Bioremediation, Biodiversity and Bioavailability

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Scope and target readership: *Bioremediation, Biodiversity and Bioavailability* accepts reviews and original papers that apply ecological concepts, theories, models and methods to the management of biological resources (primarily plant), through the use of applied ecological problems to test and develop basic ecological theory, and primary fields of applied ecology: conservation biology, global change, pollution biology, wildlife and habitat management, land use and management, aquatic resources, restoration ecology, nuisance species, and the effects of genetically modified organisms. *Bioremediation, Biodiversity and Bioavailability* also welcomes papers in chemical ecology that integrate ecology and chemistry in an attempt to increase our understanding of the biological significance of natural products, embracing the evolutionary biology of chemically-mediated biotic interactions (mechanistic approaches and environmental aspects), biotic controls on the chemistry of the environment, geochemical control of the structure and function of ecosystems. Cycles – in particular their controls – are considered, either of individual elements or of specific classes of natural or anthropogenic compounds in ecosystems. Trophic relationships, intra- and interspecific communication, competition, and other kinds of chemical communication in all types of interactions between organisms will be considered, but preference will be given to plant systems. Mechanistic approaches should deal with the identification, biosynthesis and metabolism of substances which carry information and with the elucidation of receptor- and transduction systems, biochemical, molecular and physiological techniques. All aspects of biological diversity, its description, analysis, conservation, management, sustainable development in a conservation framework, and controlled rational use are welcome.

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Cover photo: Top left: Compressed flowers of *Misopates* mutant L 2003/1191; top right: Strong *deficiens* allele of *Antirrhinum*; bottom right: The *plena* mutant of *Misopates orontium* with elongated inner sepals. More details in Lönnig *et al*., pp 1-30.

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CONTENTS

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ABSTRACT

Special Feature: According to Dollo's law, evolution is irreversible. Yet, of the eight derived features essentially distinguishing *Misopates orontium* from its closely related *Antirrhinum majus*, five differences have phenotypically been clearly diminished or fully overcome by mutant genes, so that *Misopates orontium* outwardly approaches, meets or even overlaps the features of *Antirrhinum majus* or *vice versa* (aspects of the life cycle, leaf form, flower size, flower colour and mode of fertilization). However, to date the morphological key distinguishing feature between the two genera, the strongly elongated sepals in *Misopates* (itself a feature being at odds with Dollo's law), could not be reduced to that of the length of *Antirrhinum* nor could the development of the short *Antirrhinum* sepals be extended to that of the length of *Misopates*, in spite of extensive mutagenesis programmes with both species (agreeing with Dollo's law as to the stasis of this difference). Also, the long sepal character strongly dominated almost all homeotic *Misopates* mutants. After a general discussion of Dollo's law, its relevance for our mutants (and *vice versa*) is examined according to different evolutionary viewpoints. Furthermore, two concerns are raised: (1) To what extent can the hypothesis be substantiated such that the long and short sepals could really constitute genuinely persistent ("immutable") characters? (2) To what magnitude can the unexpected constancy of a feature distinguishing genera like the sepal difference be generalized for systematics and paleontology? Moreover, four basic genetic explanations (losses of gene functions, redun-dancy, the origin of new genes and chromosome rearrangements) are examined in this connection, and their relevance for some pivotal questions on the origin of species is investigated. As far as the authors are aware, this is the first thorough paper on Dollo's law in botany.

ABSTRACT

Invited Mini-Review: The application of recent biotechnological tools for conservation of rare fruit species from developing countries, including *in vitro* and hydroponic culture protocols, improved propagation techniques and molecular marker application, is described. Promising propagation methods include forcing germination of seeds, *in-vitro* protocols well adapted to these rare fruit species that allow the introduction, micropropagation and rooting of plant material, and developing hydroponic culture protocols that allow the early propagation of high-risk genotypes. In addition, the growth of seedlings in controlled environmental conditions in greenhouse and cold chamber provides a useful strategy for obtaining vigorously growing plants from seeds year round. A standard karyotyping protocol has been described working in several species as preliminary tool to start molecular (DNA) studies. In addition, different protocols for DNA isolation and quantification have been assayed in these rare fruit species. Molecular markers based on PCR amplification of the DNA have also become an essential tool for the characterization and conservation of these species. Regarding this PCR amplification of the DNA, two main strategies, RAPD (if the DNA sequence is unknown) and SSR markers (if the DNA sequence is known), have been assayed. These markers have been applied in the genetic characterization of this germplasm, the establishment of genetic relationships between cultivars and species, and the future construction of genetic maps of these rare fruit species. Additional advantages encouraging the utilization of these new technologies in breeding programs include the high levels of synteny between genomes of related species, and a well-established international network of cooperation among researchers.

ABSTRACT

Original Research Paper: In a pilot-scale constructed wetland treatment system, Hg, Se, and As were removed from flue gas desulfurization wastewater through a combination of physical, chemical, and biological processes that resulted in their

accumulation in the sediment. The first objective of this research was to characterize sediment-associated Hg, Se, and As into operationally-defined fractions using sequential extraction procedures. All measurements were taken after 17 months of wastewater treatment. Mercury concentrations in the sediment varied from 0.025 to 0.035 mg kg^{-1} in the treatment system, while concentrations of Se and As in the sediment increased from 3.57 to 8.79 mg kg^{-1} and 11.91 to 14.08 mg kg^{-1}, respectively. Results suggest that Hg and As are stable, immobile, and non-bioavailable in the sediment, as long as current sediment conditions such as pH and redox potential remain stable. Approximately half of the total selenium in the sediment is mobile and bioavailable, while the other half is stable and not bioavailable to plants and organisms. Identification of the main phase associations of Hg, Se, and As in sediments helps to understand the biogeochemical processes involved and to evaluate the risk and remobilization potential of these elements in the constructed wetland. A toxicity assessment of this sediment was then performed to obtain the information needed to support environmental management decisions related to mitigating risks associated with FGD wastewater. The second objective of this research was to evaluate the toxicity of these sediments to *Hyalella azteca*. Despite the use of this constructed wetland treatment system to treat simulated FGD wastewater for over a year, the sediment was not toxic to *H. azteca*. It was apparent from this research that measuring sediment toxicity and total concentrations of Hg, Se, and As in sediment cannot provide the required information about mobility, bioavailability, and the potential impact on the aquatic system.

ABSTRACT

Invited Review: *Lemna* spp. of the family Lemnaceae have been widely studied for their potential application in phytoremediation. A few *Lemna* species are already being adopted to enhance natural attenuation for both organic and inorganic pollution in polishing ponds of wastewater treatment facilities, and constructed wetland designed for decontamination of metal pollution. In view of this growing interest, we review in this article the potency and limitation of *Lemna* species as effective phytoremediation agents. We find that *Lemna* species have many unique properties ideal for phytoremediation plants species: they are have fast growth and primary production; high bioaccumulation capacity; ability to transform or degrade contaminants; ability to regulate chemical speciation and bioavailability of some contaminant in their milieu; resilient to extreme contaminant concentration; and can be applied on multiple pollutants simultaneously. In addition, they have properties significant for public health likewise livestock production and aquaculture, and ecological function. However, we also find a few important limitations of *Lemna* as an ideal phytoremediation agent. The plants are small in size and floating in nature. Hence, they are easily blown off the water surface resulting in transferring contamination to uncontaminated sites because *Lemna* biomass degrades easily thereby readily releasing the contaminant back into the water pathway. This also results in both low sedimentation and contribution to humic material in the benthic. Further, *Lemna* has very high wet-dry biomass ratios which may be deceiving to believe that they have high bioaccumulation on one hand, while on the other, the energy required to dewater the biomass may be equivalent to conventional treatment plants. Nevertheless, *Lemna* species remain one of excellent plants for studying process in phytoremediation, and a good phytoextraction agent for application in shallow and small polishing ponds.

ABSTRACT

Invited Mini-Review: Turfgrasses are an integral component of the urban landscape. Their ecology is strongly influenced by the primary management practices of frequent mowing, fertilization, and irrigation. While much is known about turfgrass plant function, relatively little research has addressed the attending soil microbial community, especially when compared to counterparts in forests, grasslands, and arable soils. This paper reviews available information on soil microbial community composition and function, focusing on organic matter decomposition, nutrient cycling, and response to global environmental change. Consideration also is given to unfavorable conditions that commonly influence the soil microbial community in turfgrass systems (soil compaction, salinity, and use of pesticides). Areas for future research emphasis in turfgrass microbial ecology are discussed.

ABSTRACT

Invited Review: In an attempt to assess the importance of the role of fungi as bioindicators in terrestrial ecosystems, we compiled the results reported by more than 100 authors worldwide. These mostly were centred on the ^{137}Cs and ^{40}K contents. The genera *Paxillus*, *Xerocomus*, *Cantharellus*, and *Hebeloma* were among those with the highest radiocaesium contents. Studies in countries not highly contaminated in the Chernobyl accident, which included other anthropogenic and natural radionuclides in the assays find the order of relative accumulation to be: $^{40}K \geq {}^{137}Cs > {}^{228,230,232}Th \approx {}^{234,238}U \approx {}^{226}Ra \approx {}^{90}Sr >> {}^{239+240}Pu > {}^{241}Am$. Laboratory studies showed that the relative position of anthropogenic radionuclides (mainly radiocaesium and radiostrontium) depends on the moment at which fallout occurred. In particular, if the radionuclide deposition occurred long before the formation of the fruiting bodies, the accumulation of radiocaesium was higher than that of radiostrontium. Other factors, such as the concentration of stable elements and the bioavailability of the different radionuclides in the soil, also affect the radioactive content of the fruiting bodies and hence the dose due to their consumption. While the dose from ingestion of mushrooms in areas clearly affected by the Chernobyl Nuclear Power Plant accident is currently estimated at 1.8 mSv/year due to ^{137}Cs, the maximum dose in unaffected areas estimated on the basis of the present findings is $4.60 \cdot 10^{-3}$ mSv/year for the main natural and anthropogenic radionuclides present in the environment.