IUFRO CONFERENCE

Global challenges and innovative management of bark and wood borers in planted and natural forests

BOOK OF ABSTRACTS

29-31 AUGUST 2023
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GLOBAL CHALLENGES AND INNOVATIVE MANAGEMENT OF BARK AND WOOD BORERS IN PLANTED AND NATURAL FORESTS

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Abstract n°1

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Abstract title: Monitoring of the pine weevil with attractive traps

Abstract

Hylobius abietis, the great pine weevil, has always been the main insect pest of young conifer plantations in Europe. Its life cycle, alternating between a larval phase on stumps and adults feeding on seedlings, makes it particularly harmful for planted forest management combining clear-cutting and early reforestation. After the large-scale outbreaks of bark beetles that affected spruce plantations and the fires that hit pine plantations, an increased risk of weevil damage is expected in reforestation following salvage or sanitary harvesting. Effective monitoring methods are therefore needed to assess this risk and target pest management actions. Although entomologists have been interested in trapping adult *Hylobius* for many years, surprisingly we do not have a standard trapping method in Europe that allows us to compare captures over time and space. We have therefore gone through all the stages involved in designing a attractive trapping system, using the results obtained and supplementing them with current methods. We compared different trap types and different attractant compounds to identify the best compromise for the trapping equipment. We then estimated the duration of effectiveness of the attractive traps and their attraction range in order to optimise the trapping density. Finally, we demonstrated the positive correlation between catch levels and damage levels in plots of young Douglas fir. This standardised monitoring method will enable us to continuously monitor pine weevil catches throughout the year on a national scale, in order to gain a better understanding of the phenology of the pest and to identify the regions most at risk, requiring increased surveillance.

Abstract n°2

Full name: Kenza Bakouri **Email:** kenza.bakouri@inrae.fr

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Co-authors: Vincent Boulanger (ONF)

Abstract title: Alternative control methods of the large pine weevil

Abstract

Hylobius abietis is one of the most destructive pests of coniferous forest plantations in Europe. It severely damages young seedlings by feeding on bark. Neonicotinoide pesticides were used to control Hylobius populations until their use being forbidden in Europe, leaving forest managers without any systemic solution. To date, alternative solutions are either poorly efficient or expensive. Published studies have shown an interesting repulsive effect of *Betula pendula* bark extract and more particularly of methyl salicylate on herbivores and especially insect pests such as pine processionary moths and bark beetles. We conducted a two-years field study design to test the associational effect of several forms of birch's methyl salicylate on Douglas to decrease damages by the large pine weevil: mixed plantations, crushed birch and diffusing the molecule. Additionally, we tested the impact of the removal of the first layer of soil around seedlings, a method used in northern Europe to decrease damages by *Hylobius abietis*. After the first year of study, two treatments show promising results: mixed plantations of douglas and birches, in association or not with the removal of the top layer of soil. Application of crushed birch around douglas seedling seems to have a positive impact on pine weevil activity, causing more damages than the control treatment.

Abstract n°3

Full name: Petr Dolezal **Email:** dolezal@entu.cas.cz
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Co-authors: Marketa Davidkova (BC)

Abstract title: Adult Feeding Preference in the Large Pine Weevil, Hylobius abietis (Coleoptera: Curculionidae); can natural regeneration of silver birch contribute to less damage to conifer seedlings?

Abstract

Several experiments were conducted to test the preferred food source and the effect of Betula pendula on the lifespan of Hylobius abietis. The first study addressed the food preferences of H. abietis on Picea abies, Larix decidua, Pinus sylvestris, Pseudotsuga menziesii, Abies alba, and Betula pendula tested under field conditions. Adults preferred P. menziesii with an average bark area consumed 440.8 ± 147.9 mm2 per seedling. The second most preferred host was P. abies. The least damage was observed on A. alba (76.8 ± 62.56 mm2 per seedling) and B. pendula. Adults feeding on birch suffered 60% mortality. In the subsequent experiment, the life expectancy of adult H. abietis was compared between the groups fed with B. pendula and P. sylvestris. For the B. pendula-fed animals, the mean survival time was 52 days, and only 10% of the adults were still alive at the end of the experiment. For the P. sylvestris-fed adults, the mean survival time could not be calculated because the overall mortality was only 18.3%. To evaluate potential practical significance, damage to P. abies and P. sylvestris seedlings by H. abietis was monitored at a site with natural regeneration of B. pendula and at a site without B. pendula. Damage to conifer seedlings was recorded at the beginning and end of the growing season. The number of undamaged seedlings decreased by 22% at the site with B. pendula and by 36% at the site without birch. Similarly, 11% of seedlings at the site with B. pendula and 19% at the site without B. pendula suffered severe damage from H. abietis or died.

Abstract n°4

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Abstract title: A novel spruce bark beetle information system as cornerstone for a holistic early warning platform in Austria

Abstract

European spruce bark beetle (Ips typographus) (ESBB) mass outbreaks have caused enormous mortality in Norway spruce (Picea abies) dominated Central European forests in recent decades. These climate change driven abrupt forest transformations have severe ecological and socio-economic consequences. Important mitigation measures include a controlled conversion of pure spruce stands into more climate-stable mixed forests. Yet, spruce will remain a relevant and viable option, particularly within its natural range, such as the mountain forests of the Alps. Therefore, effective management of spruce forests based on accurate risk assessment is urgently needed to mitigate future outbreaks.

Scientists from the University of Natural Resources and Life Sciences Vienna (BOKU) and the Austrian Research Centre for Forests (BFW) joined their forces to interdisciplinary develop a novel ESBB early warning and risk management system with high temporal and spatial resolution for entire Austria. This holistic system considers the relationships between abiotic, biotic as well as operational factors that influence bark beetle infestations.

As first fundamental milestone, we present a practice-oriented and user-friendly ESBB information system, which already includes several maps to assess the risk of ESBB infestations. The development is supported by recent advances in remote sensing, increased data availability and innovative modeling approaches. In particular, novel methods based on Sentinel-2 time series allow for a detection of tree species proportions and forest disturbances on an annual time scale with high spatial resolution of 10 m. Moreover, a further developed annually updated version of a predisposition assessment system allows to estimate the current susceptibility of forests to ESBB infestations. Simulations of ESBB development status with the established PHENIPS model and tree water availability via drought stress indicators enable a daily assessment of the current forest condition. Hence, the novel system will provide crucial support for silvicultural measures and risk management under climate change.

Abstract n°5

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Co-authors: Robert M. McElderry, Simon Blaser, Sophie Stroheker, Ryan S. Padrón, Martin M. Gossner, Konrad Bogner, Massimiliano Zappa, Eckehard G. Brockerhoff

Abstract title: Disentangling multiple drivers of spruce bark beetle outbreaks for forecasting and management planning

Abstract

Mitigating the risks and economic impacts due to pest outbreaks requires both early warning and effective management. The quality of warning systems and management strategies depends on our understanding of outbreak dynamics, but disentangling the multiple drivers of pest outbreaks is scientifically challenging. We are developing a comprehensive statistical analysis of European spruce bark beetle (*Ips typographus*) infestation dynamics using a 37-year time series of sanitation felling and pheromone trap catch across Switzerland. Preliminary analyses indicate that the foremost predictor of infested wood volume is the volume of salvaged timber in the previous year. More thorough harvest of infested wood in the previous year results in a net decrease in infested wood. Net increases are associated with elevated numbers of bark beetle generations per year, drought stress, and the occurrence and intensity of storms. In this preliminary linear model, which does not include time-lagged effects, the random year effect shows a sinusoidal curve, which suggests boom-and-bust cycles that characterize outbreak dynamics. To include time-lagged effects of drivers such as storms and drought, we are now working on a long short-term memory network model to generate improved forecasts that will be linked to an online platform where forest managers and policy officers can access multiple decision tools. Alongside the existing beetle flight phenology tool (see borkenkaefer.ch), we will produce the following new tools: stand and site level predisposition, expected volume of infested wood for the current year, predicted outbreak phase (non-outbreak, build-up, outbreak, collapse), and forecasts of acute spruce susceptibility to beetles in response to sub-seasonal drought forecasts. Ultimately, this should provide a wealth of important information to support national risk managers and local practitioners for the planning of bark beetle management.

Abstract n°6

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Co-authors: Evelina Andersson (SLU)

Abstract title: Population dynamics of the spruce bark beetle Ips typographus in forest conservation areas and the ecological interplay with biodiversity and natural enemies

Abstract

In this study we investigated the difference in population dynamics of the spruce bark beetle Ips typographus (L.), natural enemies and species richness in bark samples between managed and unmanaged forests during an outbreak in southern Sweden. Bark samples collected from 190 standing trees in production forests, nature reserves and woodland key habitats, were utilized to investigate differences in attack densities, reproductive success and abundance of arthropods and natural enemies. Additionally, environmental data and surrounding infestations across spatial scales were obtained and analysed from satellite data. The results showed that conservation areas included in this study had higher spruce volumes and drier ground compared to managed forests, and consequently had an environment theoretically more prone to attacks.

Despite this nature reserves did not have a higher attack density, offspring production or reproductive success compared to the managed forests, and even lower if we control for the variations of nearby attacks. Furthermore, nature reserves possessed a higher species richness of arthropods compared to the managed forests, and generally a higher abundance of natural enemies compared to the two other managements. This suggests that the ecosystem functions and interactions associated with bark beetle infestations in conservation areas, differ from the managed forests and this have implications for the resilience to local outbreaks in time and space.

Abstract n°7

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Abstract title: Friends and foes of the European spruce bark beetle Ips typographus

Abstract

Due to a series of damaging climatic events, such as the Vaia storm in 2018, high snow pressure events and extreme droughts have led to forests with decreased fitness in the southern Alps. This has further caused the outbreak of the European spruce bark beetle Ips typographus with an intensity which was previously unseen in the Southern Alps. This project aims to investigate the ecology of I. typographus with a special focus on its associated partners. Various organisms such as bacterial and fungal symbionts as well as mites and nematodes, are associated with the spruce bark beetle. We will utilize next generation sequencing techniques to characterize the community associated with spruce bark beetles. We want to characterize bacterial and fungal core symbionts of the spruce bark beetle with a special focus on regions affected by different stages of the bark beetle outbreak. Moreover, we want to investigate the nematode and mite community associated to the spruce bark beetles in the current outbreaking hot spot in the Southern Alps. The project aims to characterize friends and foes of I. typographus and their impact in the ecology of this important forest pest.

Abstract n°8

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Organisation: University of Padova

Co-authors: Andrea Battisti, Enrico Negrisolo, Gregor Belui

Abstract title: Physiological, molecular, and behavioural investigations on Ips typographus vision (Coleoptera, Scolytinae)

Abstract

Aggressive bark beetle species such as the Eurasian spruce bark beetle Ips typographus, play a fundamental role in forest ecosystems but, along with their importance from a biodiversity and ecological point of view, they can also lead to extensive forest mortality and massive economic damage during outbreaks. Nowadays Ips typographus' eyes, visual perception of the reality and recognition of specific targets like host plants are understudied topics on which very little is known. Studying of such sense can open the way to new systems resulting in more efficient management methods, particularly important during the switch from an endemic to an epidemic condition. In addition, the integration of visual cues in trapping systems of Ips typographus may offer new opportunities for surveillance. Research reported here concerns morphology and physiology of the compound eyes of I. typographus, including an exploration of the opsin genes involved in light recognition and consequent behavioural tests. The number and size of ommatidia is reported and the light spectral sensitivity analysed through the electroretinography (ERG) technique. The results confirmed the capability of this bark beetle to perceive green light (530 nm) and showed a new, distinct response to UV light (370 nm), thanks to two different photoreceptors. Further evidence of such findings was obtained through the exploration of beetle genome, where the presence of two different opsins involved in green and UV light perception was found, confirming the ERG results. Finally, behavioural y-maze experiments were set up to confirm the response of I. typographus to different light stimuli and intensity. Overall, the results may explain the host selection of the beetle and its orientation and dispersal pattern.

Abstract n°9

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Co-authors: Bernard Slippers, Johannes Spaethe, Jeremy D. Allison

Abstract title: Color vision in the European woodwasp, Sirex noctilio

Abstract

The woodwasp, Sirex noctilio, is a global pest of pines. Although it is known to be attracted to light and possess sexually dimorphic body colouration, the visual ecology of S. noctilio is poorly understood. A precondition for colour vision is the presence of at least two spectral types of photoreceptors in the eye. Our aim was to (i) identify the photoreceptor types of the compound eye by electroretinography (ERG), (ii) characterise the visual opsin genes of S. noctilio by genomic comparisons and phylogenetic analyses and (iii) analyse opsin mRNA expression, iv) morphological description of the compound eyes and ocelli; and v) semi-field behavioural tests of the colour preference of newly emerged wasps. ERG measurements revealed two photoreceptor types in the compound eye, maximally sensitive to 527 and 364 nm. In addition, we identified three opsins in the genome, homologous to the hymenopteran green or longwavelength sensitive (LW) LW1, LW2 and ultraviolet sensitive (UV) opsin genes. The LW1 and UV opsins were found to be expressed in the compound eyes, and LW2 and UV opsins in the ocelli. The lack of a blue or shortwavelength sensitive (SW) homologous opsin gene and a corresponding receptor suggests that S. noctilio is a UVgreen dichromate. The morphological results show no sexual dimorphism in the visual system but a positive correlation between insect size and eye morphology was observed. Analysis of trap captures did not identify any colour preference, but an effect of trap location was observed with traps in the north- eastern position capturing more woodwasps, suggesting that other factors, e.g., global landmarks or other non-colour visual cues might guide initial flight behaviour of S. noctilio.

Abstract n°10

Full name: Jessica Hartshorn **Email:** jhartsh@clemson.edu

Organisation: Clemson University

Abstract title: Integrating -omics for use in bark and wood-boring beetle management

Abstract

I will provide a brief introduction to -omics technologies and how they can be used in forest health. I will also provide background information on the session speakers and request feedback from participants following the end of the session regarding potential projects and collaborations using -omics technologies to advance forest health and forest management.

Abstract n°11

Full name: Sigrid Netherer **Email:** sigrid.netherer@boku.ac.at

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Abstract title: Drought and bark beetle associated ophiostomatoid fungi influence defense ability of Norway spruce resistance against Ips typographus

Abstract

Drought affects the complex relationships between Norway spruce (Picea abies), the Eurasian spruce bark beetle (Ips typographus, Coleoptera: Curculionidae) and associated microorganisms. To understand the onset of attack, the interplay of drought, tree physiological and biochemical traits, response to ophiostomatoid fungi, and bark beetle host acceptance were investigated in a mature spruce stand. Rain-out shelters (roofs) to induce moderate drought were established over 2 years. We examined 10 roof and 10 non-manipulated control trees for resin flow, pre-dawn twig water potential, carbohydrate, terpenoid, and phenolic concentrations in bark and phloem, before and after inoculation of the bark beetle associated fungi Endoconidiophora polonica (EP) and Grosmannia penicillata (GP). Bark beetle host acceptance was controlled in field bioassays using 'attack boxes' specially designed for this purpose. We found that in moderately stressed trees resin flow and concentrations of mono- and diterpenes remained stable, but contents of the stilbene isorhapontin increased. Resin flow rates and terpene concentrations in the bark clearly influenced host acceptance. The inoculation of GP caused larger lesions in drought-stressed than in control trees. EP, GP and bark beetles stimulated chemical defense, especially the concentrations of diterpenes, but GP reduced the contents of phenolic and carbohydrate compounds in the hypersensitive wound reaction zones. We conclude that a continued stimulation of resistance during prolonged drought and endemic infestations, while trees produce less carbon and fungi metabolize secondary metabolites and carbohydrates, may eventually override tree defenses, accelerate resource depletion and facilitate colonization by I. typographus during mass attack.

Abstract n°12

Full name: Petter Öhrn **Email:** petter.ohrn@skogforsk.se

Organisation: SKOGFORSK

Abstract title: Seasonal and site-specific variation in Norway spruce (Picea abies) response to inoculation with the spruce bark beetle-associated bluestain fungus Grosmannia europhioides

Abstract

Higher temperatures and drought have favored forest pest insects and reduced the vigor of host trees in recent years. Although the spruce bark beetle reproduces in older trees and attacks on living spruces are usually preceded by a good supply of wind-felled trees, the severe drought stress can reduce the trees' defenses predisposing them to bark beetle attacks. In Sweden, the hot and dry weather conditions in summer of 2018 weakened the trees, while the heat led to increased beetle activity with a second generation of spruce bark beetles. This triggered a bark beetle outbreak of an unprecedented scale, that led to more than 32 million m3 of spruce forest being killed (2018-2022). Sweden is usually too cold for the first generation to both develop and reproduce the same year. With ongoing climate change, such events may however become more common. An important question is, therefore, how we can adapt forestry to reduce the risk of bark beetle damage.

The summer of 2018 was a unique opportunity to quantify seasonal variation and potential lag effects on the spruce tree defense response, in the years following severe drought. With one-month-intervals, i.e., from May to August in 2019 and in 2021, inoculations with a bark beetle associated fungus Grosmannia europhioides was carried out on three field sites using spruce provenances of Swedish and East European origin, representing early and late bud burst, respectively.

There were some seasonal differences, with generally larger lesions in the early season. In both 2019 and 2021, the lesion size correlated with the previous year autumn drought. Trees growing on dry soils had larger lesions indicating lower capacity of tree defense due to water stress in 2019 but not in 2021, which may indicate a tree defense recovery after the severe drought in 2018.

Abstract n°13

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Organisation: Natural Resources Canada - Great Lakes Forestry Centre

Abstract title: Assessing Overwintering Conditions and Temperature Dynamics in Potential Mountain Pine Beetles (Dendroctonus ponderosae) Host Species: Implications for MPB Infestation Risk in Novel Habitats.

Abstract

We investigated the overwintering conditions and temperature dynamics experienced by mountain pine beetle (MPB) in potential host species in Ontario and compared them to native host species in British Columbia, Canada. Our objectives were to: 1) compare under-bark temperatures to ambient stand temperatures in three potential MPB host species (jack, red, and white pine), 2) build a model of under-bark temperature, 3) predict the suitability of novel areas to MPB infestation based on overwintering thermal constraints. We inserted temperature probes under the bark of trees at the interface between the sapwood and phloem, where MPB larvae are typically found. Probes were sealed and left to record temperatures at 30-minute intervals throughout the winter season (September to May). To account for the influence of snowpack and aspect, temperatures were measured both above and below the snowpack, as well as on the north and south sides of each tree. Ambient temperatures in the same stand were recorded using probes placed at corresponding heights on the outside of trees. Our results demonstrate the relationships between under-bark temperature and air temperature, providing valuable insights into the suitability of sites for MPB infestation and the potential risk posed by MPB in Ontario's boreal forest.

Abstract n°14

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Organisation: University of British Columbia

Co-authors: Lori DANIELS (University of British Columbia), Allan CARROLL (University of British Columbia)

Abstract title: Interspecific competition by woodborers may prevent bark beetle outbreaks after wildfires in western North America

Abstract

In the dry coniferous forests of North America, wildfires and insects have historically interacted to create diverse and resilient landscapes, but there is increasing concern that alterations in one or more disturbance regimes by climate change could create novel, and potentially harmful disturbance synergies. Many bark beetle species respond quickly to wildfires, rapidly increasing to outbreak levels due to a sudden resource pulse of fire-injured trees and causing significant mortality in areas that were previously unavailable to them. However, among bark beetle species prone to pulse-driven population irruptions, outbreaks aren't always observed. Recent work in western North America has demonstrated that other subcortical insects, especially woodboring beetles (Buprestidae, Cerambycidae) also rapidly colonize injured trees following fire. Using the Douglas-fir beetle (Dendroctonus pseudotsugae) as an example of a pulse-driven bark beetle system, we will investigate the hypothesis that high populations of woodboring insects can outcompete bark beetles, preventing outbreaks from occurring even if other factors are conducive for one to arise. Generalized additive models indicate a high degree of co-infestation by woodborers and bark beetles immediately following wildfires, demonstrating both groups are attracted to and infest stands with the same characteristics. However, our results also indicate bark beetle reproductive performance is strongly linked to woodborer infestation levels-bark beetles and woodborers can successfully reproduce together up to a point, whereby increasing infestation by woodborers becomes a negative, competitive pressure on bark beetle performance. These results will be discussed within the context of disturbance legacies, future strategies for managing woodborer and bark beetle outbreaks after wildfires, and the potential for ecological surprises after disturbance interactions.

Abstract n°15

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Organisation: USDA-Agricultural Research Service

Abstract title: Type and Duration of Water Stress Influence Host Selection and Colonization by Exotic Ambrosia Beetles

Abstract

Fungus-farming ambrosia beetles in the tribe Xyleborini tunnel into plants and trees to establish chambers for cultivating their nutritional fungal mutualists and rearing offspring. Some xyleborine ambrosia beetles preferentially infest and perform better in living but weakened trees. Flood stress predisposes horticultural tree crops to infestation, but the impact of drought stress has not been well studied. Our objectives were to compare the effects of flood stress vs. drought stress, and to assess the duration of flooding, on host selection and colonization by xyleborine ambrosia beetles. Container-grown Cornus florida L. trees were flood stressed using a pot-in-pot system to submerge the roots in water while drought stressed conditions were imposed by withholding irrigation and precipitation. When experimental trees were held under field conditions for 14 days, 7.5 more ambrosia beetles landed on stems of the flood stressed vs. drought stressed trees. During two additional experiments over 14 and 22 days, ambrosia beetles tunneled into the flood stressed trees but not the drought stressed or standard irrigation trees. By simultaneously deploying trees that were flood stressed for varying lengths of time, more tunnel entrances, xyleborine adults and offspring were recovered from trees that were flooded for 1–16 days and 7–22 days compared to trees that were flooded for 14–29 days and 28–43 days. These results indicate that acute and severe drought stress does not predispose C. florida to infestation, but flood stress and the duration of flooding influence ambrosia beetle host selection and colonization. Understanding the role of host quality on ambrosia beetle preference behavior will assist with predicting the risk of horticultural tree crops to infestation by these opportunistic insects.

Abstract n°16

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Co-authors: Massimo FACCOLI (University of Padua), Diego GALLEGO (University of Alicante, Spain - Sanidad Agricola Econex S.L.), Manuela BRANCO (Universidade de Lisboa), Eckehard G. BROCKERHOFF (Swiss Federal Research Institute WSL), Juan CORLEY (EEA Bariloche & CONICET), David R. COYLE (Clemson University), Brett P. HURLEY (FABI), Herve JACTEL (UMR BIOGECO - INRAE), Ferenc LAKATOS (University of Sopron), Victoria LANTSCHNER (INTA EEA Bariloche & CONICET), Simon LAWSON (University of the Sunshine Coast), Gonzalo MARTINEZ (INIA), Demian F. GOMEZ (Texas A&M Forest Service)

Abstract title: To the ends of the world – trapping and hunting down Mediterranean pine bark beetles in five continents

Abstract

There are several European and Mediterranean pine bark beetle species (Coleoptera: Curculionidae: Scolytinae) that over the decades have invaded and become established in North America and the Southern hemisphere, something that poses a novel threat to both the pine plantations and natural forests. To assess the occurrence and relative abundance of pine bark beetles in these regions but also to compare the trapping performance of different blends of multispecies lures, a broad network of interception traps was established in five continents. Traps were installed in six non-European countries (Argentina, Australia, New Zealand, South Africa, the United States, and Uruguay), and in six European countries (France, Greece, Hungary, Italy, Portugal, and Spain). In each country, half of the traps were baited with alpha-pinene and ethanol, and the other half with alpha-pinene, ethanol, and a combination of bark beetle pheromones (ipsdienol, ipsenol, and Z-verbenol). After the sampling that took place in 2016-2017, five Mediterranean scolytine species (Hylurgus ligniperda, Hylastes ater, H. angustatus, Orthotomicus erosus and O. laricis) were found in non-European countries. Hylurgus ligniperda and Hylastes ater were the most widespread species found in several of the invaded regions, whereas Orthotomicus laricis and Hylastes angustatus were trapped only in Argentina and South Africa, respectively. Regarding the performance of the different blends and despite the large variation among species and countries, most bark beetle species were attracted to the blend that was enhanced with bark beetle pheromones, apart from Orthotomicus erosus that was more attracted to the blend containing only alpha-pinene and ethanol. This study constitutes the first step towards the development of an international multi-lure monitoring protocol for the survey and early-interception of invasive alien bark beetle species.

Abstract n°17

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Organisation: Scion (New Zealand Forest Research Institute)

Co-authors: Nicolas Meurisse (Scion, NZ Forest Research Institute), Carl Wardhaugh (Scion), Eckehard Brockerhoff, (Swiss Federal Research Institute WSL)

Abstract title: An overview of invasive bark and ambrosia beetles in New Zealand

Abstract

There are about 20 species of native bark and ambrosia beetles in New Zealand, though most remain undescribed. Approximately a dozen other species have been introduced, equally distributed between bark beetles (either conifers or broadleaf trees specialists) and ambrosia beetles (all polyphagous species in the tribe Xyleborini).

The European elm bark beetle *Scolytus multistriatus*, vector of the causal agent for Dutch elm disease *Ophiostoma novo-ulmi*, has been actively managed since its discovery in 1989. The golden-haired and black pine bark beetles, *Hylurgus ligniperda* and *Hylastes ater*, are common species of dead wood in pine plantations, but their economic impact is limited.

Two highly invasive species of ambrosia beetles *Xyleborinus saxesenii* and *Xylosandrus crassiusculus*, are also present in New Zealand. *Xyleborinus saxesenii,* which has been in the country for more than 60 years and is known to attack more than 30 host trees, has recently been reported damaging apple and pear trees in orchards on the two main islands. *Xylosandrus crassiusculus* is a more recent invader, only known in New Zealand since 2017 and still restricted in distribution to the Auckland Region.

In this presentation, we discuss the arrivals of these different species of Scolytinae in New Zealand, mostly from Europe and Australia. We also investigate the locations of the first findings and explore the potential pathways for entry and dissemination within the country.

Interceptions of exotic Scolytinae and Platypodinae at New Zealand's borders also highlight the risk of future introductions of these beetles and their fungal associates. As novel bark and ambrosia beetle invasions and related tree health issues continue to emerge globally, we advocate for improved surveillance for early detection at key potential entry points and other bridgehead locations.

Abstract n°18

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Abstract title: Retracing the world-wide invasion of the pine bark beetle Hylurgus ligniperda

Abstract

The red-haired pine bark beetle Hylurgus ligniperda (Coleoptera: Scolytinae) is considered the most successful invader among all bark beetles. Native to Europe and other parts of the Palearctic Region, it has invaded numerous countries in Australasia, Africa, Asia and South and North America. To investigate the invasion routes of H. ligniperda and to determine whether there is evidence for 'bridgehead effects' (secondary invasions originating from invaded areas), we carried out a population genetic study with individuals from numerous native and non-native populations across all continents where the species occurs. We analysed a mitochondrial marker (Cytochrome oxidase I, COI) and a nuclear marker (Arrestin 2, Arr2) and performed a haplotype network analysis and other analyses in R. In addition, we used invasion records of H. ligniperda in each country and interception data compiled by several national plant protection agencies to reconstruct the timeline of invasions. The results indicate that several independent invasion events originating from Europe occurred as early as pre-1940 and that some of the invasive populations served as the origin of subsequent invasions within and between continents. This study is an illustrative example of a highly successful invasive species which benefits from effective invasion pathways and abundant availability of host material (i.e., widely planted plantations of non-native trees), resulting in large non-native populations that lead to further (secondary) invasions via bridgehead effects.

Abstract n°19

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Abstract title: Comparative phylogeographic histories of two conifer–damaging Hylurgus bark beetles in Eurasia

Abstract

Hylurgus ligniperda and H. micklitzi are native European species of bark beetles often occurring in sympatry, especially in the Mediterranean basin. The polyphagous H. ligniperda is an economically-important pest infesting a large number of conifer species in the genera Pinus, Abies, Larix, Picea, and Pseudotsuga. Present all over Europe, it has also invaded almost all continents, largely damaging pine trees. The oligophagous H. micklitzi is a circum-Mediterranean bark beetle feeding only on four species of Pinus but, in contrast to H. ligniperda, it has never been observed as an invader in any other region. Both species develop on the lower section of weak, dying or newly dead trees and infest the main root system and wood in contact with the ground. As these species share similar life history traits as well as pine hosts, and may occur in sympatry in Europe, they provide excellent models for applying a comparative approach to identify historical patterns of population differentiation and the influence of species-specific ecological characteristics. By combining knowledge on host and insect species with mitochondrial DNA markers, we intend to unravel the evolutionary histories of these congeneric species. For both species, specimens were obtained from ethanol-baited traps deployed in native areas of France, Spain and Italy, and in invaded China for H. ligniperda, and in the native distribution range of France and Spain for H. micklitzi. Preliminary results suggest that H. ligniperda has two main divergent clades in France, while H. micklitzi is characterised by lower genetic diversity and shallow population structure.

Abstract n°20

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Abstract title: Ecology of Anisandrus maiche, a newly established ambrosia beetle in North America

Abstract

The ambrosia beetle Anisandrus maiche was first reported from North America in 2009 and has since been reported from nine states in the midwestern and eastern U.S. This exotic wood-boring beetle has also been introduced and established in regions of Europe. Anisandrus maiche is attracted to ethanol, which was used to characterize seasonal flight activity. Peak flight activity of A. maiche in Ohio, USA occurs in late spring/early summer after the peak flight activity of Xylosandrus germanus, thereby increasing the risk of horticultural tree crops being infested. Deciduous trees stressed by flooding or freezing, but not drought, are selected for colonization. Verbenone interrupts the attraction of A. maiche to ethanol and could be useful as part of a push-pull strategy.

Abstract n°21

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Abstract title: Native and non-native ambrosia beetles and their fungal associates in Switzerland

Abstract

Ambrosia beetles and bark beetles (Scolytinae) are among the most common invasive forest insects. Apart from their potential direct impacts on forests, many species exhibit associations with a range of symbiotic or coincidental fungi and other microorganisms. Among these microorganisms, some have the potential to act as plant pathogens, leading to disease in affected trees. Previously, this issue has not been investigated extensively in Switzerland. The objective of this study were to examine the efficiency of ethanol-baited traps and stem and branch sections in capturing native and non-native ambrosia beetles, to study their phenology, and to determine the presence of fungi on these beetles. Scolytinae were collected from three distinct regions in Switzerland: north of the Alps, in the central Alps, and south of the Alps, using flight interception traps baited with ethanol, log and branch sections baited with ethanol, and by collecting naturally infested wood. We captured nine ambrosia beetle species whereby Xylosandrus germanus was the most abundant non-native species, and at some sites, it was more abundant than any native species. In addition, the presence of Anisandrus maiche, a previously unreported non-native species in Switzerland, was documented in canton Ticino. Our study also revealed the presence of several fungal associates of these ambrosia beetles, which will be discussed.The relatively high abundance of the two non-native ambrosia beetles and their potential to vector fungal pathogens suggests that they have the potential to cause negative impacts in forest environments.

Abstract n°22

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Abstract title: Establishment and spread of non-native bark-and wood-boring beetles

Abstract

One of the biggest threats to forest ecosystems globally is the introduction and establishment of non-native species. In Sweden alone, several bark- and wood-boring beetles have established populations in recent years. Three of such species are the larch bark beetle Ips cembrae and the larch longhorn beetle Tetropium gabrieli in southern Sweden, as well as the small spruce bark beetle I. amitinus in northern Sweden. The aim of this work was to assess their current distribution in Sweden and evaluate the factors that influence their local colonization and further spread.

Pheromone-baited traps were used to estimate the local population sizes of I. cembrae and T. gabrieli. A survey method was developed for delimiting the distribution of I. amitinus based on inspection of logging waste on fresh cuttings. The method was used for establishing the southern range limit and the inter-annual spread. Field and laboratory experiments were also used to assess factors that influence the species local colonization.

We found that local population sizes of both I. cembrae and T. gabrieli were related to the amount of suitable habitat in the landscape. We found that I. amitinus is already spread over large parts of northern Sweden and is one of the most common bark beetle species found in the region. Our results indicate that factors such as their reproductive strategy, forage for food and escape the enemy pressure influenced the probability of colonization.

Allee effects, operating through the above-mentioned components, might explain the low colonization probability for small local populations in the southern area and the abrupt range limit for I. amitinus in the north.

Abstract n°23

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Abstract title: Research update on Cross-channel dispersal of Ips typographus, and the risk the beetle poses to Sitka spruce in Britain

Abstract

The destructive pest Ips typographus recently established multiple localised populations across SE England, raising concerns over its potential future impact upon Sitka spruce Picea sitchensis (SS), the most economically important conifer species planted in Britain. Through collaborative trapping work with the Universit libre de Bruxelles, we have demonstrated that the likely origin of the UK beetle establishments is from natural cross-Channel dispersal, and that future dispersal events into southern England may be expected.

Research conducted by our team has demonstrated that under laboratory conditions, I. typographus is similarly attracted to SS as to its primary host Norway spruce P. abies (NS), that in choice experiments using cut billets it will select SS as a breeding resource as frequently as NS, and that development rate and breeding success are similar on the two tree species. Validation of the lab-work was conducted in a field trial in the Ardennes forest, in which SS cut billets were attacked and utilised as successfully as NS.

Whilst our findings to date indicate the potential suitability of SS for colonisation by I. typographus, anecdotal evidence suggests that SS forests may be more resistant to I.t. attack than NS. Due to the UK quarantine status of the beetle, our research to date has required working with cut tree material only. To better understand the risk of population growth and outbreak of I.t. in SS forest stands, we plan to investigate the abundance of beetles in European-grown SS stands. We will gather available data on the impacts of recent I.t. outbreaks on European SS plantations and investigate the susceptibility of live SS trees to attack from I.t. when experimentally stressed. To detect any differences in the effectiveness of response to I.t. attack, we will also compare the role of induced and constitutive defences in SS and NS.

Abstract n°24

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Abstract title: Regional adaptation of Integrated Pest Management to control invasive forest insects

Abstract

Globalization is increasing the threat of invasive forest insects to ecosystems. Control efforts against the same pest species progressively take place across distant jurisdictions as Integrated Pest Management (IPM) programs or tactics developed in one region are adopted by another. This knowledge exchange speeds up responses and collaboration; however, transplanted IPM programs often overlook pre-existing or emerging differences between regions that may explain their varying success. These differences include biological variation in the pest system, environmental conditions, issues of scale and capacity of the response, regulatory environments, and cultural context. We examine the role of these factors in the adoption and outcomes of IPM programs, drawing from case studies and an online survey of IPM experts. We propose an evaluation framework for regional adaptation of IPM programs during their adoption and implementation in new regions, and recommend strategies to reduce risks and to maximize uptake, efficacy, and long-term program resilience under climate change. To limit the spread and impacts of invasive forest insects, coordinated action through international networks needs to involve sharing of knowledge not limited to success stories.

Abstract n°25

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Abstract title: Interference in bark beetle host selection: Effects of allochthonous kairomones, anti-aggregation substances and non-host volatiles on bark beetles and their antagonists

Abstract

The consequences of climate change currently increase the impact and severity of bark beetles in forests on a global scale by intensifying their spread, fecundity, invasiveness, and aggressiveness. Existing non-chemical options in bark beetle management are often laborious and costly, whereas chemical options can have negative effects on non-target species and may be prohibited in some areas. To provide forest owners and managers with a selection of options fitted for a wide range of situations, it is necessary to develop new and innovative monitoring and control methods to complement current procedures.

Manipulating semiochemicals that bark beetles and their antagonists use to locate their respective hosts is one option in the field of environmentally friendly biotechnological methods. In this field we have conducted experiments using slot traps in different forest stands and with different target species to study the effects of kairomones in habitats where they do not occur naturally, substances that signal anti-aggregation and various non-host volatiles from different origins, such as essential oils.

Our data suggest that using the above-mentioned substances can be a successful strategy in bark beetle management by 1) preventing bark beetle infestations by repelling or anti-aggregational signals, and 2) reducing established bark beetle densities by attracting antagonists.

Abstract n°26

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Abstract title: Douglas-fir beetle anti-aggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH): Unparalleled success of a bark beetle pheromone treatment

Abstract

The Douglas-fir beetle (Dendroctonus pseudotsugae Hopkins) anti-aggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH) has been used operationally to protect live Douglas-fir trees (Pseudotsuga menziesii (Mirbel) Franco) in western North America for the past 23 years. The treatment has become a standard part of forest and natural resource management throughout this region. Four companies currently have MCH formulations registered with the Environmental Protection Agency in the United States for commercial sales and operational use in North America. No other bark beetle pheromone treatment in North America, and possibly anywhere in the world, has come close to the success of MCH in reducing unwanted tree mortality during outbreaks. The unparalleled success of this treatment is related to the unique aspects of the Douglas-fir/Douglas-fir beetle system. This paper will describe the development of this treatment including efforts to improve the efficacy of the original treatment and current research to develop a truly biodegradable formulation of the pheromone. The implications of this successful research and development program will be discussed in relation to developing similar treatments for other bark beetle species.

Abstract n°27

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Abstract title: Semiochemical context influences the response of Ips avulsus to different enantiomeric ratios of pheromone compounds

Abstract

Three sympatric species of Ips colonize pine hosts in the Southern United States. These bark beetles limit interspecific interactions and promote reproductive isolation by using different pheromones. Ips avulsus uses ipsdienol and lanierone, Ips calligraphus uses ipsdienol, cis-verbenol and trans-verbenol, and Ips grandicollis uses ipsenol. Cross attraction can also be avoided using different enantiomeric ratios of the same pheromone compound. Due to geographic and seasonal variation, studies on the enantiomeric ratio of ipsdienol used by I. avulsus have reported conflicting results. There is growing evidence that semiochemical context (i.e., different co-baits used in trapping experiments) may also influence the response of bark beetles to different enantiomeric ratios of pheromone compounds. In this study, we designed a trapping experiment with a changing semichemical context to test for a context-dependent response of I. avulsus to enantiomeric ratios of ipsdienol. Traps were baited with (+)-ipsdienol or racemic ipsdienol and co-baited with ipsenol, lanierone, or both ipsenol and lanierone. We found that both lanierone and ipsenol induce context-dependent responses from I. avulsus to ipsdienol. We suggest that the presence or absence of the co-baits reflect an ecological context by signaling the presence or absence of conspecifics and competitors. We recommend that future studies on bark beetle pheromones, especially those designed with the intent of determining optimal blends for monitoring and management, should test for interactions between compound enantiomeric ratios and pheromone compounds produced by sympatric bark beetle species.

Abstract n°28

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Abstract title: Suppression of bark beetle populations using pheromone traps - a case study on the island of Samothraki (Greece)

Abstract

The increasing frequency and intensity at which bark beetle outbreaks emerge in the last decades highlight vividly the need for an efficient and accurate monitoring scheme that would allow the prompt implementation of control and management measures. Among them, logging and removal or debarking of infested trees provides and still remains the most plausible and efficient management approach against bark beetles. However, when an emerging bark beetle outbreak was promptly detected in the pine forest of the island of Samothraki (Greece) in 2020, this has offered the opportunity to assess and evaluate the contribution of a dense network of pheromone traps on the control of bark beetle populations. To do that, a network of 78 Theysohn® traps has been installed in the spring of 2022 in the pine (Pinus brutia) forest of Samothraki (Greece). Each trap was baited with kairomone lures (KaiPin®) which are being replaced every 40 days to retain their attracting capacity. Identifying and analyzing the samples from the first year alone, revealed the occurrence of twenty-three species that showed distinct seasonal abundance patterns through the year. As this project will carry on for a second year (2023), it will ultimately assess the potential of mass-trapping as a complementary and sustainable management tool that, in concert with sanitation loggings, can effectively protect Mediterranean pine forests from bark beetles.

Abstract n°29

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Abstract title: Do pheromone traps help to reduce new attacks of Ips typographus at the local scale after a sanitary cut?

Abstract

The spruce bark beetle, Ips typographus, is causing severe economic losses during epidemic phases triggered by droughts and/or windstorms. Sanitation felling and salvage logging are usually the most recommended strategies to limit the damages. However, any additional control method to limit the economic impact of an outbreak would be welcome. In this respect, the efficiency of pheromone trapping is still controversial or poorly documented.

In a two-year study, at the peak of a severe outbreak in Belgium, we quantified the wood volume and presence/absence of new attacks at 126 sites attacked during the previous year and within 100 m from the initial attack. We compared three treatments, randomly allocated to experimental sites: 1) three crosstraps baited with pheromones, 2) one poisoned tree-trap baited with pheromones and 3) control sites (no trapping device). We found a strong decrease of the attacks relative to the previous year in all treatments, including the controls (>50% of the control sites had no new attacks). In both years, new attacks were more frequent in sites with crosstraps than in sites with a tree-trap and in control sites. In 2020, the attacked volumes were slightly higher in sites with crosstraps than in control sites and no significant difference was found with tree-trap sites. In 2021, there were no significant differences between treatments for the volumes attacked.

Overall, we found no evidence in favor of the efficacy of pheromone trapping to reduce Ips typographus damages at the local scale when combined with sanitation felling and during a severe outbreak. The use of baited crosstraps could even be hazardous, as it seemed to increase the occurrence of new attacks. The exact impact of sanitation felling remains to be confirmed, but it likely contributed to the important decrease in attacks relative to the previous year.

Abstract n°30

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Abstract title: Primary attraction in Ips typographus - New avenues to reduce the spread of pioneer beetles?

Abstract

With rising occurrence of extreme weather events like storms or droughts, the susceptibility of trees towards biotic agents, like the bark beetle Ips typographus, is also growing. There are still large knowledge gaps concerning the initial attraction of early-season pioneer beetles and selection of an appropriate host that is weak enough to allow successful infestation. This selection appears to be guided by olfactory cues emitted by host trees that enable assessment of tree vitality. Avoiding successful attacks of trees by pioneer beetles during the earliest swarming period could slow beetle population build-up in the transition phase from endemic to epidemic infestations. Luring pioneer beetles away from host trees with powerful attractants or the use of unattractive regeneration material may provide an innovative management approaches, but requires a thorough understanding of the role of primary attractants during host selection. We hypothesise that low vigour trees are more attractive to early-season pioneer beetles and that tree vitality can be detected from tree volatile emission profiles. We measured monoterpene emissions of stressed and unstressed trees in situ to investigate the potential effect of volatiles on primary attraction. Here we present our methodological approach as well as first results which indicate differences in amount and ratio of monoterpene emissions. We further show the possible applications of our research in forest management.

Abstract n°31

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Abstract title: A reliable method for pyrethroid detection using GC-MS

Abstract

Central European forests are currently experiencing unprecedented outbreaks of the bark beetle. Overpopulations of these tree-killing insects have wide-ranging ecological and economic impacts. Methods of suppressing bark beetle calamities include sanitation harvests and chemical treatment of infested trees. While new methods are being developed, foresters rely mostly on chemical means of mitigation for the time being. For this purpose, a class of synthetic pesticides known as pyrethroids is currently available. Commonly used pyrethroids include deltamethrin (DELT) and alpha-cypermethrin (CYPE).

Despite their relative safety, as compared to other insecticides (e.g., organophosphates), they are still hazardous substances. Although their toxicity towards insects is 2250 times greater than towards vertebrates it has been shown that they are not completely harmless towards humans. Moreover, pyrethroids are highly toxic to aquatic organisms and their fate in the environment is not entirely known.

It is necessary, therefore, to handle these compounds with their potential for collateral damage in mind. In practice, this can only be achieved if the usage of pyrethroids can be reliably monitored.

At the Czech University of Life Sciences, we are currently working on the development of such an analytical method using gas chromatography with mass spectrometric detection using time of flight mass analyser (GC-TOF-MS). Our aim is to develop a robust methodology for the analysis of various forestry-related samples.

The parameters of GC (xGC)-TOF-MS method for analysis of pyrethroids in forestry related samples are described. The importance of matrix calibration, as compared to solvent calibration, is demonstrated.

With this method in hand, we will be able to monitor the use of pyrethroids and their fate in environment, focusing particularly on their natural degradation under varying conditions. In turn, this will allow for a more targeted use while minimising environmental contamination.

Abstract n°32

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Abstract title: Portable electroantennograms – working towards a field-based tool for applied chemical ecology

Abstract

The active space, or attraction radius, of a pheromone source is extremely difficult to quantify in real-time at biologically active concentrations. Historically, pheromone plume structure experiments used odour source surrogates that have similar atmospheric behaviour to the target pheromone but are simple to quantify in real time. However, the biological significance and concentration thresholds of these studies cannot be quantified, as surrogates do not elicit an insect behavioural response. Portable electroantennograms (pEAG) can give us an insight to the insect's response to a pheromone source with the potential to further our understanding of the pheromone's plume dynamics in an open-field situation. Here, we report the development of a pEAG that is portable (both light weight and small), can incorporate whole insects of a range of sizes (4 to 30 mm antennal length), has wireless communication, a standalone power supply, and record dual-channel antennae. This device has undergone comprehensive testing in large scale wind tunnels and preliminary trials in open air have begun. The pEAG is a promising first step towards the realisation of a myriad of new opportunities for future real-time analysis of in-field EAG responses. This will allow us to aim towards quantifying a biologically active structure and spatial extent of pheromone plumes, to advance our understanding of insect chemical communication within a complex landscape. This knowledge could be applied broadly to the development of improved surveillance and eradication technologies.

Abstract n°33

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Abstract title: New tools for monitoring the phenology, dispersal and population dynamics of forest insects

Abstract

We will review recent advances in monitoring and modelling the phenology, dispersal and population dynamics of forest insects with an emphasis on bark beetles. The new tools include automated traps, weather radar analysis, dispersal modelling and stable isotopes.

Abstract n°34

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Abstract title: Detection of bark beetle attacked trees - comparison tradition technique with snifferdogs

Abstract

Early detection and removal of bark beetle-infested trees remain crucial aspects of bark beetle management. Substantial progress in the identification of attacked trees was achieved with remote sensing. But still, the identification of infested trees is prone to errors due to differing accuracy and the timeliness of detection. The most reliable method of identifying bark beetle attack has been close visual inspection of the tree trunk. A novel method of detection is the use of specially trained dogs; this is by far the most promising technique for the rapid detection of bark beetle-infested trees and is already a technically proven concept for praxis. Due to the novelty of using dogs in detecting bark beetle-infested trees, we compare success of the method with the traditional approaches. Spruces were pre-treated with a synthetic pheromone at several tree positions in six experimental forest stands of 4–12 ha. The tree positions were selected based on their arrangement in a random scheme or in patches considered suitable for bark beetle colonisation. Three dogs of different ages, sex, and levels of experience in detecting Ips typographus were compared with three experienced human bark beetle specialists. We used GPS positioning of dog tracks (unleashed), handlers, human experts, and detection points during the search under a blind-test procedure for tracking positions. The potential utility of the search methods was estimated with three aspects: 1) search success: detection of infested trees, 2) search effort: length of route, and 3) search efficiency: trees detected / unit time. Dog-handler pairs were overall more successful in detecting trees attacked by bark beetles than human experts. In particular, the success rate of dogs was higher in plots with random arrangement pre-baited trees and search efficiency was four times higher than that of the human experts.

Abstract n°35

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Abstract title: Development of tools to anticipate pine wood nematode infestation via Monochamus

Abstract

Monochamus galloprovincialis, referred as pine sawyer beetle, serves as a vector for the parasitic pine nematode Bursaphelenchus xylophilus. Pine sawyers lay eggs of nematode in the bark of dead timber.

The Nouvelle Aquitaine region is sensitive to this problem due to its proximity to Portugal, already affected, and the abundance of the Monochamus vector. As a result of the foreseeable increase in the risk of disease spread via freight transport and the slower movement of its natural vectors, there are two interesting avenues for developing preventive strategies against this pathogen:

To try to set up a first-line diagnostic service for the presence of Pinewood Nematode that would be efficient, rapid and affordable. The principle of this first-line service would be to carry out an initial analysis of suspected cases in order to rule out negative cases, and to redirect potentially positive cases to official services.

Evaluate the tolerance of biological material from the Maritime Pine program to Monochamus and thus Pinewood Nematode, in order to select tolerant varieties.

Abstract n°36

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Abstract title: Recent bark beetle outbreak in Czechia

Abstract

M. Knek, J. Lubojack, J. Lika

Forest Protection Service, service included in the scientific department of the same of the Forestry and Game Management Research Institute, annually gathers the data about occurrence of forest harmful agents. Several outbreaks of different insect was recorded throughout the long term history. Outbreaks of bark beetles are of the largest and the most devastating. In recent years, since 2013, historically the biggest outbreak in spruce stands was recorded. The highest infestation belonged to Ips typographus mainly, but Ips duplicatus is still in epidemic stage locally. Mixed attack of both species and together with Pityogenes chalcographus occurs very often. While Ips typographus is known as the major phloemophagous pest on spruce for decades, even centuries, Ips duplicatus spread its distribution through the country within last few decades, reaching very new locations and representing the most aggressive and invasive species. In the period of the last outbreak, since 2018 until 2022, more than 50 mil. m3 of registered spruce bark beetle infested wood was recorded (70% of forest area monitored), with an all-time high of 15 million m3 in 2020. The total volume of registered spruce bark beetle infested wood decreased in 2021 for the first time in eight years! Significant decrease appeared also in 2022, but the situation may change again to the opposite rapidly and easily in the case of weather change. Actual stage of spruce bark beetles is necessary to suggest as catastrophic on most of the whole Czechia. Bark beetle gradation is still out of control on many places and its retreat could occur only with a de facto loss of attractive spruce stands or longer-term climatic reversal. The main priority in forest protection is maximal attention to investigation of freshly infested trees and their proper sanitation.

Key words: Czechia, forest protection, insect pests, bark beetles, Ips typographus, Ips duplicatus

Abstract n°37

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Abstract title: Forest decline as a driver of spatial distribution and temporal dynamics of oak-associated borers (Coleoptera: Buprestidae)

Abstract

Forest health is deteriorating worldwide due to changing climate patterns. This promotes the abundance and diversity of secondary forest pests, like borers belonging to the group of Agrilinae (Coleoptera: Buprestidae), which are frequently involved in oak declines in Europe. The community of oak-associated Agrilinae is quite diverse in Europe, and may undergo major modifications with global change. To improve our knowledge on the environmental factors driving the spatial distribution and population dynamics of these insects, we firstly assessed the efficiency of different trapping designs to sample oak-associated borers. As green multi-funnel traps hanged in the canopy layer prove to be efficient to collect Agrilinae, we used them to evaluate the contribution of oak decline and other environmental factors to the spatial distribution and temporal dynamics of oak-dwelling borers in France. Traps were set in oak stands exhibiting a gradient of decline, across six forests in 2021, and during six consecutive years in one forest. The community of borers was homogeneous among forests, and included large amounts of Mediterranean species. The severity of decline at the plot and stand scales enhanced the abundance, species richness of borers and influenced the composition of their community. Tree density, longitude and mean June temperature also promoted the abundance of the community. Our multi-year survey indicated that inter-annual fluctuations in decline level weakly correlated with those of borer species, especially because most species experienced a major population crash in 2017. This was not related to a change in stand health, and suggests that extreme climate events such as a warm early spring followed by a late frost can decimate borer populations. This may explain why borer damage has been relatively limited recently in France.

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Abstract title: Gut symbiont acquisition and transmission in the Eurasian spruce bark beetle, Ips typographus

Abstract

The Eurasian spruce bark beetle (*Ips typographus* L., Curculionidae) is the most destructive forest pest in Europe. Recent rising temperatures have accelerated its life cycle, as well as increased the susceptibility of its main host tree, Norway spruce (*Picea abies* L., Pinaceae) to insect attacks. These conditions have favored the occurrence of mass outbreaks where the beetles transition from attacking weak trees to killing healthy ones. *I. typographus* associates with ophiostomatoid fungi that may help them overcome the tree's chemical defenses. While the roles of these fungal ectosymbionts have been studied, the involvement of other microbial partners in this pest's ecological success is unclear. Thus, we characterized the bacterial and fungal communities associated with the insect and its surroundings.

We compared the microbiota of wild-collected and lab-reared *I. typographus* across life stages and environments. To do so, we profiled the bacterial and fungal communities using amplicon sequencing of the 16S and ITS ribosomal RNA genes. We estimated the bacterial load change at different life stages with quantitative PCR. To complement the culture-independent data, we isolated and identified bacteria from adults, larvae and oral secretions from females. Additionally, we observed beetle behavior and recorded possible mechanisms of symbiont acquisition and transmission.

The bacterial communities were dominated by Gammaproteobacteria (*Erwinia, Pseudoxanthomonas, Pseudomonas, Rahnella, Izhakiella*). The fungal communities were mainly composed of yeasts of the Saccharomycetales order (*Ogataea, Kuraishia, Peterozyma, Saccharomycopsis, Wickerhamomyces, Yamadazyma*). The presence of a stable core of microbes shared by all the life stages, but distinct from those associated with the surrounding bark, suggests that bark beetles select their gut symbionts from the environment and pass some of them from one generation to the next. Maternal inoculation via the deposition of oral secretions next to newly laid eggs, as well as coprophagy in immature imagoes, are possible mechanisms for symbiont acquisition and transmission.

Abstract n°39

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Abstract title: Fungi associated with ambrosia beetles in southern beech forests of Patagonia, Argentina

Abstract

In temperate forests, bark and mycetophagous ambrosia beetles rely on, directly interact with, and help to shape fungal communities in addition to playing important roles in stand turnover and as landscape disturbance agents. Worldwide, fungal symbionts have been studied in fewer than 5% of described ambrosia beetle species. In Nothofagus (Southern beech) forests of Northern Patagonia, there have been many studies on mortality and decay involving fungal agents, but fewer studies of ambrosia beetles or of their fungal associations. We sampled galleries, adults and larvae of Gnathotrupes (Curculionidae, Coleptera) in monospecific stands of lenga (N. pumilio) across four sites affected by mortality and decay within Los Alerces National Park (PNLA) in Chubut Province, Argentina. In each site, five trees with evidence of recent wood-borer activity were sampled. In five galleries per tree, larvae or adults were collected, isolations were made from the galleries and the bodies of the insects and fungi were identified by morphological and molecular techniques (ITS region). A total of 95 isolates revealed a taxonomically and functionally diverse assemblage of fungi including plant pathogens, saprotrophs, and entomopathogens. The most common fungi from plant pathogenic genera were blue stain fungi, Ophiostoma patagonicum and Leptographium gestamen, followed Ilyonectria and Huntiella decorticans. The most common saprophytic fungi were the yeast Cyberlindnera. Wood decay-causing Basidiomycota and species of the ambrosial genus Raffaelea were also present. The only entomopathogen that was isolated belonged to Beauveria, and could play a role regulating beetle populations. The results demonstrate diversity across fungal functional guilds, including fungi that play roles in nutrient cycling and decline in tree health, potential options for biological control of insects, and the first ambrosial fungi described from Gnathotrupes spp.