Increasing damage due to the pine processionary moth in Europe: role of climate and landscape changes

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regimes can affect insect development and survival directly, impair tree defensive capacities and tolerance, and alter multitrophic interactions among herbivores, symbionts, and natural enemies. Further, these processes often interact, such as when increased temperatures allow range expansion into regions with new host species, temperature and drought jointly interfere with tree defense, and physical factors influence the abundance and signaling of community members that exert tritrophic feedbacks. The richly developed and multidisciplinary area of plant-insect interactions can provide some guidance in how to address this complexity. Frameworks such as processes of coadaptation, patterns of resource allocation, mechanisms of plant defense, and phenological synchrony provide particularly useful focus areas for empirical studies. We present results from several feeding guilds and biomes to illustrate how some of these processes can be influenced by a changing climate. These examples likewise illustrate how our knowledge of plant-insect interactions can help inform our basic understanding of how climate influences insect population dynamics, and management approaches in a rapidly changing environment.

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As highlighted in the Intergovernmental Panel on Climate Change (IPCC) report, disentangling the effects of climate and landscape changes is a challenging issue to assess the role of global warming as a driver of contemporary population dynamics and distribution shifts. We review the case of the winter pine processionary moth, *Thaumetopoea pityocampa*, (PPM) that is a serious and increasing economic and public-health concern in Europe. The problems due to the PPM result from three main causes: 1) the northward and upward expansion due to climate warming, 2) the increasing use of its hosts as ornamental trees, and 3) accidental transportations outside its range with ornamental trees. It has been shown that the distribution changes observed during the last 2 decades and the concomitant forest damage are primarily due to milder winters favouring larval survival. Even if host tree availability is not a limiting factor for the expansion, recent results from landscape analyses in France nevertheless indicate that forest health might largely depend on trees outside forests and permeability of non-forest areas to the moth. Thus modifying ornamental practices may contribute to mitigate the consequences of climate warming on forest health.

Living on the edge: outbreaks of a bark beetle at its range margins, life-history, associated fungi, and host defenses. Villari, C. (*Ohio State University, USA; villari.2@osu.edu*), Colombari, F., Faccoli, M. (*University of Padova, Italy; fernanda.colombari@unipd.it; massimo.faccoli@unipd.it*), Bonello, P. (*Ohio State University, USA; bonello.2@osu.edu*), Marini, L., Battisti, A. (*University of Padova, Italy; lorenzo.marini@unipd.it; andrea.battisti@unipd.it*).

Ips acuminatus is a bark beetle infesting Scots pine throughout Europe, recently causing severe damage in the southern Alps, at its range edge. Climate change may be a driver of these outbreaks as it likely affects forest ecosystems by modifying the relationships among organisms, especially under marginal conditions. We have characterized the beetle's life-history, attack dynamics, its associated fungal community, and its interactions with host plant defenses in these areas. Results suggest that populations of the southern Alps may benefit from climate warming through earlier spring emergence and modified hibernation behavior, which allow the beetle to survive in larger numbers and achieve critical population thresholds that cause more frequent tree mortality. Moreover, both pathogenic and nutritional associated fungi, systematically associated with the beetle, seem to participate in exhausting host plant defenses, indirectly assisting in beetle establishment processes. Finally, an expanded analysis of host plant defensive strategies showed that Scots pine utilizes a varied defense chemistry in which only part of its constitutive metabolism is influenced by tree growth, while no overall trade-offs between different defensive metabolites were found. Global warming will likely increase the outbreak frequency of *I. acuminatus*, causing a rarefaction of Scots pine at its southern range edge.

G-08 Consequences of changing trophic interactions on forest insect population dynamics

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Population dynamics under climate change: modeling the interactions between predator and prey. Ammunét, T. (*Swedish University of Agricultural Sciences, Sweden; tea.ammunet@slu.se*), Ayres, M. (*Dartmouth College, USA; matt.ayres@dartmouth.edu*), Bjorkman, C., Klapwijk, M. (*Swedish University of Agricultural Sciences, Sweden; christer.bjorkman@slu.se; maartje.klapwijk@slu.se*).

Insects as ectotherms are directly affected by changes in temperature. The direct responses to climate change may in turn have an effect on the population dynamics of species. In particular, increases in reproductive rates, directly influenced by temperature, may lead to larger fluctuations in insect pest population densities and therefore have an effect on the risk to forests. On the other hand, many pest insect populations are influenced or driven by endogenous processes and trophic interactions. Natural enemies influencing these interactions and endogenous processes in pest insect populations are themselves also subjected to a changing environment. Detecting the effects of climate change on trophic interactions and consequent effects on coupled predator-prey populations is, however, often difficult and laborious. Furthermore, continuous changes in temperatures may create a continuous change in the factors affecting the population dynamics of both the predator and the prey. We approached the problem by modeling the change in parameters affecting population dynamics. We assumed a continuous increase in population parameters of both predator and prey reflecting the increases in temperature and explored the resulting long term population dynamics between predator and prey. In addition, the effects on population dynamical stability were explored.