counteracted metal-induced lipid peroxidation. The results of the present study show a protective effect of proline on metal toxicity through inhibition of lipid peroxidation and suggest that the accumulation of proline may be related to a tolerance mechanism for dealing with Cu stress.

B208

The Characteristics of Chlorophyll Fluorescence of Alpine Plants Acclimated at Low Altitude

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The characteristic and diurnal fluctuation of chlorophyll fluorescence were surveyed from the leaves of three alpine plants from June, 1996 to August, 1999, in order to investigate the adaptation potential of alpine plants to low altitude. Although the photochemical efficiency of PSII of dark-adapted leaves (Fv/Fm) was different with species, it showed positive relationship with relative humidity in alpine habitats (1850~1950 m a.s.l.). In the low altitude (150 m a.s.l.), however, Fv/Fm showed negative relationships with temperature and light intensity, suggesting that the alpine plants were under the stress of high temperature and light intensity in the low altitude. Non-photochemical fluorescence quenching (NPQ) was higher in sun plants (*Chrysanthemum zawadskii ssp. coreanum*) than in shade or wetland plants (*Allium taquetii, Silene fasciculata*), and was higher in alpine plants with dynamic photoinhibition (*Potentilla stolonifera var. quelpaertensis, C. zawadskii ssp. coreanum, Thymus quinquecostatus*) than in those with chronic photoinhibition (*Anaphalis hayatae, Trifolium lupinaster var. alpinum*). These results indicate that alpine plants with high NPQ are highly adaptive to low altitude. The photochemical efficiency of PSII exhibited much reduced levels in midday (12:00~15:00) both in natural habitats and in low altitude. This midday depression was generally due to reversible decline of Fo and Fm in habitats, whereas it resulted from decrease in Fm combined with an increase in Fo in low altitude. This results suggest that alpine plants were dynamically photoinhibited in natural habitats and chronically photoinhibited in low altitude.

B301

Simultaneous Utilization of Two Different Pathways in Degradation of 2,4,6-Trinitrotoluene by a White Rot Fungus Irpex lacteus

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In previous studies none of the fungal strains could carry out two different initial reactions simultaneously in the 2,4,6-trinitrotoluene (TNT) metabolism. This study confirmed that a white rot fungus, Irpex lacteus isolated in Korea, was able to metabolize TNT with two different initial transformations. In the initial transformation of TNT in one metabolic pathway a nitro group was removed from the aromatic ring. As the intermediates in this process [H-]-Meisenheimer complexes of TNT colored dark red were confirmed by comparison with a synthetic compound. 2,4-Dinitrotoluene as a following metabolic product were detected and nitrite which produced as a result of denitration of [H-]-Meisenheimer complexes supported this pathway. In the other TNT pathway nitro group in TNT was successively reduced to

amine group via hydroxylamines. Hydroxylamino-dinitrotoluenes (2- and 4-OHAmDNT) and amino-dinitrotoluenes (2- and 4-AmDNT) were identified as the intermediates. A membrane-associated aromatic nitroreductase activity was detected in a cell-free extract of I. lacteus. This enzyme catalyzed the nitro group reduction of TNT and required NADPH as a cofactor. This enzyme activity was not observed in the presence of molecular oxygen.

B302

Transformation of 2,4,6-Trinitrotoulene (TNT) by the Bacterium Isolated from Activated Sludge

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A 2,4,6-trinitrotoluene (TNT) degrading bacterium was isolated from activated sludge of sewage treatment plant, and its biodegradation capability was examined. TNT was completely disappeared within 6 hours of further incubation when 100 mg/L of TNT was added into the bacterial culture which had been preincubated for one day. However, this bacterium was unable to use TNT as a sole source of carbon. TNT degradation might be accomplished by a cometabolic process using glucose as a growth substrate. 2-Hydroxylamino-4,6-dinitrotoluene and 4-hydroxylamino-2,6-dinitrotoluene were identified as the first detectable degradation products of TNT and their transient accumulation and conversion to other metabolites were observed. 2-Amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene were detected as the following detectable metabolites of hydroxylaminodinitrotoluene (OHAmDNT) isomers and subsequently metabolized to diaminonitrotoluene (DANT) isomers. Dinitrotoluene (DNT) and nitrite were also formed from a denitration pathway, and this suggested that this bacterium also used two different pathways simultaneously for TNT biodegradation as in a study with Irpex lacteus. Some other effects of environmental factors on TNT transformation by the isolated bacterium were also examined.

B303

Cloning and Nucleotide Sequence Analysis of *xylG* Encoding 5C-2HMS Dehydrogenase from *Pseudomonas* sp. S-47.

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Pseudomonas sp. S-47 is capable of degrading 4-chlorobenzoate to produce 5-chloro-2-hydroxymuconic semialdehyde (5C-2HMS) by the enzymes encoding by *xylXYZLTE* cluster. The resulting 5C-2HMS can be transformed to 5-chloro-2-hydroxymuconic acid (5C-2HMA) by 5C-2HMS dehydrogenase. In this study, *xylG* gene encoding 5C-2HMS dehydrogenase was cloned from the chromosomal DNA of strain S-47. The nucleotide sequence of *xylG* showed to be composed of 1,600 bp with ATG initiation and TGA termination codons. A deduced amino acid sequence of the 5C-2HMS dehydrogenase (XylG) exhibited 98%, 93%, and 89% identity with those of the dehydrogenases from *Pseudomonas putida* mt-2, *Pseudomonas putida* G7, and *Pseudomonas* sp. CF600, respectively.

B304

Cloning of 4CBA Dechlorinase Genes (*fcbABC*) from *Pseudomonas* sp. DJ-12 to Expand the Biodegradable