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Actual status of the beech bark necrotic disease in North Western Bulgaria

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ABSTRACT: In this paper we present recent findings about the beech bark necrotic disease in selected localities situated in the mountain ranges Vitosha and Stara planina in Bulgaria. The resulting values of necrotic disease expressed by the necrotisation index (I_{SN}) ranged from 0.72 to 1.12. In Slovakia such low values of I_{SN} were obtained only for seven out of 52 examined localities. The I_{SN} results are more favourable than the results obtained using the same methods for four localities situated in Northern Hungary (I_{SN} values ranging from 1.11 to 1.18). The results of monitoring of three selected biotic vectors of beech necrotic disease were follows: the focus of occurrence of the species *Bucculatrix ulmella* was in submountain beech forests. Considerable affinity to lower situated sites was found in *Ectoedemia liebwerdella*. We also found that the boundary of the occurrence of this species is approximately at 1,000 m a.s.l. The frequency values of *Cryptococcus fagi* were significantly influenced by the altitude. In four out of six localities we recorded the occurrence of three species of the genus *Nectria*: *Nectria cosmariospora*, *Nectria galligena* and *Nectria coccinea*.

Keywords: beech; *Fagus sylvatica* L.; bark necroses; biotic vectors; *Nectria* sp.; Bulgaria

The climate changes in Bulgaria in the postglacial time led to the occurrence of the mixed hydrothermal vegetation in more moist parts of the country or at higher altitudes in the mountain belt (Stefanov 1943). The European beech (*Fagus sylvatica* L.) is distributed almost all over whole Europe. To the east it occurs in Poland, Slovakia and Romania and to the south it crosses the Balkan Peninsula and covers the mountains of Bulgaria from 400 m up to 1,900 m above sea level. That is why the mutual investigations on the phytopathological status of beech forests in Slovakia and Bulgaria are actual and interesting from scientific and practical aspects. *Fagus sylvatica* L. is the main forest-forming species in the mountain belt and is characterised by its strong adherence to the hydrophytic habitat. It needs moderate climate and higher moisture in the summer season.

The European beech represents 16.7% of the forest cover in Bulgaria. In the mountain ranges Vitosha and Stara planina in Bulgaria beech is an important component of the forest ecosystems (Rosnev, Petkov 1996). The health status and ecological stability of beech stands in these mountains are influenced by unfavourable phytopathological conditions and diseases of beech trees to a considerable extent. Important is the necrotic disease of beech bark caused by several parasitic fungi, e.g. from the genus *Nectria* (Fr.) Fr., *Ophiostoma* Syd. et P. Syd., *Phomopsis* Sacc., *Valsa* Fr., *Verticillium* Nees: Link. The disease has a negative influence on the health status and quality of wood production of beech trees.

The problem of beech necrotic disease in Europe has been studied by many authors: by Perrin (1983), Perrin and van Gerwen (1984) in France, by Metzler and von Erffa (2000), Schütt and

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Summerer (1983) in Germany, by Gellini et al. (1988), Montecchio (2003) in Italy, by Jančařík (2000) in the Czech Republic, by Cicák and Mihál (1997, 2002), Mihál and Cicák (2003) in Slovakia, by Mihál and Cicák (2005) in Hungary, by Lazarev (1985), Halambek et al. (1996) in the countries of former Yugoslavia, by Chira and Chira (1998), Chira et al. (1996) in Romania and by Gajevaja et al. (1995), Merežko et al. (1994) in Ukraine.

According to available literature, the problem of beech bark necrosis in Bulgaria has not been subjected to study yet, except for the paper by Rosnev and Petkov (1996) dealing with beech health status, necrotisation and T-disease of beech in the Stara planina Mts. In this paper we present the first relevant data on beech bark necrosis for selected localities in the Stara planina and Vitosha Mts.

MATERIAL AND METHODS

The study area and objects of investigation

According to geobotany, Bulgaria is situated in the European deciduous tree area and the investigated objects in the Western Balkan range and in the Vitosha mountains are included in its Illyrian (Balkan) province.

According to forest vegetation regionalisation, the regions of investigations are in the Moesian forest vegetation area in the middle-mountain forests of beech, silver fir and Norway spruce in the Kraishte-Ihtiman sub-area and in North Bulgaria.

The climate is moderately continental with long-term average annual temperatures from 4.5°C to 8.8°C and average annual rainfalls from 730 mm to 1,500 mm. The soils are Cambisols with pH > 5.2 on metamorphic rocks: andesites, syenites, rhyolites, situated on slopes with predominantly shady (northern) exposure.

The conditions for the growth of beech in the middle belt (from 1,000 to 1,300 m a.s.l.) are optimal but there are also stands with different productivity due to the variety of the sites and the strongly barred relief. Table 1 shows a short description of research localities.

Methods of work

In the case of beech stem bark, the necrotic disease degree is evaluated by a five-degree classification scale, elaborated for this purpose (Cicák, Mihál 1997). The scale enables to evaluate visually the strength of attack on individual trees belonging to the first to fifth tree class (according to Kraft) with sample size n = 100. Considering the beech growth stages, the scale can be applied only within certain limits. It can be used only beginning with the small pole stage, determined by the mean diameter from six to twelve centimetres.

To simplify the interpretation of the results, the evaluation was performed using the so called bark necrosis index (I_{SN}). Each of the data represents the mean degree of the injury (computed as the weighted arithmetical mean) for each individual tree class. More details concerning the computation and usage

Table 1. Basic characteristics of the studied localities

Characteristics	Dragalevski monastir	Vitinya	Pravets	Petrohan	Barzia	Etropole
Orographic formation	Vitosha	Stara planina	Stara planina	Stara planina	Stara Planina	Stara Planina
Location	42°37´N 23°17´E	42°47´N 23°48´E	42°53´N 23°53´E	43°07´N 23°07´E	43°08´N 23°08´E	42°49´N 24°02´E
Exposition	NE	NE	N	NE	NW	NE
Altitude (m a.s.l.)	1,080	970	700	1,400	1,150	720
Average age (years)	70–130	90	50	100–110	90–120	120–130
Parent rock	andesites, syenites	syenites	syenites	syenites, rhyolites	syenites	syenites, rhyolites
Stocking	0.8	0.6–0.7	0.7–0.8	0.7	0.6	0.5–0.6
Slope (°)	5–8	10–15	5	18	28	24
Tree composition (%)	beech 100	beech 97, hornbeam 2, oak 1	beech 100	beech 100	beech 100	beech 99, hornbeam 1

Table 2. Frequency of necrotisation and index of beech bark stem necrotisation (I_{SN}) in selected localities

Localities	Frequency of necrotisation in necrotisation degrees (%)								I_{SN} (mean ± standard error)
	0	1	2	3	4	1–4	2–4	3–4	
Dragalevski monastir	19	65	13	3	0	81	16	3	1.00 ± 0.07 [a]
Vitinya	9	73	14	3	1	91	18	4	1.12 ± 0.06 [b]
Pravets	22	62	4	6	6	78	16	12	1.12 ± 0.10 [b,c]
Petrohan	7	83	5	5	0	93	10	5	1.08 ± 0.06
Barzia	30	66	4	0	0	70	4	0	0.72 ± 0.07
Etropole	28	64	4	2	0	72	6	2	0.79 ± 0.06 [a,d]

Statistical significance of differences in I_{SN} between localities is marked by a, b, c, d

of the I_{SN} index were given in Cicák and Mihál (1998).

Significance of differences in the necrotic disease of beech stem expressed by I_{SN} between individual study plots was tested by Mann-Whitney *U* test. We chose this test because of the non-parametric character of data resulting from discrete values used in the evaluation scale.

To assess the degree of necrotic damage to beech stems we also sampled fruiting bodies of fungi of the genus *Nectria* (Fr.) Fr. They were present most frequently on the bark of stems damaged by necrosis and also on broken and lying stems. The sampled fruiting bodies of the genus *Nectria* (Fr.) Fr. were determined in the laboratory according to the determination keys provided by Breitenbach and Kränzlin (1986) and Rossman et al. (1999).

Together with the assessment of the degree of necrotic damage we also recorded the occurrence of biotic vectors of the disease: *Cryptococcus fagi* Bärensp., *Bucculatrix ulmella* Zeller and *Ectoedemia liebwerdella* Zim. The presence was identified from the buttresses to a height of 2 m around the whole stem perimeter.

RESULTS AND DISCUSSION

The results of necrotic damage to beech trees in all examined localities expressed by the frequency of stem necrotisation classified according to the individual damage degrees and I_{SN} are summarised in Table 2. The I_{SN} values obtained in four localities (Dragalevski monastir, Pravets, Vitinya and Petrohan) ranged from 1.00 to 1.12. The results from these localities are comparable with the results obtained by Mihál and Cicák (2005) in four localities in Northern Hungary (the values of I_{SN} ranged from 1.11 to 1.18). In two localities (Barzia and Etropole) the values of I_{SN} were more favourable and reached 0.72 and 0.79, respectively. Such low values of I_{SN} were obtained only in seven out of 52 localities examined in Slovakia (Cicák, Mihál 2002). According to the results, we can distinguish two groups of localities. The first consists of two localities only – Barzia and Etropole, the second contains all the other localities. The localities Barzia and Etropole are different from the others by lower frequency of stems with the third and fourth degrees of necrotisation and higher frequency of stems without necrotic symptoms – degree 0. These results also influenced the values of I_{SN} that were the most favourable mainly for the localities Barzia and Etropole. In spite of the found differences, the results can be considered as largely uniform. This fact was also confirmed by the testing of significance of differences between the individual localities using the Mann-Whitney *U* test (Table 2). The differences were confirmed only between the locality Dragalevski monastir and the localities Pravets and Vitinya and between the localities Vitinya and Etropole ($p < 0.05$).

The results of beech bark necrotic disease obtained in six localities in the mountain ranges Vitosha and Stara planina, expressed by I_{SN}, are favourable. The I_{SN} values in three localities (Vitinya, Pravets and Petrohan) were somewhat higher than 1.0, in the locality Dragalevski monastir the index was precisely equal to 1.0. Rosnev and Petkov (1996) found different values of necrotisation frequency of beech in 17 localities in the Stara planina Mts. (from 5.0% in Smjadovo locality to 45.0% in Omurtag locality). The value of necrotisation frequency from 10.0% to 44.4% was found in Etropole locality.

One of the reasons for the given favourable status of necrotic damage to beech trees in localities in NW Bulgaria is a low proportion of trees belonging to the 4th and 5th tree classes (4.8%). This applies to all the evaluated stands. In comparison with Slovakia (12.8%), this value is three times lower. These tree classes have the highest impact on final I_{SN} for the whole stand. The same was also confirmed by Cicák

Table 3. Frequency of occurrence (%) of biotic vectors of beech necrotic disease in selected localities in Bulgaria

Localities	Altitude (m a.s.l.)	*Bucculatrix ulmella*	*Cryptococcus fagi*	*Ectoedemia liebwerdella*
Pravets	700	62.0	49.0	77.0
Etropole	720	25.0	83.0	17.0
Vitinya	970	5.0	75.0	97.0
Dragalevski monastir	1,080	23.0	50.0	0.0
Barzia	1,150	0.0	20.0	4.0
Petrohan	1,400	0.0	84.0	0.0

Bucculatrix ulmella Zeller – pupae, *Cryptococcus fagi* Bärensp. – colonies of adult individuals, *Ectoedemia liebwerdella* Zimm. – galleries in bark after mining

and Mihál (2002). These authors evaluated a sampling set consisting of 6,579 trees from the whole Slovakia and they found that the degree of necrotic damage to beech was significantly influenced by the tree sociological status in the stand (I_{SN} increased with decreasing tree sociological status). From the aspect of plant pathology it means that the trees heavily damaged by necrosis and belonging to the 4th and 5th tree class that are left in the stand increase the infection pressure on the trees of the whole stand. To leave the trees belonging to the 4th and 5th class is problematic from the aspect of forest cultivation, mainly when the stand has already been attacked by epiphytotic.

The results of monitoring of three selected biotic vectors of beech necrotic disease are summarised in Table 3. The focus of the occurrence of the species *Bucculatrix ulmella* was found in submountain beech forests. A significant correlation with lower situated sites was confirmed in *Ectoedemia liebwerdella*. We found that the boundary of occurrence for this species was at about 1,000 m a.s.l. Above this altitude, we detected only a single case of a very low frequency 4% (Barzia locality). In the localities Dragalevski monastir and Petrohan the frequency was zero. The same results were reported by Mihál and Cicák (2001) for 40 localities throughout the whole Slovakia. We can suppose that in the species *Bucculatrix ulmella* and *Ectoedemia liebwerdella* a certain role is also played by their classification to the Lepidoptera – not allowing their massive occurrence at higher situated sites on the background of their bionomics.

Cryptococcus fagi is considered to be the most important biotic vector of beech necrotic disease; its bionomics, distribution and significance in European forests were described by Pfeffer (1958). Several authors reported it as an important pest living on beech bark and at the same time being a vector of necrotic beech disease. Lonsdale (1980) described it as a biotic vector closely associated with parasitic fungi of the genus *Nectria*. From colonies of *Cryptococcus fagi* Lonsdale and Sherriff (1982) isolated conidia of the following fungi: *Nectria coccinea, Nectria viridescens* and *Verticillium lecanii*, causing the necrotic disease of beech bark. The spores of fungi belonging to the *Nectria* genus were also determined on bodies of *Cryptococcus fagi in vitro* by Suvák (1998), who at the same time identified the occurrence of the spores of fungi belonging to the genera *Alternaria* and *Verticillium*. According to Suvák (l.c.), the relation between the degree of necrotic disease and degree of bark attack by *Cryptococcus fagi* was not statistically significant. The same conclusions were derived by Leontovyč and Zúbrik (1998). *Cryptococcus fagi* is primarily detected in commercial beech forests where it occurs at higher densities on trees in stand walls and where the population of this pest frequently increases after thinning interventions (Gora et al. 1994). The precise identification of mutual relations between *Cryptococcus fagi* and *Nectria* can be a problem, however, it follows from the above-mentioned facts that the agent of the genus *Nectria* takes part in the disease transfer in beech forests.

In four localities we recorded the occurrence of three species of the genus *Nectria*. The species *Nectria cosmariospora* Ces. et De Not. was recorded in the localities Dragalevski monastir and Petrohan. The species *Nectria galligena* Bres. apud Strasser was found in the localities Petrohan and Barzia, the species *Nectria coccinea* (Pers.) Fr. in the locality Etropole. The most important fungal pathogens on beech bark also include the species *Nectria coccinea* and *Nectria galligena*. The species *Nectria ditissima* Tul. et C. Tul. and *Nectria galligena* are the most harmful pathogens causing necroses, die-back and drying of beech in many localities in the Stara planina Mts. (Rosnev, Petkov 1996).

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Aktuálny stav nekrotického ochorenia kôry buka v severozápadnom Bulharsku

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ABSTRAKT: V príspevku uvádzame aktuálne výsledky nekrotického ochorenia kôry kmeňov buka na vybraných lokalitách v pohoriach Vitoša a Stará planina. Výsledky nekrotického ochorenia vyjadrené indexom nekrotizácie (I_{SN}) sa pohybovali v rozpätí od 0,72 do 1,12. Takéto nízke hodnoty I_{NK} boli zistené na Slovensku len na siedmich z 52 lokalít. Výsledky I_{NK} sú priaznivejšie ako výsledky, ktoré boli získané použitím rovnakej metodiky na štyroch lokalitách v severnom Maďarsku (hodnoty I_{SN} sa pohybovali v rozpätí od 1,11 do 1,18). Výsledky monitoringu troch vybraných biotických vektorov nekrotického ochorenia buka boli nasledovné. Ťažisko výskytu druhu *Bucculatrix ulmella* bolo v submontánnych bučinách. Výraznú viazanosť na nižšie nadmorské výšky sme zistili u *Ectoedemia liebwerdella*. Zistili sme, že hranica výskytu tohoto druhu je približne vo výške 1 000 m n. m. Hodnoty frekvencie výskytu *Cryptococcus fagi* neboli výrazne ovplyvnené nadmorskou výškou. Na štyroch zo šiestich lokalít sme zaznamenali výskyt troch druhov húb rodu *Nectria*: *Nectria cosmariospora*, *Nectria galligena* a *Nectria coccinea*.

Kľúčové slová: buk lesný; *Fagus sylvatica* L.; nekrózy kôry; biotické vektory; *Nectria* sp.; Bulharsko

V príspevku uvádzame prvé aktuálne údaje o nekrotickom ochorení kôry buka na vybraných lokalitách v pohoriach Stará planina a Vitoša v severozápadnom Bulharsku. Z uvedenej problematiky je z územia Bulharska známa jediná práca (Rosnev, Petkov 1996).

Nekrotické ochorenie kôry kmeňov buka sme hodnotili pomocou originálnej päťbodovej klasifikačnej stupnice (Cicák, Mihál 1998). Na každej lokalite sme hodnotili 100 stromov 1. až 5. stromovej triedy (podľa Krafta). Získané údaje o stupni nekrotického ochorenia sme vyhodnotili pomocou indexu nekrotizácie kmeňov (I_{NK}), ktorý sme doplnili aj hodnotami frekvencie stromov v jednotlivých stupňoch nekrotizácie. Pri testovaní rozdielov vypočítaných indexov nekrotizácie medzi jednotlivými lokalitami sme pri štatistickom hodnotení použili Mann-Whitney *U* test $P = 0,05$.

Výsledky nekrotického poškodenia buka na všetkých lokalitách, vyjadrené frekvenciou nekrotizácie kmeňov v jednotlivých stupňoch poškodenia a I_{NK}, sú v tab. 2. Hodnoty I_{NK} získané na štyroch lokalitách (Dragalevski monastir, Pravec, Vitinja a Petrochan) sa pohybovali v rozpätí od 1,00 do 1,12. Výsledky z týchto lokalít sú porovnateľné s výsledkami získanými v severnom Maďarsku (Mihál, Cicák 2005). Na dvoch lokalitách (Barzija a Etropole) boli výsledky I_{NK} priaznivejšie – 0,72 a 0,79. Takéto nízke hodnoty I_{NK} boli zistené len na siedmich z 52 lokalít na Slovensku (Cicák, Mihál 2002).

Podľa výsledkov môžeme rozdeliť lokality na dve skupiny. Jednu skupinu tvoria lokality Barzija a Etropole a druhú ostatné lokality. Lokality Barzija a Etropole sa od ostatných líšia nižšími hodnotami frekvencie kmeňov v 3.–4. stupni nekrotizácie a vyššími hodnotami frekvencie kmeňov v stupni 0 (bez nekróz). Uvedené hodnoty ovplyvnili aj výsledky I_{NK} , ktoré sú najpriaznivejšie práve na lokalitách Barzija a Etropole. Výsledky môžeme považovať za veľmi vyrovnané. Potvrdila to aj signifikantnosť rozdielov medzi jednotlivými lokalitami, testovaná Mann-Whitney *U* testom (tab. 2). Rozdiely sa potvrdili len medzi lokalitami Dragalevski monastir a lokalitou Pravec a Vitinja a medzi lokalitou Vitinja a Etropole ($P < 0,05$).

Za jednu z príčin priaznivého stavu nekrotického poškodenia buka na lokalitách v severozápadnom Bulharsku môžeme považovať nízky podiel stromov 4. a 5. stromovej triedy (4,8 %) vo všetkých hodnotených porastoch. V porovnaní so Slovenskom (12,8 %) je tento podiel takmer trikrát nižší. Uvedené stromové triedy najviac negatívne

ovplyvňujú výsledok I_{NK} za celý porast (Cicák, Mihál 2002).

Výsledky monitoringu troch vybraných biotických vektorov nekrotického ochorenia buka uvádzame v tab. 3. Ťažisko výskytu druhu *Bucculatrix ulmella* bolo v submontánnych bučinách. Výraznú viazanosť na nižšie nadmorské výšky sme zistili u *Ectoedemia liebwerdella*. Hranica výskytu tohoto druhu je približne vo výške 1 000 m n. m. Zhodné výsledky uvádzajú Mihál a Cicák (2001) zo 40 lokalít z celého územia Slovenska. Hodnoty frekvencie výskytu *Cryptococcus fagi* neboli ovplyvnené nadmorskou výškou.

Na štyroch lokalitách sme zaznamenali výskyt troch druhov húb rodu *Nectria*. Druh *Nectria cosmariospora* Ces. et De Not. bol zaznamenaný na lokalitách Dragalevski monastir a Petrochan. Druh *Nectria galligena* Bres. apud Strasser bol zistený na lokalitách Petrochan a Barzija a druh *Nectria coccinea* (Pers.) Fr. na lokalite Etropole.

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