

## Current state of beech bark necrotic disease in Southern Poland

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**ABSTRACT:** The degree of the beech bark necrotic disease was evaluated in three selected localities in southern Poland, in different orographic complexes, Beskid Sądecki, Beskid Niski, and Bieszczady. The degree is expressed by means of the stem necrotising index ( $I_{SN}$ ), crowns necrotising index ( $I_{CN}$ ), and whole tree necrotising index ( $I_{NWT}$ ). The values of the indices laid in the following limits:  $I_{SN}$  0.73–0.84%,  $I_{CN}$  0.12%–0.51%, and  $I_{NWT}$  0.84%–0.90%. The current status of the beech necrotic disease in Southern Poland can be considered as favourable. The values of  $I_{SN}$  recorded in Southern Poland were lower by 30% than the average  $I_{SN}$  for whole Slovakia. We also recorded the frequency of selected insect pests (*Bucculatrix ulmella* Zeller, *Cryptococcus fagi* Bärensp., and *Ectoedemia liebwerdella* Zimm.), which act in the beech stands as vectors of the necrotic disease. With *C. fagi*, we recorded a high frequency reaching even 100%. In contrast, we did not at all observe the occurrence of *B. ulmella* and *E. liebwerdella*, which are common in the beech stands in Slovakia, as well as in Hungary, Romania, and Bulgaria. In the localities studied, we recorded the occurrence of two species of parasitic fungi of the genus *Nectria* (Fr.) Fr. causing the beech bark necrotic disease, viz. *Nectria cosmariospora* Ces et De Not. and *N. galligena* Bres. ex Strasser.

**Keywords:** beech; *Fagus sylvatica* L.; necrotic disease; stem; crown part; Southern Poland

In recent decades, the beech bark necrotic disease has become a serious phytopathogenic, silvicultural, and landscape-ecological problem in Europe. Locally, this disease obtains the character of epiphyticia. It is studied by many authors, e.g. in France (DECOURT et al. 1980; PERRIN 1983), Germany (METZLER, VON ERFFA 2000; SCHÜTT, SUMMERER 1983), Poland (MAŃKA 1997; RYKOWSKI et al. 1989), Austria (SCHIMITSCHEK 1980), Slovakia (CÍČÁK, MIHÁL 2001, 2002; MIHÁL, CÍČÁK 2001, 2003), Ukraine (GAJEVAJA et al. 1995), Hungary (MIHÁL, CÍČÁK 2005), former Yugoslavia (LAZAREV 1985), Romania (CHIRA, CHIRA 1997, 1998; CHIRA et al. 1996), and Bulgaria (ROSNEV, PETKOV 1996).

In this contribution, we present the current results of the evaluation of the degree of the beech bark necrotic disease in selected localities in Southern Poland. Be-

cause of the absence of analogical investigations in Poland, these results are original and complete the knowledge of this disease. The aim of this paper is to compare the state of the beech bark necrotic disease in Southern Poland and North Slovakia, and to monitor the occurrence of biotical vectors of this disease and of the parasitological fungi of the genus *Nectria* (Fr.) Fr.

### MATERIAL AND METHODS

The beech bark necrotic disease was studied on April, 17 and 19, 2007 in three selected localities in Southern Poland, in the orographic complexes Beskid Sądecki, Beskid Niski, and Bieszczady. The localities are briefly characterised in Table 1.

The necrotic disease of beech stems in the mother stand were evaluated using the classification scale by

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Table 1. Basic characteristics of the individual localities

Characteristics	Kiczera	Przysłop	Przelecz Zebrak
Orographic formation	Beskid Sądecki	Bieszczady	Beskid Niski
Location	49°26'N 20°46'E	49°11'N 22°22'E	49°16'N 22°12'E
Exposition	W	S	W
Altitude (m a.s.l.)	600	610	825
Average age (years)	70	70	100
Parent rock	flysch	flysch	flysch
Stocking	0.8	0.6	0.4
Slope (°)	10–15	12	15–20
Tree composition (%)	beech 80, fir 15, spruce 4, pine 1	beech 80, spruce 10, fir 4, maple 6	beech 95, fir 3, spruce 1, maple 1

CICÁK and MIHÁL (1997). The necrosis of the crown (branches) was evaluated according to our original classification scale (CICÁK et al. 2007).

By combination of both classification scales, we obtained an original scale used for the evaluation of the necrotic disease of whole trees (Table 2).

In order to characterise the whole vertical profile of the stand, we evaluated 100 trees of 1<sup>st</sup>–5<sup>th</sup> age class (according to Kraft) in each stand. The data on the degree of stem necrotising were evaluated by means of the index of the stem necrotising ( $I_{SN}$ ), separately for each age class and generally for all age classes together. In the same way, we evaluated necrotising of crowns (index of crown necrotising –  $I_{CN}$ ) and of whole trees (index of whole tree necrotising –  $I_{NWT}$ ). A methodical explication of the indices, which represent, as a matter of fact, the mean of the recorded degrees of necrotising, was presented earlier by CICÁK and MIHÁL (1998).

For testing the significance of differences between individual localities in the necrotic disease of crowns, stems, and whole trees, expressed by indices of necrotisation, we used the Mann-Whitney  $U$  test.

Table 2. Combination of degrees of stem and crown necrotisation

Degree of stem necrotisation	Degree of crown necrotisation			
	0	1	2	3
0	0	0	1	1
1	1	1	2	2
2	2	2	3	3
3	3	3	3	3
4	4	4	4	4

Simultaneously with the degree of necrosis, we recorded the frequency of the occurrence of the selected insect pests, which act as vectors of the fungi from the genus *Nectria* (Fr.) Fr. They were represented by two butterfly species, *Bucculatrix ulmella* Zeller and *Ectoedemia liebwerdella* Zimm., and the bark lice *Cryptococcus fagi* Bärensp. Their frequency was recorded around the whole perimeter of each stem, from its buttresses up to the height of 2 m.

We also registered the occurrence of phytopathogenic fungi of the genus *Nectria* (Fr.) Fr. causing the tracheomycotic necrotic disease type of the beech. In laboratory, the fungi were identified according to the keys and papers by BREITENBACH and KRÄNZLIN (1986), ČERVENKA et al. (1971), HARTMANN et al. (1995), MIHÁL et al. (2000), MÖSER (1963), and STROUTS and WINTER (1994).

## RESULTS AND DISCUSSION

The degrees of beech bark necrotising in three localities in Southern Poland characterised by indices of stems ( $I_{SN}$ ), crowns ( $I_{CN}$ ), and whole trees ( $I_{NWT}$ ) necrotising are given for each age class in Table 3. In all localities, we observed an increase of the degree of stems necrotising proportional to the worsening sociological position of the tree in the stand. This trend confirms the existence of relationship between the necrotic disease of stems and sociological position of stems, which was proved in a set of 6,579 trees from 54 localities from the whole Slovakia (CICÁK, MIHÁL 2002). A similar trend was also observed with the values of the crown necrotising index. On the contrary, in the evaluation of the degree of whole tree necrotising we did not record a similar increasing trend of  $I_{NWT}$  with the worsening of the sociological position of the tree.

Table 3. Index of necrotisation –  $I_{CN}$ ,  $I_{SN}$ ,  $I_{NWT}$  (mean  $\pm$  standard error) of the evaluated parts of trees in individual tree classes ( $I_{CN}$  – index of crown necrotisation,  $I_{SN}$  – index of stem necrotisation,  $I_{NWT}$  – index of whole trees necrotisation)

Locality	Evaluation part	Tree classes					
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	
Kiczera	crown	0.17 $\pm$ 0.07	0.10 $\pm$ 0.05	0.00 $\pm$ 0.00	0.22 $\pm$ 0.15	0.25 $\pm$ 0.25	0.12 $\pm$ 0.03 <sup>A</sup>
	stem	0.57 $\pm$ 0.09	0.76 $\pm$ 0.11	1.06 $\pm$ 0.19	1.33 $\pm$ 0.17	1.75 $\pm$ 0.48	0.84 $\pm$ 0.07
	whole trees	0.57 $\pm$ 0.09	0.76 $\pm$ 0.11	1.06 $\pm$ 0.19	1.33 $\pm$ 0.17	1.75 $\pm$ 0.48	0.84 $\pm$ 0.07
Przysław	crown	0.24 $\pm$ 0.12	0.17 $\pm$ 0.08	0.56 $\pm$ 0.22	0.63 $\pm$ 0.42	0.50 $\pm$ 0.50	0.33 $\pm$ 0.08 <sup>B</sup>
	stem	0.57 $\pm$ 0.15	0.55 $\pm$ 0.11	0.96 $\pm$ 0.19	1.13 $\pm$ 0.13	1.25 $\pm$ 0.75	0.73 $\pm$ 0.08
	whole trees	0.62 $\pm$ 0.16	0.64 $\pm$ 0.13	1.08 $\pm$ 0.22	1.38 $\pm$ 0.26	1.50 $\pm$ 0.96	0.84 $\pm$ 0.10
Przelec Zebra	crown	0.28 $\pm$ 0.09	0.77 $\pm$ 0.18	0.64 $\pm$ 0.15	0.57 $\pm$ 0.30	0.00 $\pm$ 0.00	0.51 $\pm$ 0.07 <sup>C</sup>
	stem	0.55 $\pm$ 0.09	0.96 $\pm$ 0.12	0.96 $\pm$ 0.17	1.00 $\pm$ 0.22	1.00 $\pm$ 0.00	0.80 $\pm$ 0.07
	whole trees	0.60 $\pm$ 0.10	1.12 $\pm$ 0.16	1.08 $\pm$ 0.19	1.14 $\pm$ 0.26	1.00 $\pm$ 0.00	0.90 $\pm$ 0.08

Statistical significance of differences in  $I_{CN}$ ,  $I_{SN}$ ,  $I_{NWT}$  of all tree classes between localities is marked by A, B and C

The values of  $I_{SN}$  presented in Table 3 are very similar in all studied localities and ranged from 0.72 (locality Przysław) to 0.84 (locality Kiczera). The values of  $I_{SN}$  recorded in Southern Poland are approximately by 30% lower than the average value for the whole Slovakia ( $I_{SN} = 1.22$ ), which was calculated on the base of the data from 54 localities in 33 orographic complexes. The values of  $I_{NWT}$  are even more similar and range from 0.84 (Kiczera and Przysław) to 0.90 (Przelec Zebra). In any case, we did not record statistically significant differences between the localities ( $P > 0.05$ ). On the contrary, the differences between  $I_{CN}$  the values from individual localities are larger (0.12–0.51) and are statistically significant ( $P < 0.05$ ).

The current state of the beech bark necrotic disease in the three studied localities in Southern Poland can be considered as favourable. Apart from the indices of necrotising, it was also confirmed by the values of the frequency of crowns, stems, and whole trees necrotising in individual degrees of necrotising, as given in Tables 4 to 6. The frequency of the stem necrotising in degree 0 ranges from 31% (Kiczera and Przelec Zebra) to 43% (Przysław). If we pool the frequency of necrotising in degree 0 with that in degree 1, the values range from 88% (Kiczera) to 92% (Przelec Zebra). It means that the frequency of necrotising in degrees 3–4 is low and ranges from 2% (Przelec Zebra) to 5% (Kiczera). The comparison of the values from Tables 4–6 shows that the frequencies of whole trees necrotising are very similar to those of stems necrotising.

In Table 7, we compare the values of  $I_{SN}$  from three localities in Southern Poland with those from three selected localities from North Slovakia. These locations we selected so as to have simultaneously minimum distance from one another among the Southern Polish localities. The comparison of localities pairs shows that the values are almost identical in one case (Przysław = 0.73 and Udava = 0.70), and that the greatest difference is between the localities Przelec Zebra (0.80) and Kačalová (1.50). Mann-Whitney  $U$  test confirmed the statistical significance of the  $I_{SN}$  values between these two localities ( $P < 0.05$ ). There are also considerable differences between  $I_{SN}$  values from Kiczera (0.84) and Bukov les (1.14), but Mann-Whitney  $U$  test did not confirm their statistical significance ( $P > 0.05$ ).

The frequency of the selected biotical vectors of the beech bark necrotic disease in the localities studied is given in Table 8. The most frequent biotical vector of this disease is the bark lice *Cryptococcus fagi* (Bärensp.). The frequency of its occurrence in 40 localities in Slovakia was 2–100% and its occurrence was

Table 4. Frequency of necrotisation of beech stem in selected localities

Locality	Frequency of necrotisation in necrotisation degrees (%)							
	0	1	2	3	4	1–4	2–4	3–4
Kiczera	31	57	9	3	0	69	12	3
Przysłop	43	47	5	4	1	57	10	5
Przelec Zebra	31	61	6	1	1	69	8	2

Table 5. Frequency of necrotisation of beech crown in selected localities

Locality	Frequency of necrotisation in necrotisation degrees (%)					
	0	1	2	3	1–3	2–3
Kiczera	88	12	0	0	12	0
Przysłop	82	9	3	6	18	9
Przelec Zebra	62	27	9	2	38	11

Table 6. Frequency of necrotisation of whole trees in selected localities

Locality	Frequency of necrotisation in necrotisation degrees (%)							
	0	1	2	3	4	1–4	2–4	3–4
Kiczera	31	57	9	3	0	69	12	3
Przysłop	41	45	7	3	4	59	14	7
Przelec Zebra	30	55	12	1	2	70	15	3

Table 7. Index of stem necrotisation on selected localities in border zone between Slovakia and Poland

	Slovakia			Poland		
	Orographic formation	Locality	$I_{SN(1-5)}$	Orographic formation	Locality	$I_{SN(1-5)}$
	Pieniny	Bukový les	$1.14 \pm 0.12$	Beskid Sądecki	Kiczera	$0.84 \pm 0.07$
	Ondavská vrchovina	Kačalová	$1.50 \pm 0.11^A$	Beskid Niski	Przelec Zebra	$0.80 \pm 0.07^B$
	Bukovské vrchy	Udava	$0.70 \pm 0.10$	Bieszczady	Przysłop	$0.73 \pm 0.08$

$I_{SN(1-5)}$  – index of stem necrotisation for 1<sup>st</sup>–5<sup>th</sup> tree classes

Statistical significance of differences in  $I_{SN(1-5)}$  on selected localities in border zone of Slovakia and Poland is marked by A, B

recorded in each of these localities. A high frequency of *C. fagi* was also observed in Southern Poland. Remarkable is the absence of the butterfly *Ectoedemia liebwerdella* Zimm., which was commonly observed on the beech bark in Slovakia, Hungary, and Bulgaria. It seems that this vector of the necrotic disease has not passed the Carpathian representing a natural barrier between Slovakia and Southern Poland. It is illustrated by an old finding of *E. liebwerdella* at the Jesienia locality, where it was discovered in 1947 by ADAMCZEWSKI (in SCHÖNHERR 1958). This butterfly was found to occur commonly, with frequency from 1–100%, in 23 among 40 localities in Slovakia (MIHÁL, CÍČÁK 2001). The possibility of a passive

transfer of the infectious agents of fungi of the genus *Nectria* – on body of adult *E. liebwerdella* – was recorded by KODRÍK and SUVÁK (1999). Similarly, in all three localities in Southern Poland we recorded the absence of the butterfly *Bucculatrix ulmella* Zeller. In Slovakia it occurred in 27 among 40 localities, with the frequency of 1–91%.

During our investigation, we also recorded the occurrence of two species of the genus *Nectria* (Fr.) Fr. – the species *Nectria cosmariospora* Ces et De Not. in the locality Przelec Zebra, and *Nectria galligena* Bres. ex Strasser in the localities Kiczera and Przysłop. The species *N. galligena* Bres. ex Strasser is generally considered to be a dangerous parasite

Table 8. Frequency of occurrence (%) of biotic vectors of beech necrotic disease on selected localities in Poland

Locality	Altitude (m a.s.l.)	<i>Cryptococcus fagi</i>	<i>Bucculatrix ulmella</i>	<i>Ectoedemia liebwerdella</i>
Kiczera	600	100	0.0	0.0
Przysłop	610	99	0.0	0.0
Przelecz Zebrak	825	100	0.0	0.0

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

provoking the necrotic disease (SUROVEC 1990). The species *N. galligena* Bres. ex Strasser and *Nectria coccinea* (Pers.) Fr. are considered to be common fungi occurring in the beech bark necrotic disease in Poland (GRZYWACZ 1990). A bad-health state of the beech stands in Bieszczady was observed in 1970s and 1980s (RYKOWSKI et al. 1989). The parasitical complex *C. fagi* – *N. coccinea* is considered to be especially dangerous for the beeches in Bieszczady (RYKOWSKI et al. 1989). The development of the root decay and dying of naturally regenerated beeches manifested by necroses were observed in western and north-western Poland (MAŃKA 1997).

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## Aktuálny stav nekrotického ochorenia kôry buka v južnom Poľsku

**ABSTRAKT:** V príspevku uvádzame aktuálne výsledky hodnotenia stupňa nekrotického ochorenia buka na troch vybraných lokalitách v južnom Poľsku, v orografických celkoch Beskid Sądecki, Beskid Niski a Bieszczady. Výsledky uvádzame formou indexu nekrotizácie kmeňov buka ( $I_{NK}$ ), indexu nekrotizácie korún ( $I_{NKR}$ ) ako aj indexu nekrotizácie celých stromov ( $I_{NCS}$ ). Hodnoty indexov sa pohybovali v rozpätí:  $I_{NK}$  od 0,73 % do 0,84 %,  $I_{NKR}$  od 0,12 % do 0,51 % a  $I_{NCS}$  od 0,84 % do 0,90 %. Stav nekrotického poškodenia buka na troch lokalitách v južnom Poľsku môžeme pokladať za priaznivý. Hodnoty  $I_{NK}$  zistené v južnom Poľsku sú až o 30 % nižšie ako priemerná hodnota  $I_{NK}$  za celé Slovensko. Zaznamenávali sme aj frekvenciu výskytu vybraných hmyzích škodcov (*Bucculatrix ulmella* Zeller, *Cryptococcus fagi* Bärensp. a *Ectoedemia liebwerdella* Zimm.), ktorí v bukových porastoch pôsobia ako vektory nekrotického ochorenia buka. Vysokú, až 100% frekvenciu výskytu sme zistili u druhu *C. fagi*. Naopak nezistili sme žiadny výskyt druhov *B. ulmella* a *E. liebwerdella*, ktoré sa bežne vyskytovali v bučinách na Slovensku ako aj v Maďarsku, Rumunsku a Bulharsku. Na sledovaných lokalitách sme zaznamenali výskyt dvoch druhov parazitických húb rodu *Nectria* (Fr.) Fr., spôsobujúcich nekrotické ochorenie buka. Boli to druhy *Nectria cosmariospora* Ces et De Not. a *N. galligena* Bres. ex Strasser.

**Kľúčové slová:** buk; *Fagus sylvatica* L.; nekrotické ochorenie; kmeň; korunová časť; južné Poľsko

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