

FUNGI OF THE GENUS *NECTRIA* s.l. (BIONECTRIACEAE, NECTRIACEAE, HYPOCREALES, ASCOMYCOTA) IN BULGARIA AND THEIR PHYTOPATHOLOGICAL SIGNIFICANCE

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Abstract

The authors report occurrence, spread, ecotrophic demands and phytopathological significance of 14 species of fungi of genus *Nectria* s.l., known so far from the territory of Bulgaria. Species *Bionectria ochroleuca*, *Cosmospora aurantiicola*, *Haematonectria haematococca*, *Nectria aurantiaca*, *N. coryli*, *Neonectria punicea* and *N. ramulariae* can be included amongst rarely occurring fungi of genus *Nectria* s.l. in Bulgaria. As the first finds, we present species *Cosmospora coccinea*, *C. purtonii*, *Nectria aurantiaca*, *N. coryli*, *Neonectria fuckeliana* and *N. punicea*, these species have not been reported so far from the territory of Bulgaria. Several species of fungi of genus *Nectria* s.l. cause significant infections of forest trees. The authors describe species *Neonectria coccinea*, *N. ditissima* and *N. galligena* as significant pathogens causing beech bark disease. On conifers, *Neonectria fuckeliana* is reported.

Key words: *Nectria* s.l., fungi, phytopathology, Bulgaria

INTRODUCTION

Fungi belonging to genus *Nectria* s.l. taxonomically belong to families Bionectriaceae Samuels et Rossman *fam. nov.* and Nectriaceae Tul. et C. Tul., order Hypocreales and class Ascomycota. According to Booth (1959), Rossman (1996) and Rossman et al. (1999), there have been more than 200 species of fungi, belonging to taxonomically and phylogenetically wider circle of genus *Nectria* s.l., described so far. These typical pyrenomycetic fungi grow as saprophytes but also as saproparasites and parasites on trees and other plants. The genus *Nectria* also includes species which are significant vascular parasites and can cause serious mycotic infections and diseases mainly of forest plants. For example, in the case of common

beech (*Fagus sylvatica* L.) there is a known disease, beech bark disease (BBD) that can locally have epiphytotic character. Apart from genus *Nectria* (Fr.) Fr., some species from genera *Anthostoma* Nitschke, *Cytospora* Ehr.:Fr., *Diatrype* Fr., *Fusarium* Link., *Ophiostoma* Syd., *Phomopsis* Sacc., *Valsa* Fr. and *Verticillium* Nees, can also be included amongst the pathogenic fungi causing BBD (Houston, 1994a; Jančařík, 2000; Mihál et al., 2007, 2009; Perrin, 1984; Surovec, 1990).

Outcome of field work on selected localities in Bulgaria is also finds and identification of several species of fungi of genus *Nectria* from Bulgarian territory, which we present in this paper. At the same time, we need to add that the occurrence of several species found has not been mentioned so far, and we want to contribute to the broadening of knowledge about mycoflora of nectriaceous fungi of Bulgaria.

MATERIALS AND METHODS

In the years 2005 to 2014, we recorded the occurrence of fungi of genus *Nectria* at 22 chosen localities in Bulgaria. Material gathered during field trips, by *in vivo* method in the form of minute fruiting bodies (sporocarps) in the sexual stage of development (teleomorpha), was collected randomly from woody substrate, i.e. from the bark of living and dead broadleaved and coniferous trees, from barked and decomposing wood and from the cutting area of beech stumps. Following the method of evaluating the degree of beech stems bark necrotic disease infection of the stand: we carried out the research every year in April, apart besides October 2007 (cf. Cicák et al., 2007). We present particular data about individual localities in Table 1.

All found species were identified in the laboratory according to the literature (Brayford et al., 2004; Breitenbach, Kränzlin, 1986; Červenka et al., 1972; Moser, 1963; Rossman et al., 1999; Samuels, 1976), as well as according to the comparison collection of the first author. All species identified by us were processed and in the form of exsiccates placed in herbarium of Institute of Forest Ecology, SAS - Zvolen. For all species of fungi presented in this paper, we used the taxonomic nomenclature according to Brayford et al. (2004), Rossman (1996) and Rossman et al. (1999).

RESULTS AND DISCUSSION

The overview of all species of fungi of genus *Nectria* that we recorded in Bulgarian localities during our research is presented in Table 2. Altogether, we identified 9 species of fungi of the genus *Nectria*, 7 of which were recorded only on live or on dead wood of beech. We collected the species *Cosmospora coccinea* Rabenh. from old fruiting bodies of *Inonotus nodulosus* (Fr.) P. Karst., the fruiting bodies of which we always found on the bark of beeches. We found *Neonectria fuckeliana* (C. Booth) Castl. et Rossman on the stem bark of dying *Abies alba* Mill. The fungi species of genus *Nectria* recorded by other authors on the territory of Bulgaria are presented

Table 1
Characteristics of research localities

Orographic unit	Locality	Altitude (m)	Localisation	Exp.*	Beech (%) composition	Age of stand	Date of research
Stara planina Mts	Troyan	480	41°53'N 24°43'E	N	100	80	25.04.2006
	Shipkovo	650	42°53'N 24°36'E	NE	100	70	28.04.2006
	Ichera	700	42°45'N 26°25'E	NW	100	80	26.10.2007
	Kotel	700	42°53'N 26°21'E	N	100	120	24.10.2007
	Etropole	720	42°49'N 24°02'E	NE	99	125	21.04.2005
	Ticha	750	42°59'N 26°21'E	SW	90	70	25.10.2007
	Karandila	1000	42°44'N 26°22'E	SE	100	80	26.10.2007
	Ribaritsa	1100	42°52'N 24°29'E	NW	100	70	24.04.2006
	Shipka	1100	42°44'N 25°20'E	NE	90	65	28.04.2006
	Barzia	1150	43°08'N 23°08'E	NW	100	110	20.04.2005
	Balkanets	1250	42°47'N 24°39'E	N	100	110	26.04.2006
	Petrohan	1400	43°07'N 23°07'E	NE	100	110	20.04.2005
Rodopi Mts	Fotinski vodopadi	750	41°53'N 24°23'E	N	100	70	24.04.2013
	Rozovo	900	41°59'N 24°23'E	NE	100	65	27.04.2012
	Marino	1150	41°59'N 24°13'E	E	100	100	22.04.2010
	Velingrad	1250	42°04'N 23°58'E	E	100	75	23.04.2010
	Rakitovo	1380	42°04'N 24°11'E	SW	100	80	21.04.2010
	Apos-lovtchark	1400	41°42'N 23°58'E	E	60	50	26.04.2013
Pirin Mts	Razlog	1150	41°53'N 23°21'E	NW	100	70	23.04.2011
Rila Mts	Raduil	1060	42°17'N 23°39'E	E	100	90	20.04.2010
Strandzha Mts	Silkosia	305	42°09'N 27°75'E	N	98	100	25.04.2009
Vitosha Mts	Dragalevski monastir	1080	42°37'N 23°17'E	NE	100	130	18.04.2005

* Exp. - exposition

Table 2
 Overview of species of the genus *Nectria* found in Bulgaria

Locality	C.co*	C.pu	N.au	N.ci	N.co	Ne.c	Ne.f	Ne.g	Ne.p
Silkosia			+						
Troyan						+			
Shipkovo						+			
Ichera								+	
Kotel					+			+	
Etropole						+			
Fotinski vodopadi		+							
Ticha						+			
Rozovo								+	
Karandila						+			+
Raduil						+			
Dragalevski manastir	+								
Ribaritsa								+	
Shipka	+								
Barzia								+	
Marino	+							+	
Razlog						+			
Balkanets	+							+	
Velingrad									+
Rakitovo				+					+
Aposlovtchark							+		
Petrohan	+							+	
Total	5	1	1	1	1	7	1	8	3

* C.co - *Cosmospora coccinea* Rabenh., C.pu - *Cosmospora purtonii* (Grev.) Rossman et Samuels, N.au - *Nectria aurantiaca* (Tul. et C. Tul.) Jacz., N.ci - *Nectria cinnabarina* (Tode: Fr.) Fr., N.co - *Nectria coryli* Fuckel, Ne.c - *Neonectria coccinea* (Pers.: Fr.) Rossman et Samuels, Ne.f - *Neonectria fuckeliana* (C. Booth) Castl. et Rossman, Ne.g - *Neonectria galligena* (Bres.) Rossman et Samuels, Ne.p - *Neonectria punicea* (J. C. Schmidt) Castl. et Rossman

in Table 3. The authors mentioned here found altogether 7 species of fungi of genus *Nectria*. We also recorded *Nectria cinnabarina* (Tode: Fr.) Fr. and *Neonectria coccinea* (Pers.: Fr.) Rossman et Samuels during our research. We can state that 14 species of fungi of the complex *Nectria* s.l. have been identified on the territory of Bulgaria so far.

Amongst rare and interesting finds, we can include species:

Bionectria ochroleuca (Schwein.) Schroers et Samuels

A species spread in tropic and subtropic countries (Rossman et al., 1999), whilst finding this species in Bulgaria can point to its cosmopolitan spread. This fungus in the biological control literature is cited as a destructive mycoparasite (Schroers et al., 1999). *B. ochroleuca* in Bulgaria was isolated from soil samples (Sabev et al., 2006; Stoichev, 2014).

Cosmospora aurantiicola (Berk. et Broome) Rossman et Samuels

A species spread in tropical and subtropical countries (Rossman et al., 1999), is currently filed amongst worldwide spreading species. In Europe, it is known from Germany (Gräfenhan et al., 2011) and Italy (Porcelli, Frisullo, 1988). This entomopathogenic species is associated with scale insects and adelgids (Rossman et al., 1999). *C. aurantiicola* was found on white peach scale *Pseudaulacaspis pentagona* (Targioni) in Bulgaria (Draganova, 2004).

Haematonectria haematococca (Berk. et Broome) Samuels et Nirenberg *com. nov.*

A pantropical species (Rossman et al., 1999), closest to Bulgaria known from the European part of Turkey. It is most frequently found on bark, also on decorticated wood, herbaceous tissue, fruits and fungi (Samuels, 1976; Rossman et al., 1999). *H. haematococca* was in Bulgaria isolated from soil samples (Sabev et al., 2006).

Nectria aurantiaca (Tul. et C. Tul.) Jacz.

A species so far known in Europe from England, France and Czech Republic (Hirooka et al., 2012; Seifert, 1985). It was also identified on dead bark on twigs of species of Ulmaceae (Ellis, Ellis, 1997; Hirooka et al., 2012).

Nectria coryli Fuckel

A species so far known in Europe from Germany (Hirooka et al., 2012), Austria (Jaklitsch, Voglmayer, 2011) and from Slovakia (Mihál et al., 2009). It was identified on dead bark of stems or twigs of deciduous trees (Hirooka et al., 2012; Mihál, 2002, 2011).

Neonectria punicea (J. C. Schmidt) Castl. et Rossman

A species so far known in Europe from France, Germany, Switzerland, Austria and Slovakia (Hirooka et al., 2013; Mihál et al., 2009). It was found on dead bark and barked wood of beech (Mihál, 2002, 2011).

Neonectria ramulariae Wollenw.

A species so far known in Europe from Germany (Rossman et al., 1999) and from England (Halleen et al., 2004). It was found on living *Rubus fruticosus* L. branches (Rossman et al., 1999). *N. ramulariae* was in Bulgaria isolated from soil samples (Sabev et al., 2006).

Also, the species *Cosmospora coccinea* Rabenh., *Cosmospora purtonii* (Grev.) Rossman et Samuels, *Nectria cinnabarina* (Tode: Fr.) Fr., *Neonectria coccinea* (Pers.: Fr.) Rossman et Samuels, *Neonectria ditissima* Tul. et C. Tul., *Neonectria fuckeliana* (C. Booth) Castl. et Rossman and *Neonectria galligena* (Bres.) Rossman et Samuels were identified in Bulgaria during our research as well as by other authors (cf. Table 3).

Frequent occurrence of fungi of genus *Nectria* in beech stands and their significant role in beech dieback is mentioned by several authors. For example Surovec (1990) considers species *Neonectria ditissima* and *N. galligena* to be the most dangerous parasites of beech. Parker (1976) found the species *Neonectria coccinea* as a parasite on beech in all age groups. According to Gäumann (1951), a necrotic disease of trees in younger age groups is caused mainly by species *Nectria cinnabarina* and *N. ditissima*. Apart from the species mentioned above, Perrin (1984) surveyed also *Neonectria coccinea*. However, species of the genus *Nectria* are also widely spread in mature or aged stands, where they were found for example by Perrin (1984) and Wudtke (1991). Some authors connect the infection by fungi of the genus *Nectria* to the degree of beech bark infestation with *Cryptococcus fagisuga* Lindinger. Lonsdale (1980) and Houston (1994a, 1994b) say that beeches strongly infested with scales are prone to the infection and in that way beech scales supports and speeds up the fungi invasion. Whereas Braun (1977) claims that fungi only speed up the development of wounds after beech scales.

From this, it is apparent that fungi of genus *Nectria* have a significant phytopathological impact on forest stands (particularly beech stands). That increases the need of deeper knowledge of occurrence, spread and bionomy of these interesting fungi.

Table 3
Fungi species of genus *Nectria* from the territory of Bulgaria

Reference/author	Species
Draganova (2004)	<i>Cosmospora aurantiicola</i> (Berk. et Broome) Rossman et Samuels
Fakirova et al. (2000)	<i>Nectria cinnabarina</i> (Tode: Fr.) Fr.
Knight et al. (2004)	<i>Neonectria ditissima</i> Tul. et C. Tul.
Pavlidis et al. (2005)	<i>Nectria cinnabarina</i> (Tode: Fr.) Fr.
Rosnev, Petkov (1995)	<i>Neonectria coccinea</i> (Pers.: Fr.) Rossman et Samuels
	<i>Neonectria ditissima</i> Tul. et C. Tul.
Sabev et al. (2006)	<i>Bionectria ochroleuca</i> (Schwein.) Schroers et Samuels
	<i>Haematonectria haematococca</i> (Berk. et Broome) Samuels et Nirenberg <i>com. nov.</i>
	<i>Neonectria ramulariae</i> Wollenw.
Stoichev (2014)	<i>Bionectria ochroleuca</i> (Schwein.) Schroers et Samuels

CONCLUSIONS

The authors report occurrence, spread, ecotrophic demands and phytopathological significance of 14 species of fungi of genus *Nectria* s.l., known so far from the territory of Bulgaria. Altogether, we identified 9 species of fungi of genus *Nectria*, 7 of which were recorded only on live or on dead wood of *Fagus sylvatica*. We collected the species *Cosmospora coccinea* from old fruiting bodies of *Inonotus nodulosus*, the fruiting bodies of which we always found on the bark of beeches. We found *Neonectria fuckeliana* on the stem bark of dying *Abies alba*. Species *Bionectria ochroleuca*, *Cosmospora aurantiicola*, *Haematonectria haematococca*, *Nectria aurantiaca*, *N. coryli*, *Neonectria punicea* and *N. ramulariae* can be included amongst rarely occurring fungi of the genus *Nectria* s.l. in Bulgaria. As the first finds, we present species *Cosmospora coccinea*, *C. purtonii*, *Nectria aurantiaca*, *N. coryli*, *Neonectria fuckeliana* and *N. punicea*, these species have not been reported so far from the territory of Bulgaria. Several species of fungi of the genus *Nectria* s.l. cause significant fungal infections of forest trees. The authors describe species *Neonectria coccinea*, *N. ditissima* and *N. galligena* as significant pathogens causing the beech bark disease. On conifers, as significant pathogen, *Neonectria fuckeliana* is reported.

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