Insect herbivory on trees: untying the effects of tree diversity, leaf traits and climate

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Abstract

Increasing the diversity of tree species in forest stands can lead to both associational resistance or susceptibility to insect herbivory. Discrepancies among existing studies remain largely unsolved, which prevent the development of a predictive framework of associational effects. Although several studies report that plant-insect interactions may change along large scale climatic gradients as a result of direct effects on herbivores or indirect effects on plant investment in chemical defenses, the potential role of climate in mediating associational effects has been overlooked.

We measured leaf insect herbivory and the foliar chemical defenses of birch (*Betula pendula*) in twelve long-term tree diversity experiments belonging to the Tree Diversity Network (TreeDivNet). Experiments covered temperate and boreal biomes, spanning a latitudinal range between 44.7 (France) and 61.7 (Finland) decimal degrees. Age of trees in experiments ranged from 5 to 57 years. We extracted climatic data (temperature and rainfall) for each study site from the CHELSA high resolution global climatology dataset. We modeled the response of chemical defenses and herbivory as a function of tree diversity and climate and explored whether the leaf insect herbivore responses were mediated by leaf traits.

Our results do not support the view that there is a general effect of tree diversity on insect herbivory. Instead, we show that the strength and direction of associational effects vary among sites, likely according to stand age and density, and are partly mediated by climatic factors and variability in leaf chemical defenses. Further work is required to elucidate factors underpinning resistance to herbivory in mixed forests, and in particular to explore the dependency of the biodiversity-resistance relationships to environmental context.

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