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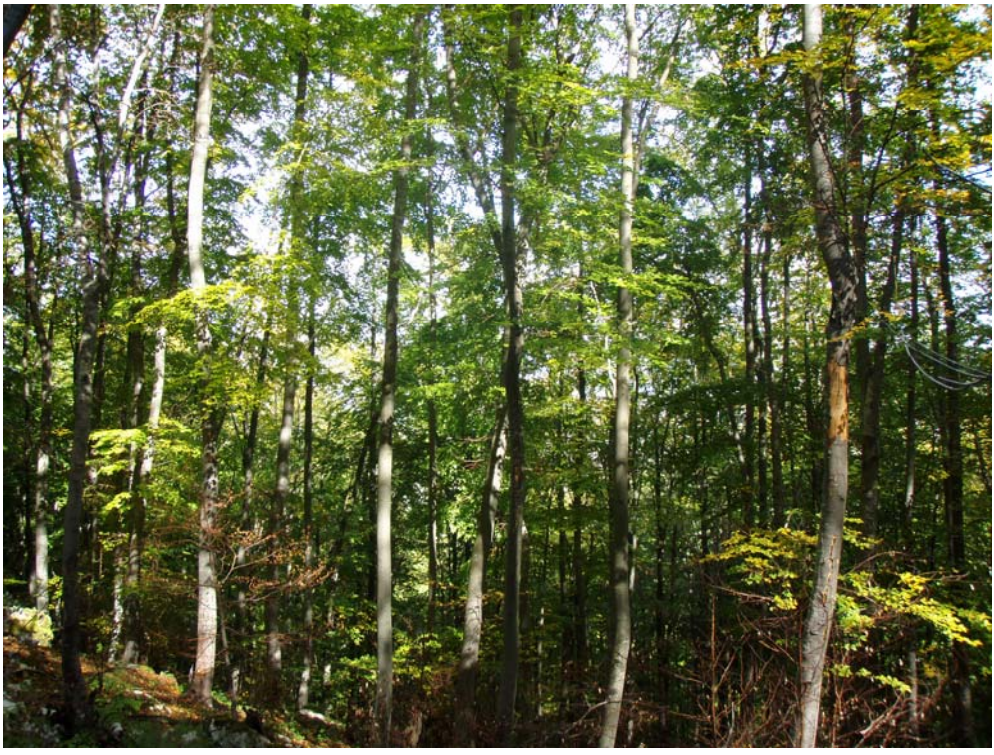

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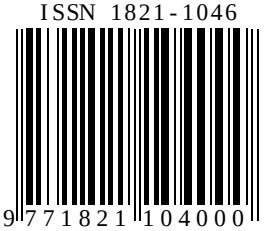

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Original scientific paper

THE HEALTH CONDITION OF BEECH FORESTS ON ICP SAMPLE PLOTS IN SERBIA

Zlatan RADULOVIĆ[1], Slobodan MILANOVIĆ[1]

Abstract: *The beech is the most widely distributed tree species in the Republic of Serbia. The beech forests account for 47.11% of the total forest area in Central Serbia. The beech is present on 51 sample plots out of 125 plots which were set. The percentage of the beech which is present on the sample plots is 40.8%, i.e. 30.4% of the total tree number. By the research conducted on beech forest mycoflora the presence of 21 fungi species was noted. Nectria coccinea, Nectria ditissima, Fomes fomentarius and Hypoxylon deustum, cause the greatest economic damage of all the reported species. The most significant insect species characteristic for Fagus genus were analyzed: Cryptococcus fagisuga, Orchestes fagi, Phyllaphis fagi and Mikiola fagi.*

Key words: beech, sample plots, plant diseases, pests

ZDRAVSTVENO STANJE BUKOVIH ŠUMA NA BIOINDIKACIJSKIM TAČKAMA U SRBIJI

Izvod: *Bukva je u Srbiji najrasprostranjenija vrsta drveta. U ukupnoj površini šuma u središnjoj Srbiji bukove šume učestvuju sa 47,11%. Od 125 postavljenih bioindikacijskih tačaka bukva je prisutna na 51 tački. Izraženo procentualno, bukvu srećemo na 40,8% bioindikacijskih tačaka, odnosno njeno učešće je 30,4% ukupnog*

[1] M.Sc. Zlatan Radulovic, M.Sc. Slobodan Milanovic, Institute of Forestry, Belgrade

broja stabala. Istraživanjima mikoflore bukve na bioindikacijskim tačkama zabeleženo je prisustvo 21 vrste gljiva. Od svih konstatovanih vrsta najveće ekonomske štete nanose Nectria coccinea, Nectria ditissima, Fomes fomentarius i Hypoxylon deustum. Od insekata analizirane su najznačajnije vrste karakteristične za rod Fagus i to Cryptococcus fagisuga, Orchestes fagi, Phyllaphis fagi i Mikiola fagi.

Ključne reči: Bukva, bioindikacijske tačke, biljne bolesti, štetočine

1. INTRODUCTION

The total forest area in Serbia is 2,412,940ha, which accounts for 27. 3% of the forest cover. The beech is the most dominant species in the forests, accounting for 60% per volume. The beech coppice and brush forest account for 52.56% of the total beech forest area in Central Serbia, as reported by Medarević et. al (2004). The largest area is managed by Public Enterprise "Srbijašume"(340,028ha), out of the total beech forest area (372,000ha) in Central Serbia and Vojvodina. The Public Enterprises of national parks manage the area of 26,529ha, Public Utilities Enterprise "Beli Izvor" manages 4,486ha, the Faculty of Forestry 1,472ha, and Public Enterprise "Vojvodinašume" manages 85ha. According to Medarević et. al (2003), the beech and beech stands dominate in Severnokučajski (70%), Jablanički (65%), Timočki (61.4%), Rasinski (59.6%), Južnomoravski (56.9%), Juznokučajski areas (60.8%), National Park Đerdap (55.1%) and Public Utilities Enterprise "Beli Izvor" (57%).

The existing 16km plot grid was reconstructed in Serbia in 2003, within the framework of ICP Forest. During 2005 new sample plots were set on 4km grid. The beech is present on 51 out of 125 sample plots which were set, i.e. there are 869 beech trees out of 2,860 trees. The percentage of the beech on the plots is 40.8%, i.e. 30.4% of the total tree number. The spatial arrangement of the sample plots on which beech is presented in Picture 1.This grid of plots served us for more detailed monitoring of beech forest health condition.

The presence of 142 phytophagous insects was reported by the research conducted by Mihajlović (2005). The majority of species (119) regularly exists in low numbers or has no greater significance. Seventeen species belong to a much larger group, the numbers of which are higher, and can cause lesser economic damage. The smallest number (6) of species belongs to the group of pests which can cause considerable damage during the multiplications of them Mihajlović (2005).

This paper analyzes the presence of species characteristic of *Fagus* genus *Cryptococcus fagisuga*, *Orchestes fagi*, *Phyllaphis fagi,* which by the significance belong to the group of the first class pests and *Mikiola fagi*, which belongs to the second group of pests (Mihajlović, 2003).

2. MATERIAL AND METHOD

The research of mycoflora and selected dangerous insects was conducted by the examination of all trees on the plots. All parasitic and saprophytic fungi were recorded on standing trees, as well as in the branch litter and stumps. The fungi were mostly identified by the appearance of the fruiting bodies and the type of rot caused by the fungi. In other cases samples were taken for the laboratory and fungi were isolated by the standard laboratory techniques. After isolation of pure cultures, fungi were identified by using keys described by Stalpers (1978). The presence of selected insects was determined based on the presence of different development stages for every tree inspected. The appearance frequency of analyzed pests per tree was obtained by dividing the number of trees where the presence of the concrete pest was registered with the number of the beech tree trunks inspected. The appearance frequency of the analyzed pests on the sample plots (experimental areas) was obtained by dividing the number of the sample plots on which the pest was registered with the number of analyzed plots. All beech trees and sample plots with beech trees were researched.

3. RESULTS AND DISCUSSION

In the sample plots on which beech is present the presence of 21 fungi species was recorded. The largest number of species is recorded on trees and branches, whereas on the leaves and roots the presence of one species was recorded. The research results are presented in the following table.

Table 1. *The fungi recorded on the sample plots*

Fungi name	Damage	No.pos.point
Apiognomonia errabunda (Rob.ex Desm.) Höhnel	Dots along the nerves	8
Armillaria spp.	Rot in root and butt end	6
Daedaleopsis confragnosa (Bolt.ex Fr.) Schroet	White rot	1
Dyatripe disciformis (Hoff.ex Fr.) Fr.	Weakness parasite	1
Fomes fomentarius (L.ex Fr.) Kickx	White dote rot	13
Hypoxylon deustum (Fr.) Petrak	White stem base rot	8
Pleurotus ostreatus (Jacq.ex Fr.) Kummer	White dote rot	1
Trametes hirsuta (Wulf.ex Fr.) Pilat	White rot and discoloration	1
Trametes versicolor (L.ex Fr.) Lloyd	White rot	6
Trametes gibbosa (Pers.ex Fr.) Fr.	White rot	5
Stereum insignitum Quélet	White rot	2
Xylaria polymorpha (Pers.ex St.Amans) Grev.	White rot	2
Schizophyllum commune Fr.	White rot and discoloration	7
Pholiota adiposa (Fr.) Kummer	White rot and false heart	3
Hypoxylon fragiforme (Pers.ex Fr.) Kickx	Discolaration and sapwood fustiness	5
Nectria coccinea (Pers.ex Fr.) Fr.	Bark necrosis	9
Nectria ditissima Tul.	Canker wounds	5

Fungi name	Damage	No.pos.point
Nectria cinnabarina (Tode ex Fr.) Fr.	Bark necrosis	6
Nectria galligena Brest.	Canker wounds	7
Laetiporus sulphureus (Bull.ex Fr.) Murr.	Brown, prism-like rot	2
Ganoderma applanatum (Pers. ex Wallr.)Pat.	White rot in the stem base	2

Eight species, out of all registered, are developed as parasites on beech and they cause greatest damages. The group consists of *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* and *Apiognomonia errabunda*. According to Karadžić and Milijašević (2004) these fungi belong to the first group due to the damage they cause.

Nectria coccinea (Pers.ex Fr.) Fr. is one of the most dangerous species attacking the beech; In the association with insect *Cryptococcus fagi* Bear. (= *C. fagisuga* Lind.) it causes beech bark disease. This disease was recorded in Serbia for the first time in 1983 (Marinković, Karadžić, 1985). This disease, as stated by Karadžić and Milijašević (2004), tends to spread in high forests, as well as in low forests, but the damages are higher in coppice stands.

Besides this fungus, *N. ditissima* Tul. and *N. galligena* Brest are often found on the beech and they cause bark necrosis and canker wounds. According to Lazarev (1984) *N. ditissima* is frequently found in beech coppice forests, and the attack intensity is strongest in the coppice forests on shallow limestone terrains. *N. galligena* prevails in seed stands, and various *Nectria* species can often be found on the same tree. In that case, *N. ditissima* causes canker and curls of the branches, *N. galligena* causes tree canker, and *N. cocinea* causes bark disease of the tree (Lazarev, 2005).

Species *Fomes fomentarius*, *Hypoxylon deustum* and *Ganoderma applanatum* cause the rot of living trees, whereas *F. fomentarius* and *G. applanatum* are often found on the trees of the seed origin. *H. deustum* is found in the stem base and is the main cause of tree decay in coppice forests.

Studying the influence of tree lesions and age on the beech false heart size, Karadžić (1981) stated that *H. deustum* and *Pholiota adipose* are most frequently isolated fungi. These fungi are frequent in the so-called radial, star-like, fan-like and other eccentric shapes of false heart.

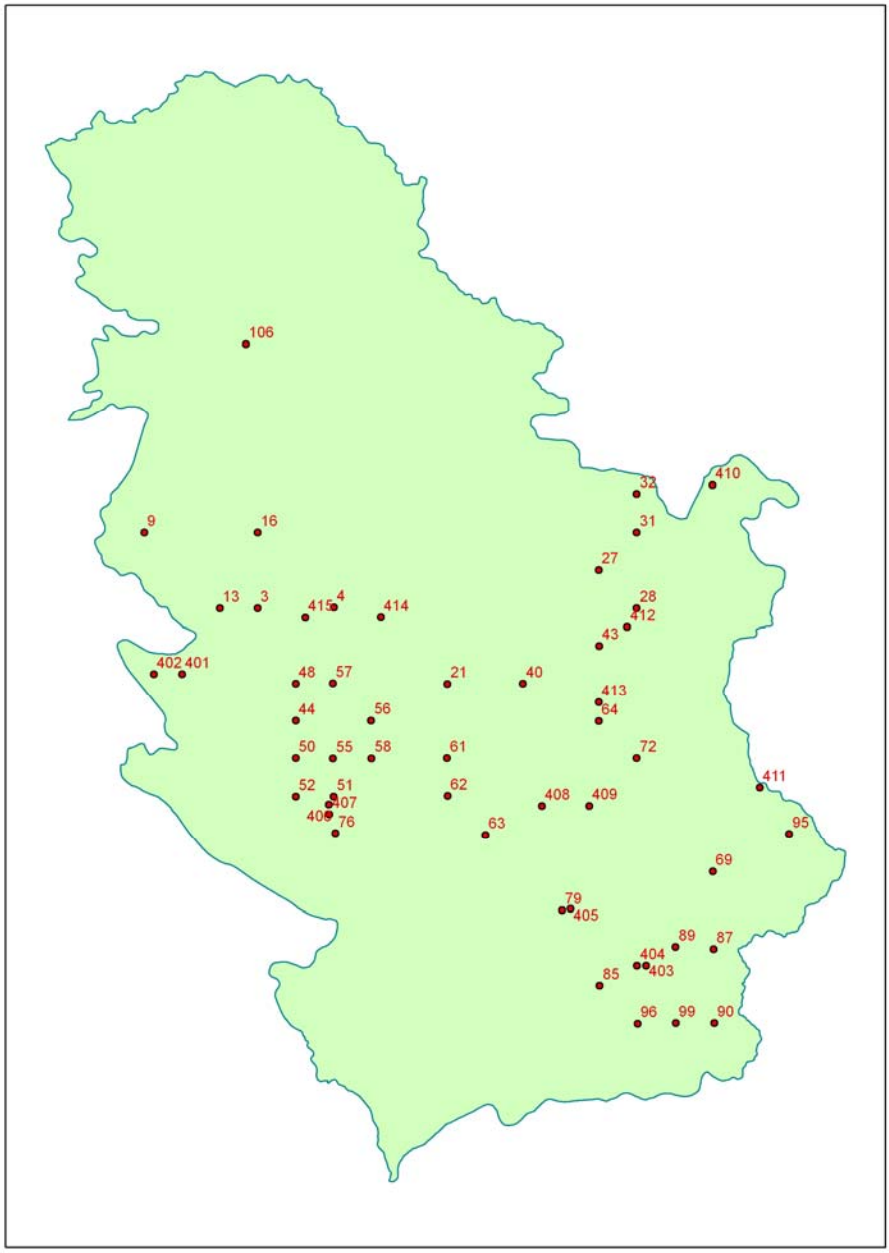


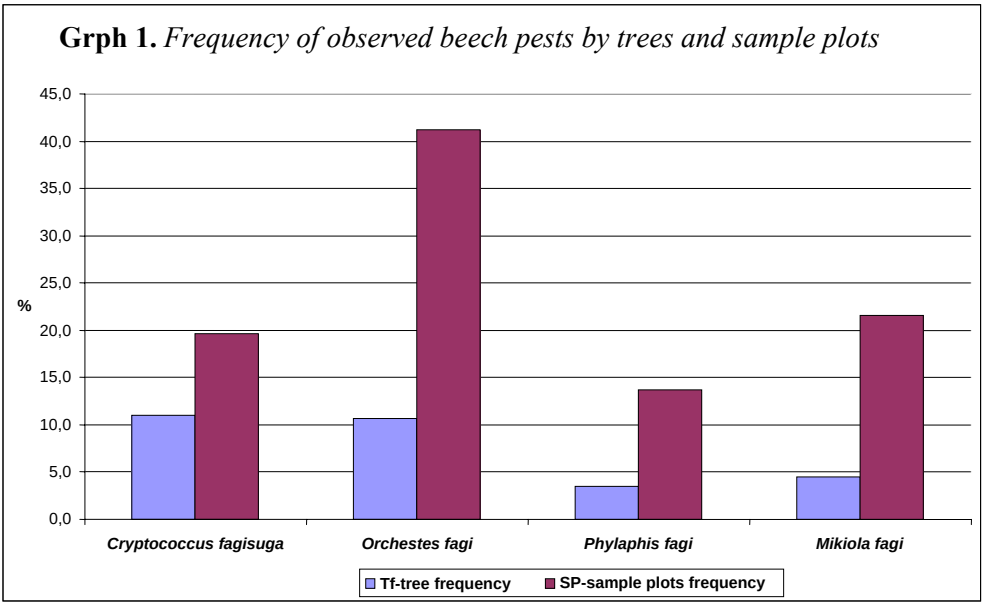
Chart 1. *Spatial distribution of ICP sample plots with beach*
(Autor slike: Marković Nenad)

Apiognomonia errabunda (Rob.ex Desm.) Höhnel is found on leaves and causes dots along the nerves and leaf defoliation. It can cause greater damage only on young trees.

Other species *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* and *Laetiporus sulphureus* are developed as weakness parasites and attack physiologically weakened trees. Most of these species continue to develop on the dead tree. Other stated species belong to the category of saprophytes and have no significance in beech forest decay.

Cryptococcus fagisuga Lind. (Homoptera, Cryptococcidae) is present in beech stands where together with fungus *Nectria coccinea* causes the beech bark disease. This species has not yet been sufficiently studied and its natural enemies, which could be used in biological struggle to a great extent, are unknown. There are indications that our beech (*Fagus moesiaca*) is more resistant than *F. sylvatica*, so we have to pay special attention to this species in the future, especially if we have in mind the area on which beech forests are spread. Suppression by chemical solutions is recommended but with restrictions, on small areas, during a heavy attack and in facilities of special significance. For this purpose solutions based on mineral oils can be used. The species *Cryptococcus fagisuga* was found on 10 out of 51 sample plots, where beech presence was recorded, i.e. on 96 out of 869 trees. The presence of this pest was reported on 11% of trees and in 19.6% of the sample plots Chart 1).

Grph 1. *Frequency of observed beech pests by trees and sample plots*



Orchestes fagi L. (Coleoptera, Curculionidae), miner of beech leaves, can considerably reduce the increment during the heavy attack, and predisposes the attacked trees to the attacks of weakness parasites and secondary pests. One larva is capable of damaging from 1/5 to ½ of a leaf (Mihajlović 2008). Under heavier attack we can find more larvae on a leaf, so this species can lead to complete defoliation of some trees, as well as to defoliation of whole beech forest complexes. Species *Orchestes fagi* was found on 21 out of 51 sample plots where beech presence was recorded, i.e. on 93 out of 869 trees. The presence of this pest was reported on 10.7% of trees and on 41.2% of sample plots (Figure 1).

Table 2. *Presence of analyzed beech pests on the sample plots*

Analyzed pests	Number of			
	Positive trees	Trees inspected	Positive sample plots	Sample plots inspected
Cryptococcus fagisuga	96	869	10	51
Orchestes fagi	93	869	21	51
Phyllaphis fagi	30	869	7	51
Mikiola fagi	39	869	11	51

Phyllaphis fagi L. (Homoptera, Callaphidae), beech leaf louse is very common species in our beech forests. Owing to the intensive juice absorbing, during heavy attack, it can lead to physiologic weakening of the whole plant and withering of some shoots. The large parts on the nutrients not used by lice are secreted into the environment in the form of honey dew. Recent studies show that a louse can absorb the assimilation amount daily, for the production of which the foliage of 5-20cm^2 is needed (Tjallingii, 2006). Therefore, the influence of this species on the increment should not be neglected. Species *Phyllaphis fagi* were found on 7 out of 51 bio-indication points where the beech presence was recorded, i.e. on 30 out of 869 trees. The presence of this pest was noted on 3.5% of trees and on 13.7% of the sample plots (Figure 1).

Mikiola fagi Htg. (Diptera, Cecidomyiidae) is present in natural beech stands of different age. Under the heavier attack it can physiologically weaken beech trees and predisposes them to the attacks of secondary pests and weakness parasites. Any special measures of fighting other than cultivation ones are not recommended. Species *Mikiola fagi* were found on 11 out of 51 sample plots where beech presence was recorded, i.e. on 39 out of 869 trees. The presence of this pest was reported on 4.5% of trees and on 21.6% of sample plots (Figure 1). The research results of presence of these beech pests on the sample plots are presented in Table 2.

4. CONCLUSION

By the the inspection of the sample plots on which beech is present, the presence of 21 fungi species was noted. *Fomes fomentarius* was recorded on 13 sample plots, *Nectria coccinea* was noted on 9 points, and the presence of *Hypoxylon deustum* and *Apiognomonia errabunda* was recorded on 8 sample plots each. However, these fungi are of different economic significance.

Eight species, out of all registered, are developed as parasites on beech and they cause greatest damages. The group consists of *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* and *Apiognomonia errabunda*.

Nectria coccinea (Pers.ex Fr.) Fr. is one of the most dangerous species attacking the beech, and in association with insect *Cryptococcus fagi* Bear. (= *C. fagisuga* Lind.) it causes beech bark disease.

Besides this fungus, *N. ditissima* Tul. and *N. galligena* Brest are often found on the beech and they cause bark necrosis and canker wounds. *N. ditissima* is frequently found in beech coppice forests, as well as *H. deustum* which is found in the stem base and represents the main cause of tree decay in coppice forests.

N. galligena, F. fomentarius and *G. applanatum* are often found on the trees of the seed origin. *Apiognomonia errabunda* can cause greater damage only on young trees.

Other species *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* and *Laetiporus sulphureus* are developed as weakness parasites and attack physiologically weakened trees. Most of these species continue to develop on the dead tree. Other stated species belong to saprophytes and have no significance in beech forest decay.

The following significant pests found in beech forests were analyzed in a detail:

Cryptococcus fagisuga was found on 10 out of 51 sample plots where beech presence was recorded, i.e. on 96 out of 869 trees. The presence of this pest was reported on 11% of trees and on 19.6% of the sample plots.

Orchestes fagi was found on 21 out of 51 sample plots where beech presence was recorded, i.e. on 93 out of 869 trees. The presence of this pest was reported on 10.7% of trees and on 41.2% of the sample plots.

Phyllaphis fagi was found on 7 out of 51 sample plots, where the beech presence was recorded, i.e. on 30 out of 869 trees. The presence of this pest was noted on 3.5% of trees and on 13.7% of the sample plots.

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Zlatan RADULOVIĆ, Slobodan MILANOVIĆ

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The existing 16km plot grid was reconstructed in Serbia in 2003, within the framework of ICP Forest. During 2005 new sample plots were set on 4km grid. The beech is present on 51 out of 125 sample plots which were set, i.e. there are 869 beech trees out of 2,860 trees. The percentage of the beech on the sample plots is 40.8%, i.e. 30.4% of the total tree number. The research of mycoflora and selected dangerous insects was conducted by the examination of all trees on the sample plots. All parasitic and saprophytic fungi were recorded on standing trees, as well as in the branch litter and stumps. The fungi were mostly identified by the appearance of the fruiting bodies and the type of rot caused by the fungi. In other cases samples were taken for the laboratory and fungi were isolated by the standard laboratory techniques. After isolation of pure cultures, fungi were identified by using keys described by Stalpers (1978).

The presence of selected insects was determined based on the presence of different development stages for every tree inspected. The appearance frequency of analyzed pests per tree was obtained by dividing the number of trees where the presence of the concrete pest was registered with the number of the beech tree trunks inspected. The appearance frequency of the analyzed pests on the sample plots (experimental areas) was obtained by dividing the number of sample plots on which the pest was registered with the number of analyzed sample plots. All beech trees and plots with beech trees were researched.

By the inspection of the sample plots on which beech is present, the presence of 21 fungi species was noted. *Fomes fomentarius* was recorded on 13 sample plots, *Nectria coccinea* was noted on 9 points, and the presence of *Hypoxylon deustum* and *Apiognomonia errabunda* was recorded on 8 sample plots each.Eight species, out of all registered, are developed as parasites on beech and they cause the greatest damages. The group consists of *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* and *Apiognomonia errabunda*.

Other species *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* and *Laetiporus sulphureus* are developed as weakness parasites and attack physiologically weakened trees. Most of these species continue to develop on the dead tree. Other stated species belong to saprophytes and have no significance in beech forest decay.

The following significant pests found in beech forests were analyzed in a detail:

Cryptococcus fagisuga was found on 10 out of 51 sample plots where beech presence was recorded, i.e. on 96 out of 869 trees. The presence of this pest was reported on 11% of trees and on 19.6% of the sample plots.

Orchestes fagi was found on 21 out of 51 sample plots where beech presence was recorded, i.e. on 93 out of 869 trees. The presence of this pest was reported on 10.7% of trees and on 41.2% of the sample plots.

Phyllaphis fagi was found on 7 out of 51 sample plots, where the beech presence was recorded, i.e. on 30 out of 869 trees. The presence of this pest was noted on 3.5% of trees and on 13.7% of the sample plots.

Mikiola fagi was found on 11 out of 51 sample plots where beech presence was recorded, i.e. on 39 out of 869 trees. The presence of this pest was noted on 4.5% of trees and on 21.6% of the sample plots.

ZDRAVSTVENO STANJA BUKOVIH ŠUMA NA BIOINDIKACIJSKIM TAČKAMA U SRBIJI

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Rezime

U Srbiji je tokom 2003. godine, u okviru programa ICP Forest, izvršena rekonstrukcija postojeće 16 km mreže bioindikacijskih tačaka. Tokom 2005. godine postavljene su nove tačke na 4 km mreži. Bukva je prisutna na 51 od ukupno 125 postavljenih bioindikacijskih tačaka, odnosno sa 869 od ukupno 2860 stabala. Izraženo procentualno, bukvu srećemo na 40,8% bioindikacijskih tačaka, odnosno njeno učešće je 30,4% ukupnog broja stabala. Istraživanja mikoflore i izabranih štetnih insekata bukve vršena su pregledom svih stabala na bioindikacijskim tačkama. Evidentirane su sve parazitske i saprofitske gljive kako na dubećim stablima tako i na ležavinama i panjevima. Određivanje gljiva je najčešće vršeno na osnovu izgleda plodonosnih tela i tipu truleži koji gljiva izaziva. U ostalim slučajevima uzimani su uzorci za laboratoriju i izolacija gljiva je vršena standardnim laboratorijskim tehnikama. Posle izolovanja čistih kultura, gljive su identifikovane korišćenjem ključeva opisanih od Stalpers-a (1978). Određivanje prisustva izabranih vrsta insekta vršeno je na osnovu prisutva različitih razvojnih stadijuma za svako pregledano stablo. Frekvenca pojave analiziranih štetočina po stablima je dobijena deljenjem broja stabla na kojima je registrovano ptrisustvo konkretne štetočine sa brojem pregledanih bukovih stabla. Frekvenca pojave analiziranih štetočina po bioindikacijskim tačkama (oglednim površinama) je dobijena deljenjem broja bioindikacijskih tačaka na kojima je registrovana štetočina sa brojem

analiziranih tačaka. Istraživanjima su bila obuhvaćena sva bukova stabla i bioindikacijske tačke koje imaju bukova stabla.

Pregledom bioindikacijskih tačaka na kojima je zastupljena bukva ustanovljeno je prisustvo 21 vrste gljiva. Na 13 tačaka je zabeleženo prisustvo *Fomes fomentarius*, na 9 *Nectria coccinea* a na po 8 tačaka *Hypoxylon deustum* i *Apiognomonia errabunda*.

Od svih konstatovanih vrsta 8 se parazitski razvija na bukvi i one i izazivaju najveće štete. U ovu grupu spadaju vrste *Nectria coccinea*, *Nectria ditissima*, *Nectria galligena*, *Fomes fomentarius*, *Hypoxylon deustum*, *Ganoderma applanatum*, *Pholiota adiposa* i *Apiognomonia errabunda*.

Ostale vrste *Armillaria* spp., *Trametes hirsuta*, *Trametes versicolor*, *Trametes gibbosa*, *Dyatripe disciformis*, *Schizophyllum commune*, *Hypoxylon fragiforme* i *Laetiporus sulphureus* razvijaju se kao paraziti slabosti i napadaju fiziološki oslabela stabla. Većina ovih vrsta nastavlja sa razvojem i na mrtvom drvetu. Ostale navedene vrste spadaju u saprofite i nemaju značaj u propadanju bukovih šuma.

Vrstu *Cryptococcus fagisuga* nalazimo na 10 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 96 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 11 % stabala i 19,6 % tačaka.

Vrstu *Orchestes fagi* nalazimo na 21 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 93 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 10,7 % stabala i 41,2 % tačaka.

Vrstu *Phyllaphis fagi* nalazimo na 7 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 30 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 3,5 % stabala i 13,7 % tačaka.

Vrstu *Mikiola fagi* nalazimo na 11 od ukupno 51 bioindikacijske tačke gde je zabeleženo učešće bukve, odnosno na 39 od ukupno 869 stabala. Prisustvo ove štetočine je zabeleženo na 4,5 % stabala i 21,6 % tačaka.

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