**Chemical Ecology of *Ips typographus* – Norway spruce Interactions**

**Seminar on April 1, 2021**

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This seminar reports on three comprehensive field studies investigating various aspects of Norway spruce susceptibility to attacks by the Eurasian spruce bark beetle, *Ips typographus* in view of global warming. The Rosalia Roof Study at BOKU, Austria, is focused on the effects of drought on bark beetle host acceptance and Norway spruce defence. Similarly, field experiments in the frame of the EXTEMIT-k project at CULS in Czech Republic are aimed to elucidate the influence of climatic stress of trees at freshly cut forest edges on concentrations and emissions of bark defence compounds. Overall bark contents of terpenoid compounds and of particular phenolic substances are increased in response to inoculation of ophiostomatoid fungi associated with the spruce bark beetle. Bark beetle attack history plays an important role in tree resistance to fungal invasion as observed at study trees in outbreak areas of the Austrian Limestone Alps and the Bohemian Forest at the border between Austria and Czech Republic.

**Norway spruce vulnerability for bark beetle attack under abiotic stress conditions**

**Anna Jirosová,** Czech University of Life Sciences, CULS, Faculty of Forest and Wood Sciences, Prague

Forests of the Czech Republic have experienced devastating damages of Norway spruce monocultures caused by bark beetle mass outbreaks in the recent years. Total volumes of trees killed mainly by the Eurasian spruce bark beetle exponentially increased from 1.5 million m3 timber annually in 2003-2015 to 23 million m3 timber in 2019. In response to these ongoing calamities, a multidisciplinary research group was established at our faculty at CULS in Prague, with the aim to advance knowledge on *I. typographus* ecology and damage mitigation.

The chemical ecology team within this research group focuses on *Ips typographus*-Norway spruce interactions with regard to beetle host selection. We ask why certain spruce trees in the forest are more susceptible to bark beetle attack, and how external stressors, such as drought, solar radiation and rising temperatures affect defence ability. In a comprehensive field study, stress levels of trees were manipulated by the cutting of fresh forest edges leading to sudden sun exposure in spring. Monitoring of trees included physiological features such as sap and resin flow, and secondary metabolites profile in the bark for tree defence. These records were related to bark beetle attacks as observed in field bioassays, showing differences between trees at the fresh forest edge and in the forest interior.

Another aspect of our studies is the biological activity of compounds in the Norway spruce/*Ips typographus*/associated ophiostomatoid fungi system, such as oxygenated monoterpenes in tree bark and compounds emitted by exo-symbiotic fungi. We are interested in which particular compounds and mixtures of compounds show attractive or repellent effects on bark beetles and might be promising candidates for usage in applied bark beetle management.

**Does bark beetle attack history change the induction of terpene and phenolic defences in mature Norway spruce?**

**Raimund Nagel,** Institute for Biology, Faculty of Life Sciences, Universität Leipzig

Terpene and phenolic compounds are important conifer defences against bark beetles and their associated fungi. Mature Norway spruce (*Picea abies*) trees, with and without documented histories of attack by the spruce bark beetle, *Ips typographus*, were inoculated with the blue-stain fungus *Endoconidiophora polonica*. We measured the concentration of terpenes and phenolics in the bark before and 14 days after fungal inoculation and the expression of genes encoding key enzymes in their biosynthesis. In addition, intermediates of the terpene biosynthetic pathway and levels of defensive hormones in the same tissue were quantified. The overall terpene concentration increased significantly, while in case of the phenolics only two increased significantly. Transcript levels of genes involved in both pathways were significantly higher after inoculation. A similar pattern was found for enzymatic activity of isoprenyl diphosphate synthases and the concentration of their prenyl diphosphate products in inoculated trees. Quantification of phytohormones revealed the significant induction of the jasmonate pathway, but not the salicylic acid pathway after fungal inoculation. Our data highlight the coordinated induction of terpenes and phenolics in spruce upon attack by *E. polonica*, the fungal associate of *I. typographus*.