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

*Ivan Mihál, Alojz Cicák*
Institute of Forest Ecology – Zvolen
Slovak Academy of Sciences

*Hristo Tsakov*
Forest Research Institute - Sofia
Bulgarian Academy of Sciences

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

<table>
<thead>
<tr>
<th>Orographic unit</th>
<th>Locality</th>
<th>Altitude (m)</th>
<th>Localisation</th>
<th>Exp.*</th>
<th>Beech (%) composition</th>
<th>Age of stand</th>
<th>Date of research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stara planina Mts</td>
<td>Troyan</td>
<td>480</td>
<td>41°53’N 24°43’E</td>
<td>N</td>
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<td>80</td>
<td>25.04.2006</td>
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<td>Shipkovo</td>
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<td>42°53’N 24°36’E</td>
<td>NE</td>
<td>100</td>
<td>70</td>
<td>28.04.2006</td>
<td></td>
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<tr>
<td>Ichera</td>
<td>700</td>
<td>42°45’N 26°25’E</td>
<td>NW</td>
<td>100</td>
<td>80</td>
<td>26.10.2007</td>
<td></td>
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<tr>
<td>Kotel</td>
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<td>42°53’N 26°21’E</td>
<td>N</td>
<td>100</td>
<td>120</td>
<td>24.10.2007</td>
<td></td>
</tr>
<tr>
<td>Etropole</td>
<td>720</td>
<td>42°49’N 24°02’E</td>
<td>NE</td>
<td>99</td>
<td>125</td>
<td>21.04.2005</td>
<td></td>
</tr>
<tr>
<td>Ticha</td>
<td>750</td>
<td>42°59’N 26°21’E</td>
<td>SW</td>
<td>90</td>
<td>70</td>
<td>25.10.2007</td>
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</tr>
<tr>
<td>Karandila</td>
<td>1000</td>
<td>42°44’N 26°22’E</td>
<td>SE</td>
<td>100</td>
<td>80</td>
<td>26.10.2007</td>
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<tr>
<td>Ribaritsa</td>
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<tr>
<td>Shipka</td>
<td>1100</td>
<td>42°44’N 25°20’E</td>
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<td>90</td>
<td>65</td>
<td>28.04.2006</td>
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<td>Barzia</td>
<td>1150</td>
<td>43°08’N 23°08’E</td>
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<td>100</td>
<td>110</td>
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<tr>
<td>Balkanevs</td>
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<td>42°47’N 24°39’E</td>
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<tr>
<td>Petrohan</td>
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<td>110</td>
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<tr>
<td>Rodopi Mts</td>
<td>Fotinski vodopadi</td>
<td>750</td>
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<td>900</td>
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<td>65</td>
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<td>Marino</td>
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<td>E</td>
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<td>100</td>
<td>22.04.2010</td>
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<tr>
<td>Velingrad</td>
<td>1250</td>
<td>42°04’N 23°58’E</td>
<td>E</td>
<td>100</td>
<td>75</td>
<td>23.04.2010</td>
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<td>60</td>
<td>50</td>
<td>26.04.2013</td>
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<td>Razlog</td>
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<td>41°53’N 23°21’E</td>
<td>NW</td>
<td>100</td>
<td>70</td>
<td>23.04.2011</td>
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<tr>
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<td>Raduil</td>
<td>1060</td>
<td>42°17’N 23°39’E</td>
<td>E</td>
<td>100</td>
<td>90</td>
<td>20.04.2010</td>
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<tr>
<td>Strandzha Mts</td>
<td>Silkosia</td>
<td>305</td>
<td>42°09’N 27°75’E</td>
<td>N</td>
<td>98</td>
<td>100</td>
<td>25.04.2009</td>
</tr>
<tr>
<td>Vitosha Mts</td>
<td>Draga-levski monastir</td>
<td>1080</td>
<td>42°37’N 23°17’E</td>
<td>NE</td>
<td>100</td>
<td>130</td>
<td>18.04.2005</td>
</tr>
</tbody>
</table>

* Exp. - exposition
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

<table>
<thead>
<tr>
<th>Reference/author</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draganova (2004)</td>
<td>Cosmospora aurantiicola (Berk. et Broome) Rossman et Samuels</td>
</tr>
<tr>
<td>Fakirova et al. (2000)</td>
<td>Nectria cinnabarina (Tode: Fr.) Fr.</td>
</tr>
<tr>
<td>Pavlidis et al. (2005)</td>
<td>Nectria cinnabarina (Tode: Fr.) Fr.</td>
</tr>
<tr>
<td></td>
<td>Neonectria ditissima Tul. et C. Tul.</td>
</tr>
<tr>
<td>Sabev et al. (2006)</td>
<td>Bionectria ochroleuca (Schwein.) Schroers et Samuels</td>
</tr>
<tr>
<td></td>
<td>Haematonectria haematococca (Berk. et Broome) Samuels et Nirenberg com. nov.</td>
</tr>
<tr>
<td></td>
<td>Neonectria ramulariae Wollenw.</td>
</tr>
<tr>
<td>Stoichev (2014)</td>
<td>Bionectria ochroleuca (Schwein.) Schroers et Samuels</td>
</tr>
</tbody>
</table>
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 cocinea* 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 cocinea*, *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 cocinea*, *N. ditissima* and *N. galligena* as significant pathogens causing the beech bark disease. On conifers, as significant pathogen, *Neonectria fuckeliana* is reported.

REFERENCES


Moser, M. 1963. Ascomyceten (Schaupilze), Band IIa, Kleine Kryptogamenflora. VEB Gustav Fischer Verlag, Jena, 1–147.


Perrin, R. 1984. Variability of the susceptibility of beech (Fagus sylvatica L.) to Nectria coccinea, one of the pathogens of bark disease. European Journal of Forest Pathology, 14, 321–325.


polyvinyl chloride (pPVC) and the impact of incorporated biocides. Microbiology, 152, 1731–1739.


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**E-mails:** mihal@savzv.sk; hristotsakovbg@abv.bg