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Mass occurrence of relict beetle species *Endecatomus reticulatus* (Herbst, 1973) and *Leiestes seminiger* (Gyllenhall, 1808) associated with rare saproxylic fungi

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Abstract: We refer on mass occurrence of *Endecatomus reticulatus* and *Leiestes seminiger* recorded on deadwood infested with rare saproxylic fungi. *E. reticulatus* was found repeatedly on dead snags of Turkey oak (*Quercus cerris*) infested with the fungus *Inonotus andersonii* within a natural old-growth forest at the Kremnické vrchy, Central Slovakia. *L. seminiger* was found in high numbers on a fallen trunk of White poplar (*Populus alba*) infested with corticioid fungus *Mycoacia fuscoatra* within a forest-steppe habitat of Čenkovská lesostep, Southern Slovakia. Both species were recorded based on tenths of individuals, what is an extraordinary population density, with respect to their general scarcity across Europe. We suggest that both beetle species may be specifically confined to recorded fungi.

Key words: *Inonotus andersonii*, *Mycoacia fuscoatra*, deadwood, CWD, old-growth forest

Introduction

The associations of invertebrates with sporocarps and mycelia of saproxylic fungi are well known and broadly studied phenomenon (Stokland et al. 2012). In general the saproxylic fungi provide three distinct food resources, each utilized by diverse fungivorous assemblage e. g. spore feeders, fruiting body feeders and mycelia feeders. Fungal tissue of wood-decomposing species represents a highly nutritional resource (Boddy & Jones 2008) with concentrations of different microelements exceeding significantly the levels in undecayed wood (Gebauer & Taylor 1999). Beetles as a hyperdiverse group count among the most important group of fungivorous insects; specialized species can be found among all three trophic groups. They prefer the wood-inhabiting polypores, mainly due to the durability of their fruiting bodies, relatively high abundance and more or less predictable annual occurrence. However, many different factors influence the host specificity (Komonen & Kouki 2005), and number of highly specialized beetle species can be found on a variety of fungal groups including Agaricales s. l. and Ascomycota (Schigel 2007).

Not all saproxylic fungi are used solely as food source; the role of perennial sporocarps in the terms of attraction centers has been also recognized (Hågvar & Økland 1997).

Although the majority of beetle-fungus associations are relatively broad ecological traits, several cases of very narrow host-specific relations in saproxylic beetle have been well documented (e. g. the family Ciidae (Pavior-Smith 1960), or the genus *Dorcatoma* (Jonsell & Nordlander 2004).

Data on host specificity of several rare saproxylic beetle species were also published, including the association of *Calytis scabra* (Trogositidae) with the genus *Antrodia* (Ahnlund & Lindhe 1992), *Phryganophilus ruficollis* (Melandryidae) associated with *Diplomitoporus kundbladi* (Lundberg 1993), and *Zilora ferruginea* (Melandryidae) recorded from wood infested by *Trichaptum abietinum* (Nikitsky & Schigel 2004). Nevertheless most of the knowledge on fungus-associations of the majority of rare or relict beetle species is very fragmented or too general, usually quoting only on mushroom infested wood (e. g. Freude et al. 1969).

Here we report on mass occurrence and host-association of two rare beetle species *Endecatomus reticulatus* (Herbst, 1973) (Endecatomidae) and *Leiestes seminiger* (Gyllenhall, 1808) (Endomychidae) in Slovakia.

E. reticulatus is a rare saproxylic beetle of the family Endecatomidae. Worldwide four species of the genus *Endecatomus* are known (Zahradník 2006). *E. reticulatus* is the only known species occurring in Europe. Historically it has been reported from the majority of European countries (Zahradník 2006), nowadays it is strongly declining in his whole range. It is regarded extinct in Germany (Binot et al. 1998), while there is only single recent locality reported from Poland (Dominik 1958). In Slovakia this species is threatened in the category vulnerable (Holecová & Franc 2001), and is regarded the first class indicator of pristine forest (Olšovský & Potocký, in prep.). Roubal (1936) reported it from the vicinity of Košice and Zvolen, later a record was published by Franc (1997) from the village of Plášťovce in central Slovakia. Recently the species was found in Drienčanský kras and Štiavnické vrchy (V. Franc pers. comm.). Several polypores are reported as host species, including *Innonotus radiatus*, *Polyporus betulinus* (Dominik 1958, Franc 1997, Zahradník 2006) and *Laetiporus sulphuraeus* (V. Franc pers. comm.). *E. reticulatus* occurs almost exclusively in well preserved broad-leaved forest with dominance of oaks, and Turkey oak (*Quercus cerris*) in particular (Franc 1997).

L. seminiger counts among very rare saproxylic beetles, although it used to be found more frequently compared to previous species. It is widely distributed across the Europe; nevertheless it has been recorded very scarcely. In Germany it has been reported from three localities (Lorenz 2007, Gossner 2013), in France it is known from 4 separate sites, similarly so in Poland (Mazur 1983).

In Slovakia it is threatened in the category vulnerable (Holecová & Franc 2001). It is regarded a second class indicator of pristine forest (Müller et al. 2005, Olšovský, Potocký, in prep.). Published data on this species are very scarce, although it might occur across whole region, we are aware only of records from Veľká Fatra Mts., and Zvolenská kotlina Basin (Wiezik 2013).

L. seminigra has been found mainly within decayed wood of various trees, including *Fagus sylvatica* (Trella 1923, Gossner 2013), *Populus tremula*, *Betula* sp. (Trella 1923), and *Abies alba* (Wiezik 2013). It is hence found within a broad scale of forest

habitats with high stocks of deadwood. Associations with *Piptoporus betulinus* and *Fomes fomentarius* have been occasionally mentioned (http://coleoptera.ksib.pl/).

Both of mentioned beetle species are regarded relict and endangered elements of natural (primeval) forest with declining populations across whole Europe. Despite their general scarcity, we recorded them in high numbers, moreover in associations with very rare saproxylic mushroom species. As far as we know, such associations connected with mass occurrence of both beetle species have not been published so far.

Materials and Methods

Specimens of beetles were collected in situ, during several field trips and inspections of different deadwood substrates. The first finding of *E. reticulatus* was done accidentally during a field trip in 2008 in an old-growth forest. Later on, broken snags of Turkey oak with sporocarps were inspected at the site deliberately. *L. seminiger* was found collaterally during a mycological field trip in 2014 in a remnant of a natural lowland White poplar forest (for detailed information on the findings see the Results). The beetle species were visually identified in situ; later on the identification was confirmed in the laboratory.

The host fungi were photo-documented in the terrain. Basidiocarps were after macroscopic a microscopic examination determined following Nakasone (1997), Bernicchia & Gorjón (2010) and Ryvarden & Melo (2014). Both collections of host fungi are deposited in private herbarium of Vladimír Kunca (PVKU 1211 and PVKU 1305).

Results

Endecatomus reticulatus (Herbst, 1973)

Material examined: C Slovakia, Kremnické vrchy Hills, Boky (48° 33´ N, 19° 0´ E), 330 m a. s. l., S-SE exp., leg., det. et coll. M. Wiezik (valid for all records): 28. VII. 2008, 5 adult individuals, 16. V. 2009, 3 adult ind., 12. VI. 2013, 6 adult ind.

Repeated mass occurrence in an old-growth forest (Fig. 1), within snags of Turkey oak infested with *Innonotus andersonii* (Ellis and Everh.) (Fig. 2). Both adults and larvae were found feeding on the sporocarps and under the loose bark of the dead trees. In all three cases dozens of individuals were observed. Together with *E. reticulatus* relatively diverse assemblage of fungivorous beetles was recorded, including rare species *Abdera affinis* (Melandryidae), *Mycetophagus ater* (Mycetophagidae) and *Eledonoprius armatus* (Tenebrionidae). Except of *M. ater*, these species were also concentrated in high numbers.

Leiestes seminiger (Gyllenhall, 1808)

Material examined: S Slovakia, Hronská pahorkatina, Čenkovská lesostep (47° 46´ N, 18° 32´ E), 115 m a. s. l., exp. 0, 23. IX. 2014, 16 adult individuals, leg., det. et coll. M. Wiezik.

Mass occurrence of *L. seminigra* in highly decayed log of White poplar, infested by corticoid fungus *Mycoacia fuscoatra* (Fr.) Donk (1931) (Fig. 3). Adult beetles were found sporadically on the sporocarps growing on the surface of the log. Dozens of beetles were found inside the decayed wood penetrated by the mycelium of the host fungus (Fig. 4). The decayed wooden substrate was characteristic by a strong fruity scent.

Figure 1. The interior of an old-growth forest with Turkey oak. *Endecatomus reticulatus* was found in large numbers on the sporocarps of *Inonotus andersonii* growing on broken oak snag situated in the centre of the picture (Photo: M. Wiezik, 2013)

Figure 2. Detail of the sporocarps of *Innonotus andersonii* (Ellis and Everh., 1890), growing on a snag of the Turkey oak. The sporocarps were visited by a number of saproxylic beetle species, including *Endecatomus reticulatus*, *Eledonoprius armatus* and *Abdera affinis*, all found in high concentrations. (Photo: M. Wiezik, 2009).

Figure 3. Sporocarp of *Mycoacia fuscoatra* (Fr.) Donk (1931) growing on a fallen log of White poplar. We found high concentrations of *Leiesthes seminigra* (Gyllenhall, 1808) in the fungus-infested wood. (Photo: V. Kunca, 2014).

Figure 4. *Leiestes seminiger* was found in high concentrations in the decayed wood of White poplar infested by *Mycoacia fuscoatra* (Fr.) Donk (1931). The arrows indicate the position of five adults. (Photo: M. Wiezik, 2014).

Discussion

We find it very interesting that the reported mass occurrences of rare relic beetles were both associated with similarly rare saproxylic fungi *I. andersonii* and *M. fuscoatra*.

Inonotus andersonii is a basidiomycete parasitic species of the oaks (*Quercus* spp.). Basidiocarps are uncommon and develop under the loose bark of recently dead trees for only one season (Floudas & Gonou-Zagou 2008) from July to October (Kotlaba 1984). The fungus infects both the bark of the tree causing a canker, and the wood on the inside of the trunk. It is rare in Europe (Ryvarden & Melo 2014), but in some territories of North America it causes increased mortality among oaks (Gilbertson & Ryvarden 1986). It is included in the Red list of Slovak fungi in the category lower risk: near threatened species (Lizoň 2001), whereas in the Red book it is regarded critically endangered (Kotlaba et al. 1995). From Slovakia only two known records were published from the National Nature Reserve Boky in Kremnické vrchy Hills and Čabraď in the vicinity of Cerovo in Krupinská planina plateau, both from *Quercus cerris* (Kotlaba et al. 1995). Holec & Beran (2006) presented it as critically endangered for Czech Republic and mentioned two localities from Moravia, where *I. andersonii* was found growing on *Quercus cerris* as well. All Slovak and Czech historical records occurred in *Quercion pubescenti-petrae* type of forest situated in lowlands up to 450 m a. s. l.

Mycoacia fuscoatra also belongs among basidiomycetes. It has been found in Slovakia very sporadically. Two, more than 50 year old records from Slovakia are deposited in the herbarium of the National Museum in Prague (PRM). They were obtained from dead branch of *Quercus petraea* and from stem of *Fagus sylvatica*, respectively. Škubla (2003) mentioned another two localities from Slovakia. Hagara (pers. comm.) recorded three collections of the species from Slovakia; hence the known distribution of this species in Slovakia is based on less than ten individual records. Situation might be quite different in Europe, where it is regarded a common species, growing on different broadleaved trees (Bernicchia & Gorjón 2010).

In the case of *E. reticulatus* a very narrow association with *I. andersonii* is supported by the repeated co-occurrence in very similar conditions. In all three reported mass occurrences, we found the beetle populations on fresh sporocarps growing on broken standing snags of Turkey oaks. All inspected snags were in initial decay stage (sensu Hunter 1990), with most of the bark in-tact. Only where sporocarps of *I. andersonii* developed, the bark was partly removed and loose. The sporocarps were found almost exclusively on standing dead snags; only in 2009 the fruiting took place on a fallen log and standing snag, both originated from the same tree. The sporocarps persisted from May until July, after then only dry and hollow remnants of the tissue retained at the surface, mainly as a consequence of massive consumption by different beetle species. We never observed repeated fructification of *I. andersonii* at the same tree, nevertheless all three findings were situated in an array of approximately 250 m. Possible mass occurrence of *E. reticulatus* was mentioned already by Roubal (1936) and V. Franc (pers. comm.) nevertheless this is the first time a host fungus is firmly identified.

We even suggest that *E. reticulatus* may also play an important role in dispersion of *I. andersonii*. Similar phenomenon has been broadly studied in bark beetles and their associations with Ophiostomatoid (blue-stain) fungi (Stokland et al. 2012), which are used by bark beetles in overcoming the host-tree resistance during a bark-beetle outbreak (Lieutier et al. 2009), but are also utilized as nutrient source for the beetle larvae (Adams

& Six 2007). The bark beetles have developed various adaptations, spanning from passive carrying of spores and other dispersal stages on their body surface up to specialized organs called mycangia, where spores are transported in special oily substances, which create optimal conditions for their survival (Stokland et al. 2012). In *E. reticulatus* such mechanisms have not been reported, nevertheless the beetle exhibits several surface features, that could play a role in similar relations. The beetle is very distinctive due to the structure of the elytra, typical by a presence of a net of elevated granules with dense semi-erected hairs in combination with smooth and shiny surfaces (http://www.meloidae.com/en/pictures/30064/?s=1). Such structures may increase the adherence of the surface to different substrates. In fact, most of the collected individuals were covered in a film of fungal material, which had to be dissolved and removed from the specimen before mounting. It is plausible that this feature may not be only a part of the beetle´s camouflage, but may have broader implications as already mentioned.

In the case of mass occurrence of *L. seminiger* we assume an increased affinity to the host species *M. fuscoatra*. Again, as both beetle and fungus are very rare, we haven't found any published data on this issue. The strong although very pleasant scent of *M. fuscoatra* may serve as an attractant mechanism for the beetle, which would explain the unprecedented accumulation of the imagines in its vicinity. Nevertheless, the current knowledge on ecology of both species doesn't allow for satisfactory assumptions on this interesting phenomenon.

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