EUROCORES Programme

EuroVOL

Ecology of Plant Volatiles, from Molecules to the Globe

EUROCORES Programme
European Collaborative Research

The EUROCORES Programme **Ecology of Plant Volatiles, from Molecules to the Globe (EuroVOL**; www.esf.org/eurovol) helps understand synthesis and emissions of biogenic volatile organic compounds (BVOC), from leaf to globe; and consequences of BVOC emissions, from individuals to communities. Such knowledge comprises different levels that range from genetic regulation of BVOC synthesis, BVOC biochemistry and physiology to the ecological role of BVOC and to the interactions of BVOC with atmospheric and biogeochemical cycles.

The EUROCORES Programme EuroVOL covers the following topics:

- The short- vs long-term control of environmental factors on BVOC emission
- The role of BVOC in plant protection against environmental abiotic stresses
- A new class of stressors: anthropogenic pollutants and BVOC
- Global change influences on BVOC emission
- BVOC-mediated plant communication in the trophic webs and in a changing environment
- Land use change impact on BVOC emission
- Modelling BVOC and BVOC effects on past atmospheric chemistry and climate.

The EuroVOL kick-off meeting was held with the Project Leaders of the three funded Collaborative Research Projects on 30 May 2011 in Strasbourg, France, to discuss their future collaboration and to launch the networking phase of the EUROCORES Programme EuroVOL.

Collaborative Research Projects (CRPs)

Molecular and metabolic bases of volatile isoprenoid-induced resistance to stresses (MOMEVIP)

(CNR, FNR, FWF, FWO, NWO, SNF)

Plant volatile isoprenoids (isoprene, monoterpenes and sesquiterpenes, collectively hereafter called VIP) play critical roles in communication with herbivores, defence against biotic and abiotic stresses, and modulation of stress-induced signalling molecules. VIP are known to allow plants to communicate with other organisms, principally herbivores and their carnivore enemies. **MOMEVIP** sheds new light on the biological functions of volatile isoprenoids, the most abundant plant volatiles, focusing on those traits that may help plants survive and cope with stresses exacerbated by global change. It stems from frontier research that has been carried out by all partners and that has brought fundamental advances in our knowledge of VIP functions and roles. Already, work carried out mainly at the proponents' laboratories has shown that VIP also protect the photosynthetic apparatus against thermal and oxidative stresses. Combining expertise in –omics and ecophysiology, and using high-throughput equipment, **MOMEVIP** makes it possible to inspect the metabolic and molecular control of VIP biosynthesis and the subtle feedback processes that VIP induction exerts on whole plant metabolism and production. The partners will integrate competences in ecology, physiology, biochemistry, molecular biology, functional genomics and bioinformatics to improve knowledge about the molecular and metabolic bases of VIP biosynthesis, and the functions of VIP in plant protection, per se and when interacting with other defensive pathways. Improved mechanistic knowledge will allow a better understanding of VIP functions, and a fully targeted improvement of plant capacity to cope with biotic and abiotic stressors. The results from **MOMEVIP** may help improve metabolic engineering of plants for the production of economically interesting metabolites.

Keywords: abiotic stress; antioxidants; apoptosis; high temperatures; ozone; photosynthesis; primary metabolism; volatile isoprenoids.

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Induction of plant VOC emission by biotic and abiotic stresses and consequences for community ecology: a multidisciplinary approach (A-BIO-VOC)

(AKA, CNR, ETF, NWO, SNF, VR)

Plants are members of complex communities, and they have evolved intricate mechanisms to defend themselves against pathogens and herbivores while engaging in beneficial interactions with organisms. Plants produce a multitude of biogenic volatile organic compounds (BVOCs), which are a crucial component of a plant's phenotype and play a dominant role in the ecology of plants. This volatile-related phenotype is plastic, because the emission is affected by biotic (linked to plant pathogens, herbivores and carnivorous arthropods) and abiotic (such as ozone or high temperature) stresses. The amounts of BVOCs disseminated into the atmosphere by plants are enormous: for example around 1000 teragrams of carbon per year in the form of terpenoids. Other plant volatiles include green leaf volatiles, nitrogen-containing compounds and aromatic compounds. **A-BIO-VOC** focuses on the ecology of inducible BVOCs from plants and the mechanisms underlying their production. The partners have joined forces to address the ways in which plants respond to combinations of biotic and/or abiotic stresses in terms of BVOC emission and the ecological effects on organisms from the surrounding plant community at different trophic levels. This is done through an integrated, multidisciplinary approach that includes transcriptomics, metabolomics, phenomics, modelling, and behavioural and community ecology. The **A-BIO-VOC** project will build on knowledge of plant responses to single stresses and gain profound insights into how multiple stresses influence plant BVOC emission and consequently the ecological effects on organisms from the surrounding community at different trophic levels.

Keywords: stress-induced plant volatiles; biotic stress; abiotic stress; crosstalk; priming; insects; plant pathogens; multidisciplinary.

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Consequences of insect invasions for plant-insect interactions mediated by volatile organic compounds (InvaVOL)

(CNR, GAČR, NWO, SNF, VR)

Plant volatiles play an exceedingly important role in the interactions among plants and insects, as many insects use plant volatiles to locate vital resources. Herbivorous insects, for instance, use plant volatiles to locate flowers that offers nectar and pollen. Of special interest for plant-insect interactions are herbivore-induced plant volatiles, which are mainly released by the plants upon herbivory and in some cases can be emitted in quantities that are a thousand-fold higher than those emitted by healthy plants. These herbivore-induced plant volatiles are thus very important signals in the context of the interactions between plants and insects. These volatiles can repel and in a few cases attract insect herbivores and affect the foraging behaviour of pollinators. They also serve as foraging cues for the natural enemies of herbivores, such as predators and parasitoids and are therefore often considered to be part of the plant's indirect defence strategy. Based on the hypothesis that these fine-tuned plant-mediated interactions will be disrupted if novel herbivores are introduced into an ecosystem, **InvaVOL** studies and models the effect of invading insects, to contribute not only to the fundamental understanding of the role of BVOCs in the interactions among plants and associated insects, but also to provide information on the environmental and possible economic consequences of invasive insects. **InvaVOL** also contributes to better ecosystem and crop protection in several developing countries in these regions.
The results of **InvaVOL** will provide parameter values for dynamic models that predict the ecological impact of the interference of invading insects on native infochemical networks.

Keywords: induced BVOCs; insect invasions; trophic webs; pollinators; parasitoids; pest insects; plant protection; dynamic modelling

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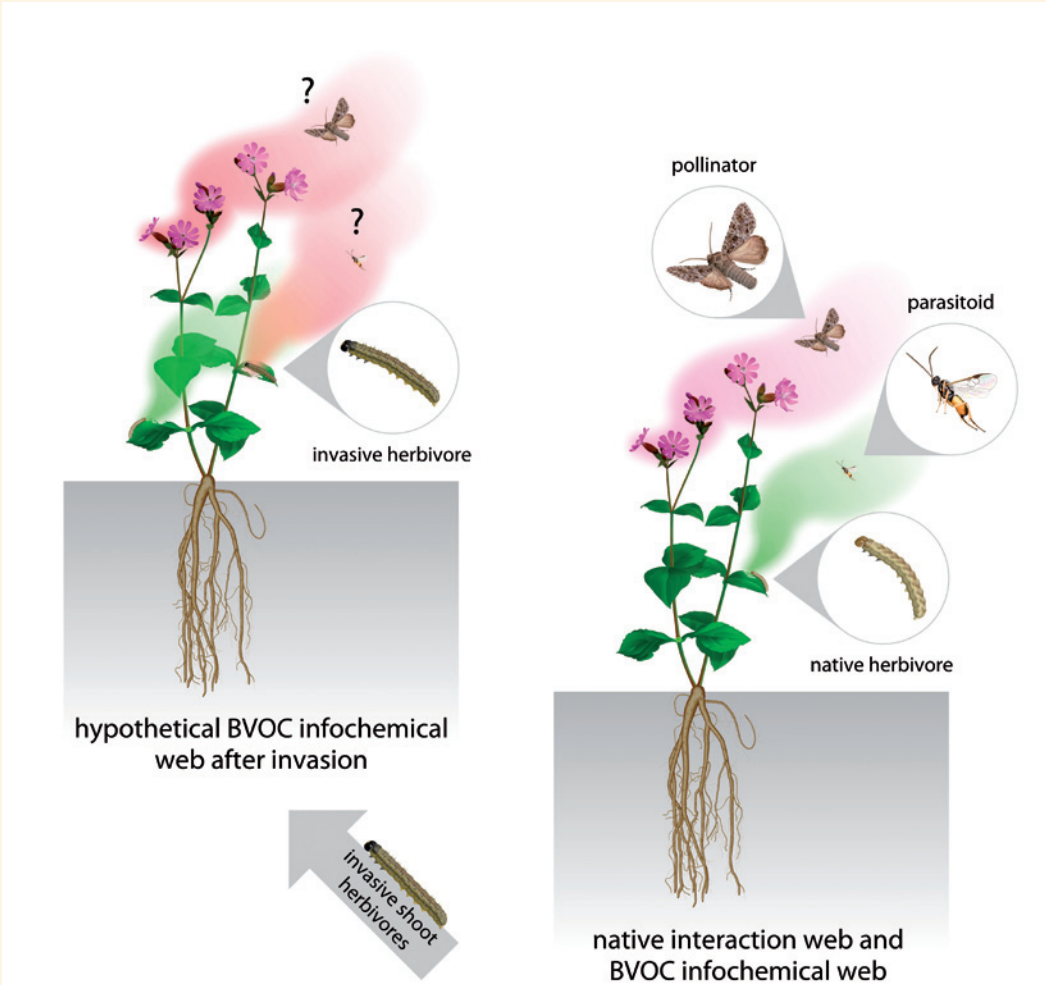
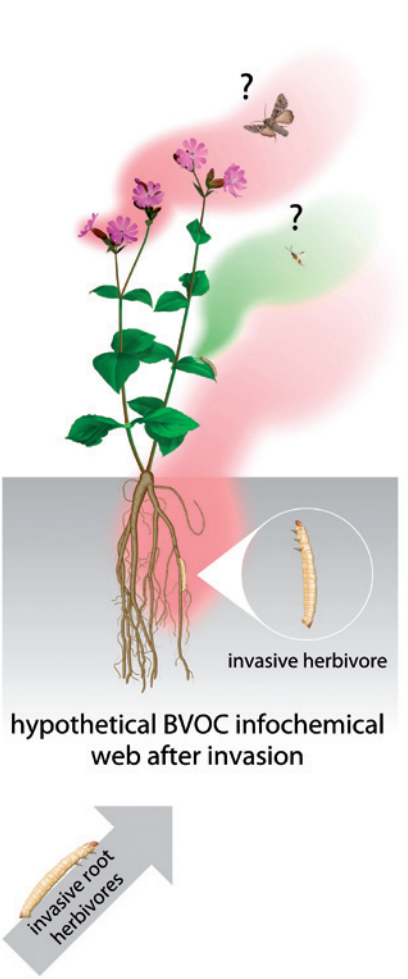


Conceptual representation of interactions among plants and native and invasive insects as mediated through plant volatiles.
Courtesy of Thomas Degen, Ted Turlings *et al.*



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Cover picture:
A newly installed greenhouse next to the Science building at the University of Neuchâtel offers space for experiments in the context of the EuroVOL CRP InvaVOL

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