the high percent of mesothermal species which are dominant in the montane conditions.

Medicinal plants in sessile oak and hornbeam forests – In sessile oak and hornbeam forests the presence of 138 plant species was reported. Out of this number 56 species, i.e. 40.1%, are medicinal ones.

Within the first healing class 10 species, i.e. 7.2% , were reported (*Achillea millefolium, Betula pendula, Crataegus monogyna, Hypericum perforatum, Juniperus communis, Quercus petraea, Sanicula europaea, Tilia cordata, Vaccinium myrtillis, Veratrum album*). All species are in the circulation, and only *Quercus petraea* is not subject to the limits in the amount of collection. *Veratrum album* is found in the Red Book, determined as the highly endangered taxon and its collection is prohibited.

In the second healing class 5 species, or 3.6%, were reported (*Agrimonia eupatoria, Plantago lanceolata, Pulmonaria officinalis, Sanguisorba minor, Solidago virga-aurea*). All species are in the circulation, except for *Sanguisorba minor,* which is not under the control of collection and circulation.

In the third healing class 12 species, or 8.7%, were determined (*Asarum europaeum, Cornus mas, Daphne mezereum, Fagus silvatica, Glechoma hirsute, Helleborus odorus, Hepatica nobilis, Populus tremula, Potentila erecta, Prunus spinosa, Rhamnus catharticus, Rubus idaeus*). The species *Glechoma hirsuta, Hepatica nobilis and Populus tremula* are not in the circulation and are important in the folk medicine. The species *Daphne mezereum, Fagus silvatica, Helleborus odorus, Prunus spinosa, Rhamnus catharticus i Rubus idaeus* are in the circulation. *Asarum europaeum, Cornus mas and Potentila erecta* are under the control of collection.

The total of 12 plant species, or 8.7%, belong to the fourth healing class (*Carum carvi, Corylus avelanna, Euphorbia amygdaloides, Filipendula hexapetala, Fragaria vesca, Heracleum sphondylium, Hypericum hirsutum, Plantago major, Ranunculus repens, Stachys officinalis, Teucrium chamaedrys, Veronica chamaedrys*). There are no limits to the species *Carum carvi, Filipendula hexapetala, Plantago major, Ranunculus repens*, regarding the amount which can be collected from the natural sites. The species *Corylus avelanna, Fragaria vesca, Teucrium chamaedrys and Veronica chamaedrys* are under the control of collection and circulation. The species *Euphorbia amygdaloides, Heracleum sphondylium and Stachys officinalis* are important in the folk medicine.

In the fifth healing class 15 species, or 10.9%, were reported (*Aegopodium podagraria, Alchemila vulgaris, Doronicum columnae, Galium boreale, Inula helenium, Lysimachia nummularia, Medicago falcate, Picea abies, Pimpinella saxifrage, Primula acaulis, Prunela vulgaris, Ribes grossularia, Salix capreae, Salix pentandra, Trifolium pretense, Trifolium repens, Viburnum opulus*). The species *Picea abies* is in the circulation without any limit, and *Alhemila vulgaris, Inula helenium and Pimpinella saxifraga* are under the control of collection and circulation, whereas the other species are not of the great economic significance.

Fruit trees in sessile oak and hornbeam forests – In sessile oak and hornbeam forests the following species of fruit trees were reported: *Crataegus monogyna, Juniperus communis, Vaccinium myrtillis, Cornus mas, Rhamnus*

catharticus, Rubus idaeus, Fragaria vesca, Ribes grossularia, Cotoneaster integerrimus, Lonicera alpigena, Lonicera xylosteum i Rosa agrestis.

Honey plants in sessile oak and hornbeam forests – Based on the analysis in sessile oak and hornbeam forests, 58 honey plants, out of which 8 ligneous ones, were reported (*Tilia cordata, Acer campestre, Picea abies, Populus tremula, Quercus petraea, Betula pendula, Carpinus betulus, Fagus silvatica*), 18 bushy (*Corylus avelanna, Crataegus calycina, Rosa pendulina, Rubus idaeus, Salix capreae, Viburnum lantana, Cornus mas, Coronilla coronata, Cotoneaster integerrimus, Crataegus monogyna, Evonymus verrucosus, Genista ovata, Prunus spinosa, Ribes grossularia, Teucrium chamaedrys, Viburnum opulus, Daphne mezereum, Vaccinium myrtillis*) and 32 herbaceous (*Calamintha vulgaris, Campanula persicifolia, Pulmonaria officinalis, Stachys officinalis, Trifolium alpestre, Trifolium montanum, Veronica chamaedrys, Vicia cracca, Galium mollugo, Anemone silvestris, Filipendula hexapetala, Galium boreale, Inula helenium, Lysimachia nummularia, Phyteuma spicatum, Plantago major, Primula acaulis, Prunela vulgaris, Scabiosa columbaria, Solidago virga-aurea, Veratrum album, Vicia incana, Aegopodium podagraria, Fragaria vesca, Helleborus odorus, Heracleum sphondylium, Hypericum perforatum, Medicago falcata, Plantago lanceolata, Polygala comosa, Succisa pratensis Mnch, Trifolium repens*). The mean honey yield of the association is 3.00. The number of honey plants in blossom is the highest in May, June and July (Figure 1).

Wood resources of sessile oak and hornbeam forests – Sessile oak and hornbeam occupy 412.85 hectares. Coppice stands account for 22.16% and 5.4%, subsequently, whereas in other parts of the area it occurs in the form of the thick scrubs, with the trees thinner than 10 cm.

Regeneration of sessile oak and hornbeam forests – The selection of the tree species for the regeneration of the ecosystem will enable its faster revitalisation. The following species were defined:

"Main tree species" which are used for the reforestation of the completely preserved sites or sites which are slightly degraded: *Quercus petraea, Carpinus betulus*

"Accompanying tree species" refer to the species of the different ecological requirements. The selection of the accompanying species is made depending on the level of degradation of the site, parent rock and pedological conditions: *Acer campestre, Fraxinus ornus*

"Bushy species" are typical for the degradational phases of the stand and can be used in the process of the faster revitalization of the damaged or destroyed ecosystems: *Ligustrum vulgare, Evonymus europaeus, Cornus sanguinea*

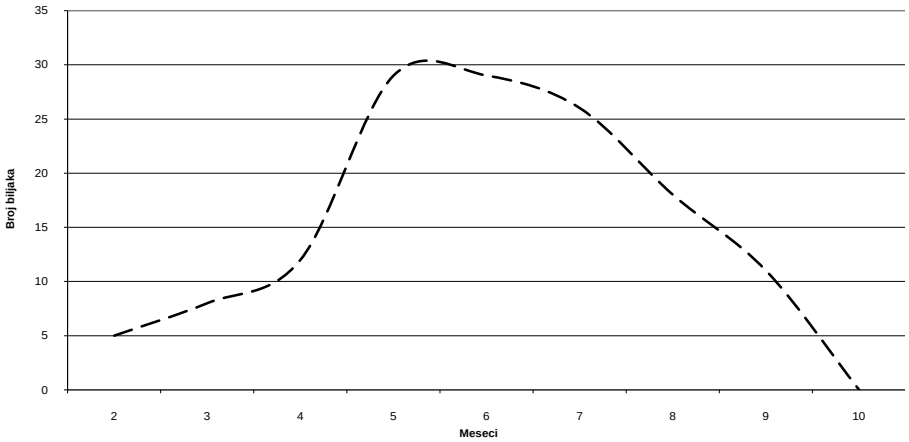
4. DISCUSSION AND CONCLUSIONS

The condition of the plant resources in the Peshter Plateau is endangered by the multi-annual destruction, which is directly reflected in the socio-demographic status of the population. These researches are aimed at the definition of the condition of the natural resources, determination of the priorities of the activities for the inhibition of the adverse effects and subsequent selection of the

methods for the improvement of the condition. By achieving the aims of the research of the sustainable use of the plant resources of the Peshter Plateau, the bases for the following activities are made:

- Implementation of the European standards and models and creation of the methodology of the registration of the renewable plant resources;

Figure 1. *The number of honey plants in sessile oak and hornbeam forests which are in blossing during a year*



- Creation of the strategic frame for the sustainable management by the renewable resources based on the principles of the sustainable development and the level of the researches of the current natural resources which have been conducted so far;
- Preservation and increase of the ecological, biological, climate, social-cultural and economic benefits of the use of the plant resources;
- Environment protection, social and spiritual functions and value of the natural ecosystems achieved by: establishment, extension and suitable management by the protected areas and associations, forest presentation the representative ecological systems and regions, preservation and management by the game, preservation of the gene pool, measures of supporting and providing of the sustainable use of the biological resources and biodiversity preservation;
- Supporting and improvement of the national programs of reforestation and reclamation of the degraded sites, establishment of the new ones and improvement of the current forests of different purposes, in order to reduce the pressure with which the current forest ecosystems are faced up;
- Base the concept of the planning of the permanent management by the renewable plant resources on the criterion – preservation of the environment quality, which means that the economic use of the renewable plant resources must not reduce the numerous ecological functions, and the preservation and enriching of the site biodiversity;
- Create the conditions for the establishment of the elements of the sustainable agricultural production;

- Preservation and improvement of the biodiversity.

The collected data enable the multi-layer comparative analysis of the area by using GIS technology, as well as the determination of the level of the threats posed to the natural ecosystems and suitability of the area for the certain activities. The anticipation of the direct and indirect results of the unintended use of the area is enabled, which means that before the final decision is made the great faults can be prevented. The series of sub-program activities which are in the interactive relations can be formulated in several general program aims: environmental protection, optimal use of the natural resources, improvement of the secondary activities, advertising analyses and analyses of the commercialization of the offer of this area, strictly in the aim of preservation of the natural resources and environmental protection (by using the principles of the sustainable development of the renewable plant resources).

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THE ENDANGERMENT OF THE ECOSYSTEM DIVERSITY OF GRDELICHKA GORGE AND VRANJSKA BASIN OWNING TO THE ANTHROPOGENIC FACTOR

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Abstract: *This paper presents the ecosystem diversity, demographic and social-economic changes in southeastern Serbia over the period 1948-2010 (Grdelichka Gorge and Vranjska Basin), as well as the analyses of the changes of the ecosystem diversity owning to the anthropogenic factor.*

The following groups of sites were reported in the observed area:

D - mire, bog and fen sites; E- grassland and tall forb sites; F - heathland, scrub and tundra sites; G - forests and forests sites and other reforestated areas; H – inland unvegetated or sparcely vegetated sites; I- regularly or recently cultivated agriculture, horticultural and domestic sites; J - constructed, industrial and other artificial sites.

The migration trends over the oberved period also caused the different degrees of endangerment of the natural sites in this area, for the benefit of the sites formed by the anthropogenic influences. Mire, bog and fen sites, as well as grassland and tall forb sites are particularly endangered.The scrub and forest sites are degraded to a great extent.

Key words: endangerment of the ecosystem, sites, anthropogenic influences, migration trends

1. INTRODUCTION

"The settlements located at the highest altitudes in Chemernik (Procholovci, Jovanovci, Bajinci, Mlachishte, Ostrozub, Dobro Polje, Bistrica, Ruplje, Borovik, Machakatica, Troskach and Vlasinske mahale) have been almost

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deserted over the last thirty or more years, the schools in them have been closed, the life has faded away.

The Vlasinska and Crnotravska villages are empty, the people have moved out. There are no sheep flocks, no cattle herds, no horses. There are no people. The roads are overgrown with the grass. The villages in the lower regions of Grdelichka Gorge and lower coarse of the Vlasina River are still populated". (Petrovic, 2007). It has resulted in the change of the intensity of the effect of the anthropogenic factor on the ecosystems, both terrestrial and aquatic.

2. OBSERVED AREA

Grdelichka Gorge and Vranjska Basin area is located between 42°22' and 42°55' north latitude and between 19°21' and 20°0' eastern longitude. It mainly spreads in the direction southwest-northeast, is about 60 km long, and occupies 173,261 hectares. It is located at the altitudes ranging from 256 to 1,923 meters above the sea level. In the altitudinal zone ranging from 700 to 1,000 meters above the sea level 27 % of the area is located, in the zone above 1,000 meters above the sea level about 25 %, in the zone ranging from 500 to 700 meters above the sea level 24 %, in the zone ranging from 300 to 500 meters above the sea level 23 %, and in the zone up to 300 meters above the sea level about 1% (Braunovic et al, 2010). The area can be divided into three climate zones: the first one refers to Vranjska Basin and wide river valleys, the second one to mountain area, and the third one to Grdelichka Gorge. Vranjska Basin and southern part of the area are exposed to the Mediterranean influences along the Vardar valley, whereas in the regions located at the higher altitudes the mountain climate with very long and severe winters and a great quantity of snow is dominant. Summers are short, with somewhat higher amount of precipitation that in the basin.The annual sum of precipitation ranges from 564.1 (Klenike) to 999.4 mm (Kriva Feja).

3. METHOD

The system of classification of sites in Serbia is based on the EUNIS classification. The sites which are within the EUNIS system kept the same names and codes, whereas the sites which do not occur within the EUNIS system got the new names and codes, thereby mainly keeping the EUNIS logics of naming. The new codes are integrated in EUNIS system of classification. Each site also got the suitable new code, relevant to the national system of classification (Lakushic et al, 2005). The creation of this system is aimed at the establishment of the referential data base on the species, sites and areas, which are the base of the Birds Directive and Habitats Directive for NATURA 2000 network, and EMERALD network of Berne Convention network, which is similar to it and is also used during the development of indicators (EEA Core Set et al.) and creation of the report on the environmental condition. The analysis of the change of the population, altitudinal distribution of settlements and population are based on the data obtained by the censuses from 1948, 1953, 1961, 1971, 1981, 1991, and 2002.

4. RESULTS

The increase in the population of Grdelichka Gorge and Vranjska Basin is typical for all inter-census period up to 1991, and over the last inter-census period (1991-2002), the stagnation was reported in all area. The decrease in the population over this period was reported in the municipalities Bujanovac and Surdulica, and in the part of the area which belongs to the municipalities Leskovac and Crna Trava. The stagnation was reported in the municipality Vladichin Han, whereas there was a constant increase of the population in the municipality Vranje, and the number doubled in 2002 in comparison with 1948 (Braunovic, Ratknic 2010/a).

The data on the population per municipalities and census years are preserved in the Table 1.

Table 1. *The population per municipalities and census years*

Municipality	1948	1953	1961	1971	1981	1991	2002
Leskovac	12776	13070	14063	14242	14055	13229	12366
Crna Trava	2352	2297	2069	1292	727	359	199
V. Han	24946	25927	26074	25231	25441	25253	23710
Surdulica	17305	20057	19467	19662	21098	21260	19738
Vranje	48388	51173	54841	63160	75571	80778	84004
Bujanovac	20841	22185	23630	26915	29929	33137	29324
Total	126608	134709	140144	150502	166821	174016	169341
The analysis of the population was done based on the data for the following municipalities (parts of the municipalities) which belong to the observed area: Leskovac 25 settlements, Crna Trava 7 settlements, Vladičin Han 51 settlements, Surdulica 25 settlements, Vranje 80 settlements and Bujanovac 33 settlements. The data were collected and analyzed for 221 settlements.							

The altitudinal distribution of the settlements directly depends on the topographic characteristics of the area, so in the altitudinal zone above 500 meters 136 settlements (61.5%) are located. The majority of settlements is located in the altitudinal zone ranging from 300 to 500 meters, i.e. 84, which is followed by the altitudinal zones ranging from 500 to 700 meters - 58 settlements, and in the altitudinal zone ranging from 700 to 1,000 meters - 50 settlements.In the altitudinal zone above 1,000 meters 28 settlements are located, and in the zone up to 300 meters only one settlement (Table 2).

Table 2. *Altitudinal distribution of settlements and population*

Altitudinal zone	Number of settlements	%	Population per census years							Projection for 2021
			1948	1953	1961	1971	1981	1991	2002	
Up to 300	1	0.45	11252	13465	17999	28613	44094	51215	55052	61800
300-500	84	38.01	54699	57515	60052	64296	71527	79109	76611	72313
500-700	58	26.24	26335	28129	28462	28289	28858	27912	25532	22107
700-1000	50	22.62	22119	22747	21415	19177	16023	12116	9933	6962
>1000	28	12.67	12203	12853	12216	10127	6319	3664	2213	373
	221	100.00	126608	134709	140144	150502	166821	174016	169341	163555

Due to the intensive processes of depopulation, the greatest changes have occurred in the altitudinal zones up to 300 meters and above 1,000 meters. In the zone up to 300 meters the population until1948 increased by 4.9 times, whereas in the altitudinal zone above 1,000 meters it decreased by 5.51 times. In the altitudinal zone ranging from 700 to 1,000 meters the population decreased by 2.2 times, in the zone ranging from 500 to 700 meters by 0.96 times, and in the zone ranging from 300 to 500 meters the population increased by 1.32 time in comparison with 1948.

The process of redistribution of population has resulted in the increase of the urban and decrease of rural population, creation of the areas of demographic growth (cities) and areas of decline (majority of rural settlements) and in the change of the ways in which the land is used.

Given the fact that Grdelichka Gorge and Vranjska Basin area is one of the most erodible areas in Serbia, in order to alleviate the erosional processes (Law on Soil Protection from 1953), the intensive reforestation by using broadleaf and coniferous species was done, thereby creating the artificial anthropogenic forest ecosystems. Some highly invasive species (Robinia pseudoacacia, Amorfa frutisoca, Ailathus glandulosa, etc.), which by their presence exert additional pressure by spreading into the natural ecosystems, thereby endangering their survival and altering their structure, were used.

Along with the above demographic changes and anthropogenic influence in the observed area, the following sites were reported:

D - MIRE, BOG AND FEN SITES

D2 - Valley mires, poor fens and transition mires

D2.2 - Poor fens

D2.26 - Mires with common cottongrass (Eriophorum angustifolium) - Reported in Vlasinska Plateau, on the siliceous bedrock at the altitudes ranging from 1,200 to 1,900 meters

D2.3 - Transition mires and quaking bogs

D2.37 - Rhynchospora alba quaking mires - Reported in Vlasinska Plateau, Chemernik and Ostrozub, on the siliceous bedrocks and red Permenian sandstone, at the altitudes ranging from 1,200 to 1,520 meters.

D2.3I - Eastern Balkan sphagnum (Sphagnum) quaking bogs

D2.3I1 - Eastern Balkan (Sphagnum) - (Drosera rotundifolia) quaking bogs - Reported in Vlasinska Plateau, Chemernik and Ostrozub, at the altitudes above 900 meters.

E – GRASSLAND AND TALL FORB SITES

E1 - Dry grassland

E1.7 - Non-Mediterranean dry acid and neutral closed grassland

E1.76 - Dry sub-continental silicate steppe grassland

E1.761 - **Dry sub-continental silicate steppe grassland on which Chrysopogon gryllus is dominant** - The relatively frequent type of site on the siliceous bedrock in this area. They were reported in Grdelichka Gorge (Palojce, Sushevljane, Predejane, Lichin dol, Grdelica), in Kukavica, Vardenik (Vrebovo, Sebevranje) and in the hilly regions of Besna kobila. The associations are

developed on the dry siliceous terrains, at the altitudes ranging from 300 to 900 meters, mainly on the flattened terrains or less inclined slopes, acid soils on sandstones, lake clays, crystalline schists, micaschists, marls or daci-andesites. These sites are warm, dry and used to be occupied by the climatogenic associations Quercion frainetto, which have been cleared.

E1.763 - Dry sub-continental silicate steppe grassland dominated by Danthonia calycina - The relatively frequent type of site on the siliceous terrains of Grdelichka Gorge and Ostrozub. These formations are mid-high, closed, floristically rich, herbaceous and steppe-like, dominated by Danthonia calycina. The associations develop at the altitudes ranging from 800 to 1,200 meters, mainly on the flattened terrains or less inclined slopes, on the acid soils, in the moderate-continental climate conditions. These sites are warm, dry and used to be occupied by the climatogenic associations Quercion frainetto, which have been cleared.

E1.9 - Non-Mediterranean dry acid and neutral open grassland, including inland dune grassland

E1.92 - Perennial open siliceous grassland

E1.921 - Dry sub-continental open siliceous steppe grassland. The site was reported in Kukavica. It occurs on the siliceous bedrock, on the different shallow acid soils, at the altitudes ranging from 350 to 1,100 meters.

E1.923 - Dry sub-Mediterranean open siliceous sites on which clovers are dominant. The site was reported in Kukavica on the siliceous bedrocks. It occurs on the different types of shallow acid soils, at the altitudes ranging from 400 to 700 meters.

E3 - Seasonally wet and wet grasslands

E3.3 - Sub-Mediterranean humid meadows

E3,31 - Helleno-Moesian riverine and humid (Trifolium) meadows.

E3.31C - Helleno-Moesian riverine and humid meadows dominated by clovers - The site was reported in Kukavica, on different types of humid soils on the siliceous bedrock. It occurs at the altitudes ranging from 250 to 350 meters.

E3.4 - Moist or wet eutrophic and mesotrophic grassland

E3.41 - Atlantic and Sub-Atlantic humid meadows

E3.411 - Sub-Atlantic humid meadows dominated by Scirpus sylvaticus. The site was reported in Vardenik, Vlasinska Plateau, Ostrozub and Chemernik. It occurs on the different bedrock (silicate, red Permenian sandstones, granodiorites), at the altitudes ranging from 350 to 1,600 meters.

E3.43 - Subcontinental riverine meadows

E3.431 - Subcontinental riverine meadows with (Deschampsia cespitosa). The sites are exposed to the long-lasting floods, and ocassionally susceptible to drying, but the level of the ground waters are constantly high. They occur at the altitudes up to 1,350 meters, on the typically fen soil. They were reported in Vlasinska Plateau.

E4 - Alpine and Sub-Alpine grassland

E4.3 - Acidophilous Alpine and Sub-Alpine grassland

E4.31 - Alpine (Nardus stricta) and related herbaceous associations

E4.312 - Moesian Northern-Scardo-Pindic Sub-Alpine (Nardus stricta) herbaceous associations. The site was reported in Besna Kobila, Stresher

(Vardenik), Chemernik and Ostrozub. These associations mainly develop on the silicates, at the altitudes above 1,100 meters.

E4.39 - Oro-Moesian acidophilous grassland

E4.392 - Moesian -Northern-Scardo-Pindic acidophilous Alpine and Sub-Alpine grassland

E4.3923 - Moesian – Northern-Scardo-Pindic Alpine and Sub-Alpine (Sesleria comosa) grass associations on silicates. The associations mainly develop on silicates, in the Sub-Alpine and Alpine zone at the altitutudes above 1,500 meters. The site was reported in Besna kobila.

E4.3925 - Moesian-Northern-Scardo-Pindic Alpine and Sub-Alpine Festuca paniculata) grass associations on silicates. The associations mainly develop on silicates, at the altitudes above 1,300 meters. The site was reported in the Vlasinska Plateau (Crkvena planina, Plana, Veliki Stresher, Golema Ravnica, Besna Kobila, Prosechenica).

E4.3926 - Moesian-Northern-Scardo-Pindic Alpine and Sub-Alpine (Festuca vallida) grass associations on silicates. They mainly develop on the siliceous bedrocks (micaschits, granite-gneiss), at the altitudes ranging from 1,500 to 1,900 meters. The site was reported in Vlasinska Plateau (Veliki Stresher, Besna Kobila, Ostrozub, Chemernik, Crkvena planina).

E6 - Inland saline sites on which grass and herbaceous plants are dominant

E6.2 - Continental inland saline sites dominated by grass and herbaceous plants

E6.23 - Central Eurasian solonchak grassland dominated by (Crypsis)

E6.231 - Sandy- sladgy saline sites with (Acorellus pannonicus) around saline wells and ponds were reported in Aleksandrovachka Saline (near Vranje). This is slatine vegetation of the ephemeral character. In the late summer the sites become dry, chapped and clear areas devoid of vegetation.

E6.24 – Central Balkan salines and saline steppes. In the observed area the site was reported in many plots (Aleksandrovachka Saline, Neradovachka Saline, salines near Oslar and Bujanovac)

F - HEATHLAND, SCRUB AND TUNDRA SITES

F2 - Arctic, Alpine and Sub-Alpine scrub sites

F2.2 - Evergreen Alpine and Sub-Alpine heaths and scrub sites

F2.23 - Southern-Palaearctic mountain dwarf scrubs with junipers (Juniperus)

F2.231 - Balkan Sub-Alpine scrub land dominated by Siberian juniper and Dwarf Japanese Garden Juniper (Juniperus sibirica) = (Juniperus nana). The site was reported in Besna kobila and Stresher, in the Sub-Alpine zone at the altitudes above 1,500 meters.

F2.26 - (Bruckenthalia) heaths. They were reported in Besna kobila, Mali and Veliki Stresher. The association develops on the siliceous bedrock at the altitudes above 1,500 meters.

F2.27 - Alpide (Arctostaphylos uva-ursi) and (Arctostaphylos alpinus) heaths. These associations develop on limestone or siliceous bedrock at the altitudes above 1,600 meters, and were reported in Besna Kobila, Mali and Veliki Stresher.

F2.2A - Alpide high mountain heaths with dwarf bilberries

F2.2A1 - Balkan high mountain heaths with bog bilberry (Vaccinium uliginosum). These associations develop on the siliceous bedrock (more rarely on limestones), at the altitudes above 1,700 meters, and were reported in Vlasinska Plateau (Veliki Stresher) and Besna kobila.

F3 – Temperate and Mediterranean montane scrub sites

F3.1 - Temperate thickets and scrub sites

F3.17 – Common hazel thickets - Lowland, hilly and mountain tall scrub associations usually with the the dense canopy. The associations are mainly the degradation phases of the different types of forests in the zone of moderate broadleaf forests.

F3.2 – Mediterranean - montane broadleaf deciduous thickets

F3.24 - Subcontinental and continental deciduous thickets

F3.242 - Balkan subcontinental deciduous thickets

F3.242C - Balkan subcontinental broadleaf oriental hornbeam thickets Carpinus orientalis) -Densely groupped, closed or scattered and open 2-3 m tall deciduous thickets. The associations develop on limestone, acid silicated (granite, red sandstone) or serpentinites and peridotites on shallow and poor soils, in the transitional Sub-Mediterranean- Subcontinental climate conditions, at the altitudes up to 1,400 meters.

F3.242E - Balkan subcontinental deciduous hop hornbeam thickets (Ostria carpinifolia). Densely groupped, closed or scattered and open 2-3 m tall deciduous hop hornbeam thickets. These associations are developed on the limestone, and less frequently on the acid silicates, on the shallow and poor soils, in the transitional Sub-Mediterranean-Subcontinental climate. Very porosous limestone bedrock and degraded soil cover enable the undisturbed plunge of the surface water, and thereby increase the degree of drought on the sites. The associations were reported at the altitudes ranging from 500 to 1,400 m.

F9 - River and fen scrubs

F9.1 - Willow scrubs (Salix) near brooks and lakes

F9.11 - Orogenic rosemary willow scrubs (Salix eleagnos). Densely groupped, usually closed, less frequently opean and scattered 2-3 m tall deciduous scrub associations. They occur as the narrow stripes along river cources. They develop on the different types of alluvial deposits, mainly on the limestone bedrock on which gravel and coarse sand are dominant, by the shores of the fast and cold mountain brooks and small rivers in which the level of water is relatively high during the summer months as well, or the level of water siginificantly decreases during the summer months, so the bedrock is to a great extent dry, loose and well-aerated. As a result of of the well-developed hydrographic network of the area, the association is frequently found.

FA - Hedgerows (FA.1 Hedgerows with exotic species, FA.2 Highly-managed hedgerows of native species, FA.3 Hedgerows rich in native species, FA.4 Hedgerows poor in native species)

FB - Shrub plantations (FB.1 Shrub plantations for whole-plant harvesting, FB.2 Shrub plantations for leaf or branch harvesting, FB.3 Shrub plantantions for ornamental purposes or for fruit, other than vineyards, FB.31 Shrub and low-stem tree orhards, FB.32 Ornamental shrub plantations, FB.4 Vineyards).

G - WOODLAND AND FOREST SITES AND OTHER WOODED LAND

G1 - BROADLEAF DECIDUOUS FORES

G1.1 - Riparian willow (Salix), alder (Alnus) and birch (Betula) forests

G1.11 - Riverine willow (Salix) forests

G1.111 - Mid-European white willow forests (Salix alba). Gallery forests with the low tree layer and thinning canopy, or less frequently the tree layer which is almost closed, with the tree height over 20 m. The associations occur on the shores of the hilly rivers, on the recent multi-layered alluvial deposit, or, less frequently on the different developmental phases of the hydromorphic gley soils. The soils have been subject to the long-lasting and intensive floods, and the level of the ground water is by rule very high. The sites occur at the altitudes ranging from 200 to 700 m, and are very frequently found in this area.

G1.116 - Fluvial white poplar (Populus alba) forests. Gallery forests with thinning or almost closed tree layer, with the tree height up to 30 m. The associations of this type occur in the driest riparian parts of the alluvial plains, on the temperately dry and light alluvial deposits and different variants of the moderately humid alluvial pararendzines, at the altitudes up to several hundred meters. If the flooding is still present, it lasts considerably shorter than in any other part of the alluvial plain.The ground water is found at the depth exceeding 2 m, so these soils can be regarded as temperately dry.

G1.117 - Fluvial black poplar forests (Populus nigra) – Gallery forests with thinning or almost closed tree layer, with the tree height up to 30 m. The associations occur on the shores of the lowland and hilly rivers, on the dry gley soils and alluvial pararendzines. The soils were flooded for a longer or shorter time, and the level of the ground water is relatively high, it occurs at the depths ranging from 120 to 180 cm. The sites occur at the altitudes up to 500 above sea level.

G1.6 - Beech (Fagus) forests

G1.69 - Moesian beech (Fagus) forests

G1.691 - Moesian collinar beech (Fagus) forests

G1.6914 - Moesian collinar forests with sessile oak (Quercus petraea). Mixed forests with closed or almost completely closed layer of tall trees. Sessile oak- beech forests occur at the transitional sites between northern exposed shaded hollows and southern exposed cliffs and crests, in oak forest zone. The associations develop on different brown and loessivated brown soils.

G1.692 - Moesian mountain acidophilous beech (Fagus) forests with moss. The site was reported in Ostrozub. These forests are mono-dominant, with thinned or less frequently with almost closed layer of tall trees. They occur as the smaller or bigger stands in beech altitudinal zone, at the altitudes ranging from 700 to 1,400 m. They are found at all exposures, by rule on greatly inclined and well-exposed cliffs, on very acid skeletal, dry and low-productive brown soils

G1.6923 - Moesian mountain beech forests with the bilberry (Vaccinium myrthyllus). The site was reported in Ostrozub.These forests are mono-dominant, with closed or almost completely closed layer of tall trees. They occur as smaller or bigger stands in beech altitudinal zone, at the altitudes ranging from 500 to 1,400 m

and all exposures. They are found on highly inclined cliffs, on very acid skeletal, dry and low-productive soils in the initial phases of podzolisation.

G1.6924 - Moesian mountain beech forests with deer fern (Blechnum spicant). They were reported in Ostrozub. These forests are mono-dominant with thinning, or less frequently with almost completely closed layer of tall trees. They occur as smaller or bigger stands in the beech altitudinal zone, at shaded slopes at the altitudes ranging from 500 to 1,400 m, on very acid brown soils.

G1.694 - Moesian mountain neutrophile (Fagus) forests

G1.6941 - Moesian mono-dominant mountain beech forests. They were reported on several sites (in Ostrozub, Chemernik, Kukavica andVlasinska Plateau). These forests are mono-dominant with closed or almost closed layer of tall trees. They occur at the altitudes from 500 to 1,600 m, always as clearly expressed altitudinal zone, occupying terrains of different inclinations and found at all exposures. Depending on the type of bedrock, these forests develop on different types of automorphic soils. Low-acid brown soils occur on silicates, whereas neutral brown soils or rendzines. Depending on the slope of terrain, age of stands and anthropogenic influences, the soils can be either very deep (60-90, and even up to 120 cm), or very shallow and extremely skeletoid.

G1.6943 - Moesian mountain beech forests with cherry laurel (Prunus laurocerasus). The site was reported in Ostrozub. These forests occur at the altitudes from 1,200 to 1,300 m, as small stands on the peculiar sites in the zone of beech altitudinal range, near mountain brooks, in the places with higher air humidity, small oscillations of humidity and temperature, small influence of the wind, cold and drought. These associations develop on silicates (crystalline schists), on the low acid, by rule very deep brown soils, which are very humid.

G1.695 - Moesian Sub-Alpine beech (Fagus) forests

G1.6951 - Moesian mono-dominant Sub-Alpine beech forests - The site was reported in Besna kobila and Stresher. Sub-Alpine beech forests occur at the altitudes between 1,400 and 1,800 m, always as smaller or bigger stands in spruce altitudinal zone, occupying the terrains of different slopes and at all exposures. Depending on the type of bedrock, these forests develop on different types of automorphic soils. Humus-siliceous or acid brown soils are found on silicates, whereas neutral brown soils or rendzines occur on limestones. The soils are by rule shallow and extremely skeletoidal. They are rarely deeper (up to 70 cm).

G1.7 - Thermophilous broadleaf forests

G1.76 - Balkan-Anatolian thermophilous oak (Quercus) forests

G1.761 - Moesian Hungarian oak (Quercus frainetto) and Turkey oak forests

G1.7611 - Typical Hungarian oak and Turkey oak forest. Well-lit forests, with closed or almost closed layer of trees, mainly found on flat or gently inclined, thermophilous terrains of hilly zone, at the altitudes up to 600 m. The bedrock is mainly silicate, and deep brown soils occur on it.

G1.7614 - Hungarian and Turkey oak with oriental hornbeam (Carpinus orientalis). It was reported in Grdelichka Gorge, the Juzna Morava River area (Kalipanska and Repinska reka) and Kukavica.These forests are well-lit, with closed or almost completely closed layer of trees. The associations mainly occur on gently inclined or steep, thermophilous terrains of hilly zone, at the altitudes up to

700 m. The bedrock is carbonate or siliceous, and different variants of dystric or eutric brown soils, by rule with a high quantity of skeleton, develop on it.

G1.9 - Non-riverine forests with birches (Betula), aspen (Populus tremula), European rowan (Sorbus aucuparia) or common hazel (Corylus avellana)

G1.91 - Birch (Betula) forests on non-marshy terrain

G1.91B – Balkan birch (Betula) forests on non-marshy terrain. The site was reported in Chemernik and Ostrozub. The associations mainly occur on gently inclined, well-exposed terrains, in hilly and lower parts of mountain region, at the altitudes between 700 and 1,300 m. The bedrock is siliceous, and the soils are mainly extremely acid. Birch forests less frequently occur on limestone and eutric soils as well.

G1.2 - Aspen forests (Populus tremula)

G1.922 - Lowland nemoral aspen forests (Populus tremula). Pioneer and sub-climate associations dominated by aspen (Populus tremula). They were located in lowland and hilly areas, on the sites which mainly accompanied acidophilous oak forests.

G1.95 - Aspen (Populus tremula) and birch (Betula) forest with elders (Sambucus). The site was reported in Chemernik and Ostrozub. The associations mainly occur on gently inclined, well-exposed terrains, in hilly and lower parts of mountain regions, at the altitudes between 700 and 1,300 m. The bedrock is siliceous, and the soils are mainly extremely acid.

G1.A - Meso - and eutrophic forests with (Quercus), (Carpinus), (Fraxinus), (Acer), (Tilia), (Ulmus) and related forests

G1.A1 - Oak (Quercus), ash (Fraxinus) and European hornbeam (Carpinus betulus) forests on eutrophic and mesotrophic soils

G1.A1C - Southeastern European oak-European hornbeam (Quercus) – (Carpinus betulus) forests

G1.A1C1 - Moesian sessile oak - European hornbeam (Quercus petraea) - (Carpinus betulus) forests. They were reported in Kukavica (Skobaljic grad, Silje). The associations mainly occur in hilly region (at altitudes between 200 and 700 m), on gently inclined and shaded terrains, always in the zone of thermophilous oak forests. The bedrock is siliceous or carbonate, and acid brown, eutric brown and humus-silicate soils, chernozems and shallow brown soils on limestones develop on it.

G1.A3 - European hornbeam (Carpinus betulus) forests

G1.A32 - Eastern hornbeam (Carpinus betulus) forests. Mid-tall, dark mesophilous forests. The associations mainly occur on gently inclined terrains of hilly region, always in the zone of thermophilous oak forests. The bedrock is alluvium or silicate, on which different types of dystric soils develop.

G1.C - Highly artifical broadleaf forest plantations (G1.C1 - Poplar plantations, G1.CE - Artificially established Turkey oak plantation, G1.D1 - Sweet chestnut plantation (Castanea sativa), G1.CN - Artificially established maple stand, G1.C3 - Black locust plantations (Robinia) used for alleviating erosion on the steep slopes.

G 3 - CONIFEROUS FORESTS

G3.F - Highly atrificial coniferous plantations (G3.F112 - Artificially established spruce stand with the naturally regenerated beech, G3.F13 - Artificially

established fir stand, G3.F14 - Artificially established Austrian pine stand, G3.F14 - Artificially established Scots pine stand, G3.F142 - Artificially established Austrian pine stand with the naturally regenerated beech, G3.F16 - Artificially established Austrian and Scots pine stand, G3.F17 - Artificially established spruce and Austrian pine stand, G3.F19 - Artificially established spruce, Scots and Austrian pine stand, G3.F21 - Artificially established Douglas fir stand (Pseudotsuga mensienzii), G3.F22 - Artificially established eastern white pine (Pinus strobus) stand, G3.F23 - Artificially established European larch (Larix decidua) stand

G5 - Lines of trees, small anthropogenic forests, recently felled forests and coppice forests (G5.1 - Lines of trees, G5.2 - Small broadleaf deciduous anthropogenic forests, G5.4 - Small coniferous anthropogenic forests, G5.5 - Small mixed broadleaf and coniferous anthropogenic forests, G5.6 - Early-stage natural and semi-natural forests and re-grown forests, G5.61 – Deciduous scrub forests, G5.62 - Mixed scrub forests, G5.63 - Coniferous scrub forests, G5.7 - Coppice and early-stage coppices, G5.71 - Coppice forests, G5.72 - Early-stage broadleaf deciduous plantations, G5.74 - Early-stage coniferous plantations, G5.75 - Early-stage broadleaf and coniferous plantations, G5.76 - Tree plantations aimed at early whole-tree harvesting, G5.8 - Recently felled areas, G5.81 - Recently felled areas of the former broadleaf trees

H - INLAND UNVEGETATED OR SPARCELY VEGETATED SITES

H1 - Terrestrial underground caves, cave systems, passages and water bodies (H1.1 - Cave entrances, H1.2 - Cave interiors, H1.3 - Dark underground passages, H1.7 - Used underground mines and tunnels - Vlasina area)

H2 - Screes

H2.3 - Moderate mountain acid silicate screes

H2.33 - Southeastern European high mountain silicate screes - The sites were reported in Besna kobila. It inhabitated silicate, cold and humid screes of Sub-Alpine and Alpine regions. The sites are mainly at the northern exposures (the snow is retained longer). They are frequently made of the very huge pieces of rocks.

H3 - Inland cliffs, rock pavements and flat areas and outcrops

H3.1- Acid siliceous inland cliffs

H3.15 - Helleno-Carpatho- Balkanic siliceous cliffs with (Silene)

H3.152 - Moesian - Northern-Scardo-Pindic siliceous cliffs

H3.1521 - Moesian - Northern- Scardo-Pindic Sub-Alpine (Silene lerchenfeldiana) siliceous cliffs. They were reported in Besna kobila. The vegetation forms the mosaic with the rich vegetation of leech and moss by which stone bedrock is overgrown. The sites inhabits the cracks of siliceous (grano-diorites, red sandstones,quartz rocks) of slopes and massive rocks. Thermophilous, sun-lit sites of mountain (less frequent hilly) and Sub-Alpine region, at the altitudes up to 1,850 m are found. The soils belong to the type of siliceous lithosol, regosol or ranker (in bigger cracks).

H5 - Different inland sites with sparcely developed vegetation (H5.5 - Burnt zone devoid of or with the very sparce vegetation, H5.6 - trampled areas

I - REGULARLY OR RECENTLY RECLAIMED AGRICULTURE, HORTICULTURE OR DOMESTIC SITES

I1 - Arable land and market gardens (I1.1 - Intensive unmixed crops, I1.2 - Mixed crops of market gardens and horticultural gardens, I1.3 – Arable land with unmixed crops grown by low-intensity agricultural methods, I1.5 - Bare tilled, fallow or recently abandoned arable land)

I2 - Cultural areas of gardens or parks (I2.1 - Big gardens with ornamental plants, I2.2 - Small garden areas with ornamental plants or gardens in the very vicinity of households, I2.3 - Weed associations of the recently abandoned gardens)

J - CONSTRUCTED, INDUSTRIAL AND OTHER ARTIFICIAL SITES

J1 - Constructions in cities, towns and villages (J1.1 - Residential buildings of city centres, J1.2 - Residental buildings of villages and urban peripheries, J1.3 - Urban and sub-urban constructions, J1.4 - Urban and sub-urban industrial and commercial sites which have been still actively used, J1.5 - Rural commercial units, J1.6 - Urban and sub-urban constructions and demolition sites, J1.7 -Very dense temporary residential units)

J2 - Rare residential units (J2.1 - Low density residential buildings, J2.2 - Rural public buildings, J2.3 - Rural industrial and commercial sites which have been still actively used, J2.4 - Agricultural constructions, J2.5 - Constructed landmarks, J2.6 - Abandoned rural constructions, J2.7 - Rural buildings and demolition sites)

J3 - Extractive industrial sites (J3.2 - Active opencast mineral extraction sites, including querries, J3.3 - Recently abandoned under-ground spaces of extractive industrial sites)

J4 - Transport networks and other constructed hard-surfaced areas (J4.1 - Weed associations of transport networks and other constructed hard-surfaced areas, J4.2 - Road networks, J4.3 - Rail networks, J4.6 - Pavements and recreation areas, J4.8 - Constructed parts of cemeteries)

J5 - Highly artificial man-made waters and associated structures (J5.3 - Highly artificial non-saline stagnant water, J5.5 - Highly artificial fontanes and cascades)

J6 - Waste deposits (J6.1 - Weed associations of waste deposits, J6.2 - Household waste and landfill sites, J6.3 - Non-agricultural organic waste, J6.4 - Agricultural and horticultural waste, J6.5 - Industrial waste, J6.6 - Waste resulting from building construction or demolition

At southwestern branches of Chermernik over the past thirty years or more the birch has been increasingly present, which had not been the case in the more distant past. As the land has not been cultivated any more, the whole area of villages Mlachishte, Bajinci, Ruplje, Crveni Breg, Machkatica, Troskach, Pavlichina and Bankovci have been transformed into the dense birch plantations. The former roads, arable fields and meadows are overgrown by it, and the landscape has changed its appearance (Braunovic, Ratknic 2010/b).

The migration trends over the analyzed period resulted in the different degrees of endangerment of the natural sites in this area, to the benefit of the sites formed by anthropogenic influences.

5. CONCLUSIONS

The population's abandonment of the rural settlement resulted in the decrease of the number of the active working population and creation of the elderly households. Along with this process the important changes in the way of land use occurred. The most arable land has not been cultivated any longer, so these areas become overgrown with weeds, or re-transformed into the pastures. The small part of the arable areas which have not been cultivated are located in the very vicinity of the settlements, whereas the great areas are in Juzna Morava valley.

Mire, bog and fen sites, as well as grass and tall forb sites, are endangered by the anthropogenic influence. The scrub and forest sites are degraded to a great extent. Their endangerment will be also intensified by the current climate change, which lead to the increase of the mean annual air temperature and change in the precipitation regime.

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THE INHIBITORY EFFECT OF FUNGICIDES BENFUNGIN WP AND KAPTAN FLON ON THE GROWTH OF MYCELIUM OF MYCORRHIZAL FUNGI

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Abstract: *The paper presents the results of the laboratory studies of the effects of two types of fungicides (Benfungin WP and Kaptan FL) on the growth rate of the mycelium of the following species of mycorrhizal fungi: Suillus luteus (L. ex Fr.) S. F. Gray, Suillus bovinus (L.ex Fr) Roussels, Suillus granulatus (L. ex Fr.)O. Kuntze, Paxillus involutus (Batsch ex fr.), Hebeloma spp., Amanita muscaria (L. ex Fr.) Hook. The observed fungicides were used in two concentrations - Benfungin WP in 0.04 and 0.06% concentrations and Kaptan FL in 0.2 and 0.3% concentrations.Benfungin had no effect on the growth of mycelium of Hebeloma spp., whereas in the direct contact in both concentrations it affected all other fungi, by stopping the growth of the mycelium.*

Kaptan FL had the similar effect in both concetrations, by stopping the growth of mycelium of Hebeloma spp., A. muscaria, P. involutus and S. luteus. It had no effect on the growth of mycelium of S. bovinus and S. garnulatus.

Key words: forest seedlings, mycorrhizal fungi, growth inhibition, fungicides

1. INTRODUCTION

The rhizosphere, the zone surrounding the root, is inhabited by numerous microorganisms which form saprophytic, pathogenic and symbiotic associations.

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The symbiosis between non-pathogenic fungi and roots of host plants is called the mycorrhizal association. In this association both components benefit from cohabitation. The fungus (mycobiont) contributes to the increase of root weight (Dahm, 2005), which enables the plant to adopt the nutrients that are located at the greater depth than the root. Along with the absorption of the nutrients, ectomycorrhiza can protect the root system from the invasion of pathogens and saprophytic microorganisms (Zak, 1964; Froidevaux, 1975; Marx et al., 2002), which makes it easier for the seedlings of coniferous tress, whose root was attacked by pathogenic fungi, to survive (Chakravarty i Sidhu, 1987; Haug i sar., 1988; Marx, 2002). In addition, it has a role in the absorption and water translocation in the plants, protection from drought, temperature extremes, and the alleviation of the influences of the heavy metals on plants (Godbold et al., 1998; Rudawska et al., 2001). For the reforestation of the terrains which have been deforested for a long time, degraded shallow soil without humus horizons, the mycorrhizal seedlings which overcome the problems regarding the surviving of seedlings used for reforestation by the presence of the fungi as the symbiont on the root, should be applied. The production of mycorrhizal seedlings should be initiated in the nurseries of forest seedling material in Serbia, which has been already present in many countries in Europe and America.

The usual application of pesticides and additional nutrition in the nursery production can have the adverse effects on the formation and development of mycorrhizal fungi, by affecting their germination, sporulation and root colonization (Hetrick and Wilson, 1991; Perrin et al., 1996). Numerous researches of these effects worldwide were aimed at finding the suitable ways of using pesticides, by monitoring the growth and development of mycorrhizal association on the root of plants upon the application of different fungicides or herbicides (Chakravarty and Sidhu, 1987; Castellano, Molina, 1993; O´Neill and Mitchell, 2000). In Serbia the sufficient attention has not been paid to the effect of the application of pesticides in the production of forest seedling material on the development of mycorrhizal fungi. Veselinović et al. (1976) analyzed the effect of fumigation with methyl bromide on the mycorrhizal inoculum. It is one of the frequent treatments in the nurseries which is applied in order to eliminate the weeds, nematodes and pathogenic fungi in the soil, but they concluded that it frequenly led to the destruction of the inoculum of mycorrhizal fungi. The similar effects on the beneficial microflora were also reported in the French nurseries (Tacon et al., 1986). Fraedrich and Dwinwill (2003) reported that after the application of soil fumigation with methyl bromide, the pathogenic species *Fusarium* sp., and *Pythium* spp. were no longer presented in the treated sites, but that, at the same time, their antagonist, *Trichoderma* spp. was destroyed.

Fungicides can cause the increase of the degree of granulation and degradation of cytoplasms of symbiotic fungus on the mycorrhizal root (Manninen et al., 1998). Upon the application of fungicides, due to the “fungicidal stress”, the presence of several mycorrhizal fungi at the same time makes them easier to survive, than their individual presence (Schreiner and Gabor, 1997). The results of the researches by Testa et al. (2006) suggest that the adverse effect of the different fungicides on the spread of mycorrhizal fungi should be used when it is needed to

limit the development of some undesirable mycorrhizal association under the controlled conditions.

The usual measures of protection which are applied in Serbia in the nurseries for the production of forest seedling materials refer to the treatments of substrates and seedlings prior to sowing and four additional application after the sprouting in order to prevent the occurrence of rot and lodging of seedlings. The constant use of these preparations is the hazard for the ecosystem since it has the adverse effect on the beneficial microflora in the soil. This paper presents the research results of the effect of the most frequently used fungicides Benfungin WP and Kaptan FL on the most significant species of mycorrhizal fungi present on the forest seedling material: *Suillus luteus* (L. ex Fr.) S. F. Gray, *Suillus bovinus* (L.ex Fr) Roussels , *Suillus granulatus* (L. ex Fr.)O. Kuntze, *Paxillus involutus* (Batsch ex fr.), *Hebeloma spp., Amanita muscaria* (L. ex Fr.) Hook.

2. MATERIAL AND METHODS

It was studied in the laboratory conditions whether the application of fungicide Benfungin WP (Galenika, Belgrade) (0.04 and 0.06 % concentrations) and Kaptan FL (Zorka, Šabac) (0.2 and 0.3 % concentrations) affects the growth of mycorrhizal fungi.

The following mycorrhial fungi were used in the experiments: *Suillus luteus, S. bovinus, S. granulatus, Paxillus involutus, Hebeloma spp., Amanita muscaria.* The isolates of fungi were obtained from Professor Doctor M. Rudawska from the Institute of Dendrology of the Polish Academy of Sciences.

The isolates of fungi, which were used in the experiment, were developed on the nutrient medium (2 %) in petri dishes. After pouring the standard MEA medium containing 20 grams of mulch (Sigma-Aldrich, USA) and 20 grams of agar (Torlak, Belgrade, Serbia) in petri dishes, the fragments of the observed fungi sized 8 x 8mm were sown. Prior to the inoculation of medium, the isolates were 21 years old. The fragments were placed in the center of petri dishes, and around them square-shaped filter paper, which after the sterilization was soaked in the certain concentration of the same type of fungicide (modified method by Uščuplić, M., Lazarev, V.,1983), was placed. The growth of the observed mycelia and reaction around the filter paper was monitored. The incubation was perfomed at $23^0C \pm 1^0C$ temperature. During the growth on MEA medium the growth rate for all species was monitored, and the inhibition of the growth of fungi was determined based on the growth rate of the control isolate on the pure MEA medium.

The experiment was conducted in five repetitions, and the obtained results were statistically processed. The mean values and mean errors were determined, and the statistical significance of the differences in the variances by using the method of variance analysis (ANOVA-Duncan method).

3. RESULTS

The experiment was controlled every seven days over a two-month period, how long the experiment lasted. These types of the observed fungicides contain the active ingredients which belong to the different chemical groups - Benomil belongs

to the group of benzimidazoles, and Kaptan is from the group of phthalimides). During the experiment the different reactions depending on the type of fungicides and their concentrations were reported.

The influence of fungicide Benfungin on the growth of colony of mycorrhizal fungi *IN VITRO*

Fungicide Benfungin affected the observed species of fungi in different ways. At the beginning of the experiment the normal growth and development of mycelium of all observed species of fungi were reported. At the end of the experiment Benfung in the lower concentration (0.04%) affected all observed species of fungi by stopping the growth of mycelium, i.e. the mycelia grew up to the filter paper and their growth was stopped in the direct contact with it. It did not have any influence only on the mycelium of the species *Hebeloma* spp, the development of which was undisturbed, i.e. it completely overgrew the filter paper. The growth rate of mycelium was the same in the species *S. luteus* and *S. bovinus*, with the growth on the control medium, whereas in all other observed species the slight deceleration of growth rate was reported. When the concentration of it was higher (0.06%), the reaction all species of fungi was the same as in the case of the lower concentration of fungicides (Table 1), i.e. the different concentrations of preparations did not have any influence on the obtained results.

Table 1. *The growth of mycelium of mycorrhizal fungi on MEA medium and media with the added fragments soaked by Benfungin WP in the different concentrations*

Medium	*S. luteus*	*S. bovinus*	*S. granulatus*	*P. involutus*	*Hebeloma* spp.	*A. muscaria*
control (MEA)	2.9 ± 0.02^{a}	3.1 ± 0.03^{a}	5.6 ± 0.03^{a}	5.64 ± 0.02^{a}	3.88 ± 0.04^{ab}	4.37 ± 0.02^{a}
Fragments with Benfungin WP in 0.04 concentration	2.9 ± 0.03^{a}	3.1 ± 0.05^{a}	4.9 ± 0.12^{b}	5.55 ± 0.03^{ab}	3.97 ± 0.05^{ab}	4.0 ± 0.14^{b}
Fragments with Benfungin WP in 0.06 concentration	2.9 ± 0.02^{a}	3.1 ± 0.05^{a}	4.9 ± 0.12^{b}	5.55 ± 0.03^{ab}	3.9 ± 0.12^{ab}	4.0 ± 0.01^{b}

The mean values marked with different letters in the same row are significantly different (Tukey HSD test of multiple ranks $P<0.05$)

The influence of fungicide Kaptan FL on the growth of colonies of mycorrhizal fungi *IN VITRO*

The presence of fungicide Kaptan FL had the different influence on the growth of mycelia of mycorrhizal fungi (Table 2).

Table 2. *The growth of mycelia of mycorrhizal fungi on MEA medium and media with the added fragments soaked by Kaptan FL in different concentrations*

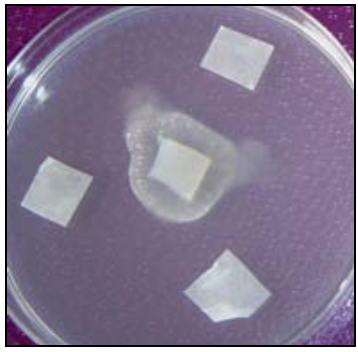
Medium	*S. luteus*	*S. bovinus*	*S. granulatus*	*P. involutus*	*Hebeloma* spp.	*A. muscaria*
Control medium (MEA)	2.9 ± 0.02^{a}	3.1 ± 0.03^{ab}	5.6 ± 0.03^{ab}	5.64 ± 0.02^{a}	3.88 ± 0.04^{a}	4.37 ± 0.02^{a}
Fragments with Kaptan FL in 0.2 concentration	2.9 ± 0.03^{a}	3.3 ± 0.05^{a}	5.9 ± 0.12^{a}	5.55 ± 0.03^{ab}	3.71 ± 0.05^{ab}	4.0 ± 0.14^{b}
Fragments with Kaptan FL in 0.3 concentration	2.9 ± 0.02^{a}	3.3 ± 0.05^{a}	5.9 ± 0.12^{a}	5.55 ± 0.03^{ab}	2.8 ± 0.12^{b}	3.3 ± 0.01^{c}

The mean values marked with different letters in the same row are significantly different (Tukey HSD test of multiple ranks $P<0.05$)

Kaptan FL in the lower concentration affected *Hebeloma* spp., *A. muscaria, P. involutus* by decelerating the growth of mycelium at the beginning of the experiment. It had no influence on the growth of *S. luteus*, and in species *S. bovinus* and *S. garnulatus* the slight stimulating effect on the growth rate was reported. When the mycelia developed up to the filter paper, there were two reactions of fungi. The mycelia of fungi *S. bovinus* and *S. Granulatus* continued to grow after the contact and completely covered the filter paper, i.e. the presence of fungicides did not have any influence on these fungi. The growth of mycelia of other fungi stopped in the contact with the filter paper.

The higher concentration of Kaptan had the similar effect on the growth of mycelia of all fungi except for *Hebeloma* spp.and *A. muscari,* in which the inhibition of growth was more intensive and the clearly differentiated inhibition zone between the mycelium and filter paper was formed. In the comparison with Benfungin, Kaptan FL had more intensive unfavourable effect on the observed mycorrhizal fungi.

Picture 1. *The growth of mycelium Hebeloma spp.and filter paper soaked by solution of fungicide Benfungin (0.06%)*



Picture 2. *The growth of mycelium Amanita muscaria and filter paper soaked by solution of fungicide Kaptan FL (0.30%)*

4. DISCUSSION

Undoubtedly, certain types of fungicides will be always applied in the process of production of forest seedling material. However, during the selection of fungicides for treatments the knowledge on the effect of these preparations on mycorrhizal fungi are necessary, i.e. the selected preparations must enable the undisturbed development of mycorrhizal fungi on the root of the seedlings. The results obtained in these researches point out to the different reactions of mycorrhizal fungi to the presence of fungicide Benfungin WP (0.04 and 0.06% concentrations) and to Kaptan FL (0.2 and 0.3% concentrations). Benfungin had no influence only on the growth of mycelium *Hebeloma* spp., whereas in the direct contact in both concetrations it affected all other fungi by stopping the growth of

mycelium. The presence of different concetrations of Benfungin WP did not have any influence on the growth of the observed mycorrhizal fungi.

Kaptan FL had the similar effect in both concentrations by stopping the growth of mycelium of *Hebeloma* spp., *A. muscaria, P. involutus* and *S. luteus*. It had the most adverse effect on the fungi *Hebeloma* spp., and *A. Muscaria*, in which the inhibition zone was formed. It had no influence on the growth of mycelium of *S. bovinus* and *S. garnulatus*.

These results point out to the fact that the application of fungicide Benfungin in the process of the production of forest seedling material had less adverse effects on the development of mycorrhizal fungi in comparison with the application of Kaptan FL. It is necessary to study the results obtained in the laboratory conditions in the field conditions.

The same results by multiple application based on kaptan were obtained by Castellano and Molina (1993) and Lazarev (1998). These scientists by different studies determined that some types of fungicides based on kaptan can have the adverse effect on mycorrhizal fungi, i.e. decrease the development of mycorrhiza. Somewhat different results were obtained by O´Neill and Mitchell (2000) during the researches of the effects of application of fungicides Kaptan and Benomyl on the development of mycorrhizal fungi which colonize *Picea sitchensis* and *Fraxinus excelsior*. The application of kaptan had the stimulating effect on the root length and ectomycorrhizal colonization of spruce and ash seedlings, whereas the application of benomyl 2-3 times caused the decrease of the number of ectomycorrhizal species of fungi on the root, as well as the reduction of the colonization of root.

The possible adverse effects of the application of pesticides, reflected in the destruction of mycorrhizal fungi, direct the further researches aimed at the controlled application of chemical preparations and the integral measures of fight. The same mycorrhizal fungi can have the important place in the biological measures of fights since they can provide the protection by secretion of antibiotic mucus from fungi or by stimulating the root cells of host plants which secrete antimicrobial metabolites by which some pathogens are killed (Dehne, 1982) or inhibited (Graham i Menge, 1982). The positive results were also obtained in the mycorrhization of seedlings by the selected species of mycorrhizal fungi upon the application of treatment of elimination of pathogenic fungi *Rizoctonia solani, Pythium sp., Fusarium oxysporum*, etc. In these conditions the seedlings are successfully inoculated by the selected mycorrhizal fungi as the saprophytic organisms are destroyed and the ectomycorrhizae which are antagonistic in the introduction of the selected species are naturally developed (Tacon et al., 1986). Regardless of the fact whether the mycorrhization is perfomed by the selected symbionts or it enables the development of the present fungi as the symbiont on the root, their presence helps to overcome the problem regarding the reforestation reflected in the inability of the transplanted plants to use the micro and macroelements from the soil (Lazarev, 2005). In numerous unfavourable conditions the presence of mycorrhiza on the root of tree seedlings is the only precondition for the surviving and growth of these seedlings (Rudawska et al, 2001).

5. CONCLUSION

The possible adverse effects of the application of pesticides, which are reflected in the inhibition of the growth of mycorrhizal fungi, direct the further researches aimed at the selection of the controlled application of chemical preparations and the increasingly significant application of biological measures of fight by knowing the specific requirements of all ligneous species individually.The pesticides should be applied only in the sensitive phases of the development of plants when they needed it most in the doses which significantly reduce the inoculums of mycorrhizal fungi.

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THE INHIBITORY EFFECT OF FUNGICIDES BENFUNGIN WP AND KAPTAN FLON ON THE GROWTH OF MYCELIUM OF MYCORRHIZAL FUNGI

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Summary

In the nurseries for the production of forest seedling material the different types of fungicides are applied as a part of the regular measures of tending and protection from the potential diseases. The most frequently used fungicides are Benfungin WP and Kaptan FL. The application of these fungicides along with the positive effect on the elimination of pathogens can have the adverse effect on the beneficial microflora in the soil. In order to study the influence of these fungicides on the most significant species of mycorrhizal fungi, the experiment was set in the laboratory conditions in which the most frequently isolated species of mycorrhizal fungi on the forest seedling material were used: *Suillus luteus* (L. ex Fr.) S. F. Gray, *Suillus bovinus* (L.ex Fr) Roussels, *Suillus granulatus* (L. ex Fr.)O. Kuntze, *Paxillus involutus* (Batsch ex fr.), *Hebeloma spp.*, *Amanita muscaria* (L. ex Fr.) Hook. The applied concentrations of fungicides were determined by the recommendation of the producer for the use of Benfungin (0.04 and 0.06 % concentrations) and Kaptan FL (0.2 and 0.3% concetrations).

Kaptan FL had the similar effect in both concentrations on *Hebeloma* spp., *A. muscaria*, *P. involutus* and *S. luteus*, by stopping the growth of them. It had no influence on *S. bovinus* and *S. garnulatus*.

Benfungin had the similar effect on the growth of mycelia of all observed species of fungi in both higher and lower concentrations. It affected all observed species of fungi by inhibiting the growth of mycelium, except for the mycelium of the species *Hebeloma* spp, the development of which was undisturbed.

Reviewer: **Ph. D. Vera Raičević**

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COMPATIBILITY OF THE MICROBIOLOGICAL PESTICIDES IN THE SYNCHRONISED SUPPRESSION OF POWDERY MILDEWS AND THE GYPSY MOTH*

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Abstract: *After an intensive defoliation on oaks and multiannual forest fruits and aromatic plants, which can be caused by early-season defoliators and the gypsy moth when they outbreak, the new foliage is susceptible to the attack of powdery mildews (agents - pathogenic fungus from order Erysiphales). To prevent the great damage, the compatibility of the microbiological insecticide Foray 48B and microbiological fungicide AQ10 was analysed in laboratory conditions, as the components of a mixture with insecticide and fungicide properties, which can be applied in the synchronic suppression of defoliators from the Lepidoptera order and powdery mildews. The application of the above mixture could prevent the succession of some harmful biotic factors and the further chain-linking of adverse effects.*

Key words: *Bacillus thuringiensis* ssp. *kurstaki*, *Ampelomyces quisqualis*, compatibility, mixture, powdery mildews, gypsy moth

KOMPATIBILNOST MIKROBIOLOŠKIH PESTICIDA PRI SINHRONIZOVANOM SUZBIJANJU PEPELNICA I GUBARA

Izvod: *Posle intenzivnog brsta na hrastovima i šumskim višegodišnjim vrstama voćkarica i aromatičnog bilja, koji mogu prouzrokovati rani defolijatori i gubar kada se jave u prenamnoženju, novo mlado lišće je osetljivo na napad pepelnica (izazivači*

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patogene gljive iz reda Erysiphales). Da bi se sprečile veće štete, u laboratorijskim uslovima, istražena je kompatibilnost mikrobiološkog insekticida Foray 48B sa mikrobiološkim fungicidom AQ10, kao komponenti mešavine sa insekticidnim i fungicidnim svojstvima, koja bi se mogla primeniti za istovremeno suzbijanje defolijatora iz reda Lepidoptera i pepelnica. Primena navedene mešavine sprečila bi sukcesiju nekih štetnih biotičkih faktora i dalje ulančavanje šteta.

Ključne reči: *Bacillus thuringiensis* var. *kurstaki*, *Ampelomyces quisqualis*, kompatibilnost, mešavina, pepelnice, gubar

1. INTRODUCTION

The Serbian forests are resources of numerous products, partly quantified and valorized. The complex, frequently complementary use of as much as possible products of forest ecosystems is of permanent importance. Along with timber, the main product, the most important in the commercial sense recently have been forest fruits and aromatic plants, in which Serbia is abundant, due to favourable site conditions. People have harvested and processed forest plants for medicinal purposes since the beginning of history. Forestry in Serbia intends to enrich 500,000 ha of degraded forests by these valuable plants.

Since these species are hosts of numerous, omnipresent, phitopathogenic fungi and economically harmful insects, in the harmony with the trend of forest protection and guidelines to organic products, Institute of Forestry in Belgrade have been studied the biological efficiency of biofungicides and bioinsecticides which could be applied simultaneously in suppressing of the two groups of economically significant and harmful biological agents.

The cases of outbreaking of economically harmful insect species in the group of defoliators, when the adequate measures of protection are not applied, usually cause a significant damage of leaf mass and defoliation, to which the infested plant usually responds by new leafing. In the case of oaks and multiannual forest fruits and aromatic plants, the young, secondary foliage with the thin, newly formed cuticle becomes highly susceptible to the infection by the pathogenic fungus *from order Erysiphales (*powdery mildews), which is often related to the mass dying of host plants after defoliation. The hibernation of this pathogen is possible not only in the stage of cleistothecium and mycelium in the infected bud, but also in the form of chlamydospores which develop on the mycelium on the fallen leaves. Their germination in the following spring and the contact with the young leaves can also cause the infections of the primary leaves (Lazarev and Tabaković-Tošić, 2006; Tabaković-Tošić, 2008; Tabaković-Tošić and Rajković, 2008).

The possibilities of plant protection against the agents of powdery mildew have been investigated for a long time, predominantly in the nurseries, and more rarely in the stands. Most often, chemical fungicides are tested and applied, mainly based on sulphur, which show good biological efficacy, but also numerous disadvantages. As their efficacy is limited in time, treatments have to be repeated often. The majority of applied preparations do not have the systemic impact; they do not protect the entire plant, but only the treated plant parts.

Biological protection against powdery mildew can be conducted by the control of its agents by biofungicides, such as e.g. Mycotal (based on *Verticillium lecanii*), Supresivit (based on *Trichoderma harzianum*), Ibefungin (based on *Bacillus subtilis*), AQ10 (based on *Ampelomyces quisqualis*), or by using growth activators, the preparations which increase host resistance, such as Bion 50 WG (Soukup, 2005).

Also, some horticultural oils offer good protection against the attack of the fungi from the order *Erysiphales*. The highest biological efficacy was achieved by neem oil (oil extracted from the plant *Azadirachta indica*), garlic oil, jojoba oil and soybean oil.

The aim of this study was to examine the biological efficacy and compatibility of microbiological fungicide AQ10 and the microbiological insecticide Foray 48B, components of the mixture for the synchronic suppression of the gypsy moth and the preventive protection of the assimilation organs against mildew infestation. The future of pest and disease controls is in the discovery and sometimes rediscovery of environmentally friendly pesticides. This research is the result of the general direction for integrated forest protection which emphasises the exclusion of chemical control and the application of biological control.

2. MATERIAL AND METHOD

AQ10 is a new biofungicide that contains fungal spores of *Ampelomyces qisqualis* for control of powdery mildew by parasitizing and killing the fungal organisms that cause the disease. *A. quisqualis* is a hyperparasite of powdery mildews, which infects 256 plant species within 172 genera in 59 families. It colonizes hyphae, conidiophores, cleistothecia in direct penetration. Host cells are killed shortly after pycnidial formation (2-4 days after infection). AQ-10 should be applied in doses of 30-50-70 g/ha (Rajkovic at all., 2010a, 2010b, 2010c). AQ10 is mostly preventive product but it acts also eradicatively and is efficient also against mycelia which passed the winter.

In the experiments, which were made in the nursery "Rogot" on the oak seedlings *Q. robur* L. , aged 8 years, biofungicide for the control of powdery mildew *Microsphaera alphitoides* Griff. and Maubl was tested.

The initial application should begin before the appearance of the symptoms and at the latest when three spots on 100 leaves have been observed. AQ10 has very short pre-harvest interval, only 24 hours, so it can be applied prior to and on the day of harvest.

The trials were set by fully randomized block design. The experiment was conducted in four repetitions. The basic plot is consists of 8 trees (1x3 m apart) 25 m^2. The estimation of leaves with secondary infection with powdery mildew was conducted as follows: 15 well-developed leaves on shoot were selected from the outer zones of branched part of each tree. It was recommended to avoid the shoots with primary infection of powdery mildews and shoots completely infected by powdery mildews, as well as shoots that arise from the interior foliage. The scale of values which was used to record the results of each leaf is 0-4.

Table 1. *Variants (doses) of the applied preparations in the laboratory tests of their compatibility and biological efficacy*

Code	Name	Rate
1	distilled water	1000 l/ha
2	Foray 48B	3000 ml/ha + water to 1000 l/ha
3	Foray 48B + AQ10 (50g)	3000 ml/ha Foray 48B + 50 g/ha AQ10 + water to 1000 l/ha
4	Foray 48B + AQ10 (30g)	3000 ml/ha Foray 48B + 30 g/ha AQ10 + water to 1000 l/ha

The experiments of biological efficacy of insecticide Foray 48B and its combinations with fungicide AQ10, were established in the period 2009-2010, during the third larval instar of the gypsy moth. From the beginning of feeding till the end of the two groups of experiments the caterpillars were fed with the natural food (Pedunculate oak leaves), but from the third instar the food was shortly soaked in water solutions of the analysed doses of the preparation (Table 1). During the experiments, temperature and light conditions were constant (temperature 21°C, light regime - 10 hours night, 14 hours a day). The potency was controlled 72, 144 and 216 hours after the establishment of the experiments, and the individuals which survived in the treated and control groups were monitored till the end of the development.

All experiments were established in the complete random block pattern in four repetitions, where the blocks for each variant present 3 Petri dishes with the corresponding number of larvae (15).

The statistical processing consisted of the analysis of variance, the calculation of the mean value of the number of alive larvae, efficacy by Abbott (E), as well as the testing of the differences of mean values of mortality (LSD test).

3. RESULTS AND DISCUSSION

In the Table 2 the data of the powdery mildews infestation on the oak leaves are presented. AQ10 was applied in two doses, at the lowest application dose (30g/ha) percentage of infection was 15.35, in the highest dose (50g/ha) 2.15. These results of studies show that if this application of biofungicide AQ10 higher doses is efficient for the control of infection, it could be recommended for control of powdery mildew on oak.

There are no statistically differences between the highest dose of application of AQ10 (ab) and fungicide Sulfur (a) (Duncan, 1955). Fungicide Sulfur SC showed the efficiency of 76.53% which is the low efficiency for chemical fungicides but still satisfactory for practice. Infection on control variant was 19.60% (c) which means that the presence of pathogens was significant in order to conduct this experiment and to properly assess the effectiveness of the investigated preparations.

Table 2. *Intensity of attacks M. alphitoides on oak leaves and efficiency of biofungicide AQ10*

Fungicide	Conc./Doses (%), kg/ha	Infection (%)	Efficacy (%)	Standard (%)
AQ10	30 g	15.35 bc	21.68	28.33
AQ10	50 g	2.15 ab	63.52	83.00
Sulfur SC	0.5%	4.60 a	76.53	100.00
Untreated	-	19.60 c	0.00	0.00
LSD 005: 6.65				
LSD 001: 9.33				

At the Institute of Forestry in Belgrade in the two-year period (2009-2010), the possibilities of synergetic effect of biological insecticide Foray 48B (active ingredient: *Bacillus thuringiensis* ssp. *kurstaki*) with biological fungicide AQ10 (active ingredient: parasitic fungus of powdery mildew - *Ampelomyces quisqualis*), was studied in the aim of the synchronic suppression of the two most significant agents on oaks and forest fruit trees – powdery mildews and the gypsy moth. The study results are presented in Tables 3 - 5.

Table 3. *Biological efficacy of the tested mixtures of biological insecticide and fungicide in the suppression of the third larval instar of the gypsy moth, 72 (a), 144 (b) and 216 (c) hours after test establishment*

Code	Number of alive larvae per repetition								X mean		E by Abbott %	
	I		II		III		IV					
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
a)												
1	15.0	14.7	15.0	15.0	15.0	14.7	15.0	15.0	15.0	14.85		
2	5.7	2.3	6.0	0.0	4.3	0.0	6.0	0.0	5.50	0.575	63.33	96.13
3	5.7	0.0	3.3	0.0	4.0	0.3	3.3	0.7	4.07	0.25	72.87	98.32
4	5.3	2.7	5.3	2.3	5.0	2.0	6.0	0.7	5.40	1.925	64.00	87.04
b)												
1	14.7	14.7	14.7	15.0	15.0	14.7	15.0	15.0	14.85	14.85		
2	2.0	0.0	1.3	0.0	0.7	0.0	1.7	0.0	1.42	0.0	90.44	100
3	0.7	0.0	0.7	0.0	0.7	0.3	0.3	0.7	0.60	0.25	95.96	98.32
4	0.3	0.0	0.7	0.0	0.7	0.0	0.7	0.0	0.60	0.0	95.96	100
c)												
1	14.7	14.7	14.7	15.0	15.0	14.7	14.7	15.0	14.77	14.85		
2	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.15	0.0	98.98	100
3	0.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.25	0.0	98.31	100
4	0.3	0.0	0.7	0.0	0.7	0.0	0.7	0.0	0.60	0.0	95.94	100

Legend:

1 - Distilled water
2 - Foray 48B
3 - Foray 48B + AQ10 (50g)
4 - Foray 48B + AQ10 (30g)

In laboratory conditions, 216 hours after the experiment was established, the identical 100% biological efficacy was attained by the all three variants, i.e., *Ampelomyces quisqualis* – active ingredient of the fungicide, did not have a negative effect on the activity and efficacy of the insecticide.

Table 4. *Test of the least significant differences per experiment groups*

Code*		Homogeneous groups		Code		Homogeneous groups		Code		Homogeneous Groups	
2009	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**
After 72 hours				After 144 hours				After 216 hours			
3	3			4	2			2	2		
4	2			3	4			3	3		
2	4			2	3			4	4		
1	1			1	1			1	1		

* Legend in Table 2

Table 5. *Test of the least significant differences per experiment groups (period 2090-2010, X mean)*

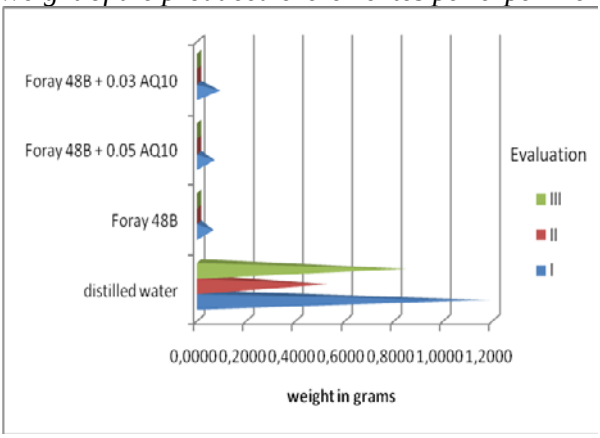
Code*	Homogeneous groups	Code	Homogeneous groups	Code	Homogeneous groups
After 72 hours		After 144 hours		After 216 hours	
3		4		2	
2		3		3	
4		2		4	
1		1		1	

* Legend in Table 2

The analysis of variance shows the statistically significant differences between the study variances on the one side, and control group on the other side (after 144 hours F-ratio is 578.39, and after 216 hours it is 7514.69). LSD test shows that, at the end of the experiment, the study preparations formed 2 homogeneous groups within which there are no statistically significant differences (Table 4) of biological efficacy in the suppression the gypsy moth larvae.

The goal of the insecticide application in forest ecosystems is the protection of the foliage against damage, by which the indirect consequences of the harmful effects of defoliators are avoided. Therefore, a very important moment is the time when feeding ceases, from the time of the insecticide application, and it can be monitored by the control of the quantity of the excreted excrements.

Figure 1. *Weight of the produced excrementes per experimental groups*



The analysis of results in Figure 2 shows at first a great difference in the weight of the produced excrements in the group fed on the treated food, compared to the control group. The feeding, i.e. the excretion, after 72 hours of exposure, continued only in the control group, which is in harmony with the mechanism of the applied pesticide. LSD test at the probability level of 95% shows the statistically significant differences between all analysed variants which make one homogenous group and the control.

4. CONCLUSION

The laboratory analyses of the potentials of synergetic effect of the insecticide Foray 48B and fungicide AQ10 mixed in different concentrations show that the biological activities and the efficacy of the mixtures are not reduced compared to the individual components when they are applied separately.

The previous research is a good base for further research of the application of the mixture of biofungicide AQ10 and the bioinsecticide Foray48B in the aim of synchronic suppression of the gypsy moth caterpillars and powdery mildews.

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COMPATIBILITY OF THE MICROBIOLOGICAL PESTICIDES IN THE SYNCHRONISED SUPPRESSION OF POWDERY MILDEWS AND THE GYPSY MOTH

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Summary

The Serbian forests are resources of numerous products, partly quantified and valorized. The complex, frequently complementary use of as much as possible products of forest ecosystems is of permanent importance. Along with timber, the main product, the most important in the commercial sense recently have been forest fruits and aromatic plants, in which Serbia is abundant, due to favourable site conditions. People have harvested and processed forest plants for medicinal purposes since the beginning of history. Forestry in Serbia intends to enrich 500,000 ha of degraded forests by these valuable plants.

Since these species are hosts of numerous, omnipresent, phitopathogenic fungi and economically harmful insects, in the harmony with trend of forest protection and guidelines to organic products, Institute of Forestry in Belgrade have been studied the biological efficiency of biofungicides and bioinsecticides which could be applied simultaneously in suppressing of the two groups of economically significant and harmful biological agents.

The laboratory analyses of the potentials of synergetic effect of the insecticide Foray 48B and fungicide AQ10 mixed in different concentrations show that the biological activities and the efficacy of the mixtures are not reduced compared to the individual components when they are applied separately.

The previous research is a good base for further research of the application of the mixture of biofungicide AQ10 and the bioinsecticide Foray 48B in the aim of synchronic suppression of the gypsy moth caterpillars and powdery mildews.

KOMPATIBILNOST MIKROBIOLOŠKIH PESTICIDA PRI SINHRONIZOVANOM SUZBIJANJU PEPELNICA I GUBARA

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Rezime

Šume Srbije su resurs mnogobrojnih, samo delom kvantifikovanih i valorizovanih produkata. Pitanje kompleksnog, često komplementarnog korišćenja što većeg broja produkata šumskih ekosistema, trajno je aktuelno. Pored drveta, kao glavnog proizvoda, u novije vreme na prvo mesto po komercijalnom kriteriju izbijaju šumski plodovi, medicinsko i aromatično bilje, kojima zbog vrlo povoljnih stanišnih uslova, Srbija obiluje. Intencije šumarstva Srbije su da se oko 500.000 ha degradiranih šuma obogati i ovim vrlo vrednim rastinjem.

Kako su ove vrste domaćini brojnih fitopatogenih gljiva i ekonomski štetnih insekata, a u skladu sa opšteprihvaćenim opredeljenjem zaštite šuma i smernicama organske proizvodnje, u Institutu za šumarstvo u Beogradu vrše se ispitivanja biološke efikasnosti biofungicida i bioinsekticida, koji bi se mogli primeniti simultano pri suzbijanju dve prethodno navedene grupe ekonomski štetnih bioloških agensa.

Laboratorijska ispitivanja mogućnosti sinergetskog delovanja insekticida Foray 48B i fungicida AQ10 pomešanog u različitim koncentracijama su pokazala da kod mešavina ne dolazi do umanjenja biološe aktivnosti i efikasnosti u odnosu na pojedine komponente kada se primene samostalno.

Dosadašnja saznanja pružaju dobru osnovu za dalja istraživanja primene mešavine biofungicida AQ10 i bioinsekticida Foray 48B u cilju istovremenog suzbijanja gusenica gubara i pepelnica.

Reviewer: **Ph. D. Iancho Naydenov**

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FAUNA OF PREDATORY MITES (ACARI: *PHYTOSEIIDAE*) IN THE ARTIFICIALLY ESTABLISHED STANDS ON THE RECLAIMED MINE SOILS

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Abstract: *The fauna of predatory mites was researched in the artificially established stands of Alnus glutinoas (L.) Gaertn., Pinus nigra Arn., P. silvestris L. And Larix leptolepis (S. et Z.) Gard. on the reclaimed mine soils of Mining Energy Industrial Complex Kolubara, in the territory of Lazarevac, Central Serbia, over the period 2006-2010. Fifteen different plant species from thirteen gena were studied: Acer L., Alnus Hill., Amorpha L., Cerasus Juss., Crataegus L., Fragaria L, Juglans L., Morus L., Populus L., Quercus L., Robinia L., Rubus L i Salix L.. The representatives of family Phytoseiidae were found on almost all observed plant species. The presence of nine phytoseiidae species was determined on this occasion.*

Key words: Phytoseiidae, predatory mites, reclaimed mine soils.

1. INTRODUCTION

The representatives of family Phytoseiidae are the subject of numerous studies in the world as a result of their increasing role in the integral protection. Phytoseiidae are the natural enemies of microarthropods. They most frequently feed on phytophagous mites from the superfamilies Tetranychoidea and Eriophyoidea, but also on small insects from the orders *Thysanoptera* and *Homoptera.* More than 2,250 species from this family (Moraes et al., 2004) have

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been described in the world so far, out of which 20 species are used in the biological control of the phytophagous mites and some insects.

In Serbia over the last twenty years or so the most significant researches of this group have been done mainly within the agrobiocenoses. Only 28 species of Phytoseiidae have been reported in Serbia so far (Kropczynska & Petanovic, 1987; Radivojević and Petanović, 1984; Petanovic & Stojnic, 1994; Stojnić, 2001; Stojnic et al., 2002; Mladenović at al., 2010). The previous faunistic researches of Phytoseiidae in the natural, mainly forest and unexplored anthropogenic sites are neglected. The future researches in Serbia should be directed towards the study of diversity of mites on the forest plant species.

2. METHOD

The researches were done in the artificially established stands of *Alnus glutinosa, Pinus nigra, P. silvestris* and *Larix leptolepis* on the reclaimed mine soils of Mining Energy Industrial Complex Kolubara, in the territory of Lazarevac, Central Serbia, over the period 2006-2010.

Mining-energy industrial complex Kolubara in the administrative sense belongs to the Municipality Lazarevac. It is located some 50 kilometers southwest of Belgrade. Kolubara mining basin is the greatest lignite basin in Serbia. The terrain is wave-like, intersected by numerous river valleys (Tamnava, Kolubara, Turija and their tributaries). The whole area of Mining Energy Industrial Complex Kolubara belongs to the Kolubara River basin, which divides this site into eastern and western parts, i.e. fields. The samples from which the samples of the plant materials were taken are located on the eastern field of the open-pit mine.

In Mining Energy Industrial Complex Kolubara, due to the mining activities and waste rock disposal from the open-pit mines, the mine soils (tailings ponds), which were reclaimed by reforestation, were formed .

The samples were collected in the following four sites of the eastern fields of Mining Energy Industrial Complex Kolubara:

Site 1: Experimental plot 5.1 Twenty-four-year-old black alder plantation

Site 2: Experimental plot 6.1 Twenty-six Japanese larch plantation with some maples

Site 3: Lazarevac, Mirosaljci – lake (from 35/b): The artificially established stand of *Larix leptolepis* and *Pinus nigra* in which the naturally regenerated black locust, *Robinia pseudoacacia* is dominant.

Site 4: Lazarevac, Baroševac Nursery, lake (from 43/a): Artificially established stand *Larix leptolepis.*

The leaf samples were collected during the growing season from the ligneous, bushy and herbaceous plants. The collected samples encompass fifteen different plant species from thirteen gena: *Acer, Alnus, Amorpha, Cerasus, Crataegus, Fragaria, Juglans, Morus, Populus, Quercus, Robinia, Rubus* and *Salix.*

The samples contain from 50 to 400 leaves, depending on the plant species. Phytoseiidae were extracted in the laboratory by exposing the leaves to the effect of ethyl acetate for 20 minutes, which was followed by the shaking and extraction

of mites under the stereo microscope. The extracted Phytoseiidae individuals were soaked in the ethyl alcohol and lactic acid solution (Evans & Browing, 1955). After the exposure to light the permanent preparations by using Hoyer's medium were made (Baker & Wharton, 1964). The suitable keys were used for the identification of Phytoseiidae (Begljarov,1981; Karg 1993). The permanent preparations are preserved in the depot of the Department of Entomology and Agricultural Zoology of the Faculty of Agriculture of the University of Belgrade.

3. RESULTS

By examining the samples, the presence of predatory mites from the family Phytoseiidae was determined on the following plant species: *Acer platanoides, A. pseudoplatanus, Quercus frainetto, Q. robur, Alnus glutinosa, Prunus avium, Juglans regia, Morus alba, Salix alba, Crataegus monogyna, Amorpha fruticosa, Robinia pseudoacacia, Rubus caesius, R. fructicosus* and *Fragaria vesca.*

Nine different species of Phytoseiidae were determined on the observed material.

Euseius finlandicus (Oudemans 1915)
The species which is the outstanding cosmopolite. Its range encompasses Europe, Asia, Africa, North and South America. It was reported in this country (Radivojević and Petanović, 1984; Kropczynska and Petanović, 1987; Stojnić, 1993; Stojnić and Petanović, 1994; Stojnić, 2001). It can be said that this species is dominant of Phytoseiidae sites. It is present on numerous plants. In this instance it was identified on thirteen plant species: *Acer platanoides, A. pseudoplatanus, Quercus frainetto, Q. robu , Robinia pseudoacacia, Juglans regia, Rubus caesius, R. fructicosus, Crataegus monogyna, Alnus glutinosa, Prunus avium, Morus alba* and *Salix alba*

Kampimodromus aberrans (Oudemans 1930)
The species which occurs in Europe, Algeria, Iran, Canada, USA, and the Commonwealth of the Independent States. It was also reported in this country (Radivojević and Petanović, 1984; Kropczynska and Petanović, 1987; Stojnić, 1993; Stojnić and Petanović, 1994). This species is present on many ligneous and herbaceous plants. During this research it was determined on three plant species: *Quercus frainetto, Amorpha fruticosa* and *Crataegus monogyna.*

Typhlodromus pyri Scheuten 1857
The species which is present in the greatest part of Europe, the Commonwealth of the Independent States, Israel, Egypt, USA, Canada and New Zealand. It is a rare species in this country, and was determined on *Prunus avium* and *Ulmus glabra* (Kropczynska and Petanović, 1987; Stojnić, 1993; Stojnić and Petanović, 1994). In this instance it has been reported on *Acer pseudoplatanus* for the first time.

Seiulus aceri (Collyer 1957)
The species which has been so far reported in England, Czech Republic, Azerbeijan, USA and in this country. It was reported only on *Acer spp., Prunus spp., Corylus spp.*, and in this country on *Juglans regia* (Radivojević and Petanović, 1984; Stojnić, 1993). During this research it has been reported on *Quercus frainetto* for the first time.

Seiulus tiliarum (Oudemans 1930)
The species which is present in almost all parts of Europe, the Commonwealth of the Independent States, Turkey, Algeria, Canada, and USA on numerous wild and cultivated plant species. In this country it was reported on *Ribes sp., Juglans regia, Corylus avellana, Cydonia oblonga, Mespilus germanica, Morus nigra, Prunus avium, P. domestica, Salix alba* and *Tilia spp.* (Radivojević and Petanović, 1984; Kropczynska and Petanović, 1987; Stojnić, 1993; Stojnić and Petanović, 1994). During this research it was found on *Rubus caesius* and has been determined on *Alnus glutinosa* and *Morus alba* for the first time.

Amblyseius (Amblyseius) andersoni (Chant 1957)
The species which is present in the greatest part of Europe, Algeria, Canada, USA, the Commonwealth of the Independent States. It was also reported in this country Radivojević and Petanović, 1984; Kropczynska and Petanović, 1987). It was found on many ligneous and herbaceous plants. During this research it was reported only on *Quercus frainetto.*

Dubininellus ribagai (Athias-Henriot 1960)
The rare species. It was first reported in Italy on *Urtica sp.* (Ribaga, 1902), then in Algeria on *Rubus ulmifolius* (Athias-Henriot, 1957) and *Vitis vinifera* (Denmark, 1966), and in Germany (Prpić, 2008), where no data on the host plant were reported. This species has been identified in this country for the first time (Mladenović at al., 2010) and in this instance found on *Fragaria vesca.*

Dubininellus maltshenkovae (Wainstein 1973)
The rare species which was first reported in Moldova on *Rubus sp.* (Wainstein, 1973), and was also found in Germany (Prpić, 2008), on *Rubus idaeus.* This species has been identified in this country for the first time (Mladenović at al., 2010) and in this instance found on *Rubus caesius* and *R. fructicosus.*

Dubininellus juvenis (Wainstein & Arutunjan 1970)
The frequent species (DeMoraes et al., 1986), found in Armenia on *Corylus, Salix sp,* Crimea (*Rubus, Urtica sp.*), Kazakhstan (grass vegetation, *Agrimonia, Malus, Salix* spp.), Moldova (*Cydonia, Rubus spp.*), Russia (*Rubus sp.*), Ukraine *Acer negundo, Arctium sp., Ballota nigra, Leonurus sp., Malus sp., Populus alba, Rubus caesius, Rubus sp., Salix caprea, Salix sp., Urtica sp.*), Finland (*Malus sp.*) and Serbia *Corylus avelana, C. colurna, Rubus idaeus*) (Stojnić and Petanović, 1994). During this research it was determined on *Rubus caesius.*

4. CONCLUSION

This paper presents the preliminary researches of the diversity of the predatory group of mites from the family Phytoseiidae in the anthropogenically conditioned forest ecosystems.

By examining fifteen species of ligneous, bushy and herbaceous plants on the reclaimed mine soils on Mining Energy Industrial Complex Kolubara, the presence of nine species of predatory mites from the family Phytoseiidae was determined.

The reseaches of Phytoseiidae fauna which have started in agrobiocenoses in Serbia is extended by this study to the range of the natural, mainly forest and unexplored anthropogenic sites.

The results of this research will serve as the complement to the faunistic and zoo-geograhic data on phytoseiidae in Serbia.

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