Cd-binding proteins (PCs). Financial support by FAPESP and CNPq.

3.12.5. Nutrients and heavy metal transfer from soil to the host-hemiparastic plant association *Cistus-Odontites luteus* growing on mine spoils

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Odontites luteus (former Scrophulareaceae) a hemiparasitic plant was found associated with Cistus species at mine sites in Italy (Cu mine) and Catalonia (Pb, Ba mine). Soil, root and shoot concentrations of selected mineral nutrients (Ca, Mg, K, Fe, S, Mn, Zn, and Cu) and of non-essential elements (Al, Cd, Pb, Ba, and Sr) were analysed in order to get a first picture on how the hemiparasitic nutrient adquisition strategy may influence the mobility of these elements. *Cistus sp.* restricted the root to shoot transport of Cu, Zn, Al and Pb. In *O. luteus* similar root and shoot concentrations of Cu and Zn suggest that in this hemiparasitic plant the transport was less hampered, probably due to a direct uptake of mobile metal species from either or both xylem and symplastic sites of the host. In contrast, mobility of Pb was restricted also in the hemiparasite. The host-hemiparasitic plant association may serve as a model system for future investigations on metal mobility as a function of metal speciation in plants. *Acknowledgement: Supported by DGICYT (BFU2004-02237CO_2-01) and Plà Recerca Catalunya 2001 (SGR00200).*

3.12.6. Toward the determination of the genetic basis of heavy metal accumulation in six wild metallicolous and non-metallicolous *Salix caprea* populations

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Due to fast growth and biomass production and the ability to accumulate high amount of cadmium (Cd) and zinc (Zn), Salix caprea is well studied for the clean up of metal-contaminated soils by phytoextraction. However only limited information on the population structure of S. caprea is available. Thus, analyses of the genetic structure of six metallicolous and non-metallicolous S. caprea populations was initiated. Genotyping 11 microsatellite markers, we found no evidence for clonal propagation. Low, but significant differentiation was observed between some S. caprea populations. By correlating the amount of heavy metal accumulation with the genotypes we anticipate to determine a genetic basis of this trait. To associate genes responsible for heavy metal accumulation, expression of candidate genes was quantified by real-time PCR during the vegetation period in leaves of S. caprea cultivated on contaminated and uncontaminated soil. The relationship between seasonal changes of gene expression as well as associations between the capacity of heavy metal accumulation and the genotypes will be discussed.

3.13.1. The roles of plant terpenoids in the environment and in the plant

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The smaller terpenes, isoprene, monoterpenes, and sesquiterpenes, play important roles in helping plants cope with stress. These compounds are made by related enzymes that are coded for by a rapidly-evolving family of genes. This has allowed these compounds to fill a variety of roles within plants including tolerance of, or resistance to, heat stress, oxidative stress, herbivory, and microbial attack. This talk will focus on the smallest isoprenoid, isoprene, and its role in protecting against thermal and oxidative stress. Isoprene does not protect against very high or sustained temperature and isoprene emission is uncommon in hot desert plants. However, plants that suffer frequent moderately high temperatures, such as tree leaves exposed to full sunlight on a still day, tend to emit substantial quantities of isoprene. Many trees routinely emit 2% of the carbon they take in for photosynthesis as isoprene, but this can range to over 50% of carbon lost as isoprene. Leaves at the tops of trees emit four times more than leaves at the bottom of the same tree. The evolution of the capacity for isoprene emission, and the atmospheric consequences will be addressed.

3.13.2. The biology and molecular genetics of terpene metabolism in plants

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Terpenes are a structurally diverse class of compounds that play important biological roles ranging from antimicrobial defense compounds to hormones controlling development programs in plants. Interestingly, terpene biosynthesis has only been observed in plants, microbes and insects, but not in animal species. In plants, terpenes are synthesized by 2 complex biosynthetic pathways compartmentalized to the cytoplasm and the plastids. Recent progress in understanding the structure and function of the terpene biosynthetic genes contributing to the cytosolic pathway has advanced our appreciation for the biological significance of these compounds in plants, as well as suggested mechanisms for how these genes may have evolved and been adapted for specific functions. Understanding the biochemistry and molecular biology of terpene metabolism has also provided insights into how these pathways may be engineered for practical applications in agriculture and medicine.

3.13.3. Regulative aspects of isoprene formation in grey poplar (*Populus x canescens*) leaves

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Trees produce a wide spectrum of volatile organic compounds (VOCs) such as isoprene. Recently much progress was made to elucidate the metabolic pathway leading to isoprene. Two possible committing steps in the plastidic pathway are the deoxyxululose 5-phosphate (DOXP) reductoisomerase (DXR) catalysing the first specific reaction of the methylerythritol phosphate (MEP)-pathway and isoprene synthase (ISPS), the final enzyme releasing isoprene from dimethylallyl diphosphate (DMADP). The presentation summarizes actual work on molecular, biochemical and physiological aspects of isoprene formation in order to understand its biological function. Seasonal and daily variations of gene expression rates of *dxr* and *ispS* in relation to enzyme activity, DMADP pools and isoprene emission rates from poplar will be shown demonstrating the high variability of isoprene formation. Furthermore immunological and immunohistochemical data on the tissue-specific localisation of ISPS will be presented.

3.13.4. Plant terpenoids in information webs: the ecology of 'crying' for help

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In response to herbivory plants produce volatiles that attract the enemies of the herbivores as a kind of 'bodyguards'. Terpenoids are a major class of herbivore-induced plant volatiles that have been recorded from a large number of plant species in response to herbivory by e.g. caterpillars, mites, beetles or bugs. The volatiles that a plant releases can be exploited by all organisms in the environment, including herbivores and neighbouring plants. Therefore, the emission of herbivore-induced plant volatiles may alter various interactions in the food web and in the information web. In this presentation a link will be made between chemical ecology, molecular biology and community ecology. More and more terpene synthase genes are being cloned and characterized and these genes allow exciting new options to investigate the role of terpenoids in multitrophic interactions. Novel tools that allow major progress include combining metabolomics and genomics with ecology. This will be illustrated with research on cucumber and Arabidopsis.

3.13.5. Modeling the emission of stored and "non-stored" monoterpenes from *Pinus pinea*

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We developed a dynamic model to describe time-dependent chanegs in VOC emissions from the foliage of Mediterranean conifer *Pinus pinea*. The model consist of a storage pool in resin ducts and two nonspecific monoterpene storage pools in leaf liquid and lipid phases. The monoterpene emission is further controlled by stomatal conductance, that is reflected in a dynamic stomatal