Obilo, O. P. and S. Ogunyemi (2005). The use of maize as an indicator crop and in the reclamation of farm land ladden with heavy metals as a result of crude oil pollution. Discovery and Innovation 17(3-4): 180-185. Environmental pollution associated with the exploitation of minerals (oil, columbite and coal) in Nigeria had led to the destruction of farm lands while rivers and ponds which served as both source of drinkable water and fishing grounds are severally polluted, killing most of the aquatic life. Field experiments were conducted in the early rainy season and mid rainy season in the year 2000 at Umunarukwu village in Oguta LGA of Imo State, Nigeria (5 degrees 22'N, 6 degrees 46'E) to investigate the effects of crude oil pollution, gas flaring and exhaust fumes of tankers (which transport these petroleum products to the urban areas) on the growth and performance of three different varieties of maize, namely, DMR ESR.W (VI), DMR ESR.Y M) and Oguta Local M), the local variety. These maize varieties were also chemically analyzed for their absorption of heavy metals along with the soil samples collected before and after planting. The amounts of lead (Pb) and Cadmium (Cd) absorbed by the local variety were significantly Pb = 9.83ppm, and Cd =0.93ppm. This local variety also exhibited an appreciable increase in plant height (in PI) despite the high accumulation of cadmium and lead in its tissue. The result of this study suggests that the local variety can be cultivated on a large scale and be used to clean up or remediate a polluted land provided the produce is destroyed and not consumed.

O'Connor, C. S., N. W. Lepp, et al. (2003). The combined use of electrokinetic remediation and phytoremediation to decontaminate metal-polluted soils: A laboratory-scale feasibility study. Environmental Monitoring and Assessment 84(1-2): 141-158. The use of a combination of electrokinetic remediation and phytoremediation to decontaminate two metal-polluted soils has been demonstrated in laboratory-scale reactors. One soil was heavily contaminated with copper, the other with cadmium and arsenic (2500 mug g(-1) Cu; 300-400 mug g(-1) Cd and 230 mug g(-1) As, respectively). Test reactors with two separated chambers, each with a capacity of 5.25 kg soil, were constructed, then the respective chambers were filled with either a mixture of the polluted soil and a control topsoil (75: 25) or topsoil alone. Reactors were sown with perennial ryegrass (*Lolium perenne* cv Elka) and a constant voltage of 30 V was applied continually across the soils in each reactor. Soil sampling took place at the start and the end of the test run, whilst plant foliage was sampled after approximately 3 weeks (both reactors) 6 weeks (Cd soil reactor only) and at the conclusion of each test run (98 days Cu soil, 80 days Cd soil). Soil and plant metal concentrations were measured, together with soil pH. Results showed that in both soils there was a significant re-distribution of metals from anode to cathode in the test reactors, coupled with an enhancement of plant Cu uptake in the cathode region for the Cu soil. Patterns of plant Cd uptake were less clear cut and were not as clearly related to the redistribution of Cd measured in the soil. There was significant acidification of soil at the anode in each test reactor, but soil pH in other parts of the reactor changed little during the course of the experiment. Plant growth was affected at the anode, but was not affected in other parts of the reactor. There was no visual evidence of metal toxicity in the ryegrass in either polluted soil. Some effects on soil fungi were apparent, with a stimulation of Fusarium infection of ryegrass in the cathode region of all reactors and the appearance of sporophores of Coprinus in the same location. It is concluded that the combination of the two techniques represents a very promising approach to the decontamination of metal polluted soils that now requires validation in field conditions.

O'Connor, G.A., J.R. Lujan, and Y. Jin (1990). Adsorption, degradation, and plant availability of 2,4-dinitrophenol in sludge-amended calcareous soil. J. Environ. Qual. 19:587-593.

Odjegba, V. J. and I. O. Fasid (2004). Accumulation of trace elements by *Pistia stratioties*: implications for phytoremediation. Ecotoxicology 13(7): 637-646. The toxicity of eight potentially toxic trace elements (Ag, Cd, Cr, Cu, Hg, Ni, Pb and Zn) to *Pistia stratioties* was examined to determine if this plant showed sufficient tolerance and metal accumulation to be used to phytoremediate waste water and/or natural water bodies polluted with these heavy metals. Young plants of equal size were grown hydroponically and amended with 0, 0.1, 0.3, 0.5, 1.0, 3.0 and 5.0 mM of each heavy metal individually for 21 days. Root elongation as well as emergence of new roots decreased significantly with increase in metal concentrations. The plant had the lowest and the highest tolerance indices for Hg and Zn respectively. The study indicated reduction in the rate of leaf expansion relative to metal type, their concentrations and the duration of exposure. A significant reduction in biomass production was observed in metal treated plants compared with the control plants. The relative growth rate of *P*. *stratioties* was retarded by heavy

metals under study. All trace elements accumulated to higher concentrations in root tissue rather than in shoot. Trace element accumulation in tissues and the bioconcentration factors were proportional to the initial concentration of individual metals in the growth medium and the duration of exposure. In terms of trace element removal, *P. stratioties* presented differential accumulation and tolerance levels for different metals at similar treatment conditions. The implications of these results for phytoremediation are discussed.

Ofer, R., A. Yerachmiel, et al. (2003). Marine macroalgae as biosorbents for cadmium and nickel in water. Water Environment Research. R. Ofer. 75: 246. Experimental studies showed that brown marine algae, *Sargassum vulgaris* and Padina pavonia, can be used to develop an efficient biosorbent for heavy metal removal from aqueous solutions. *Sargassum vulgaris* exhibited high uptake capacities for cadmium (0.9 to 1.1 mmol Cd/gr) and nickel (0.85 to 1 mmol Ni/gr) that are higher than those of other types of biomass and powdered activated carbon, while P. pavonia showed a broader range of nickel and cadmium uptake capacities (0.7 to 1 mmol Ni/gr and 0.8 to 1.1 mmol Cd/gr). The metal adsorption and desorption processes were rapid, with 70% of the sorption and desorption completed within 10 minutes. The equilibrium data for both algae fit well to Langmuir and Freundlich isotherm models. More than 90% desorption of adsorbed metals from the algae was achieved by hydrochloric acid and ethylenediaminetetraacetic acid (1:1 molar ratio). After eight to nine adsorption and desorption cycles, *S. vulgaris* showed a 15 to 35% decrease in metal uptake capacities; P. pavonia showed a higher decrease of 50 to 60%.

Ohmiya, K., K. Sakka, et al. (2003). Application of microbial genes to recalcitrant biomass utilization and environmental conservation. Journal of Bioscience and Bioengineering 95(6): 549-561. Recent papers concerning the application of microbial genes to recalcitrant biomass utilization and environmental conservation are reviewed. Microbial genes have been integrated and expressed in plants and microorganisms. When cellulose-degrading enzyme genes are expressed in rice plants, the transgenic plants exhibit swollen cell walls which increases the digestibility of rice straw in the rumen. When genes encoding aromatic compound-degrading enzymes are expressed in plants, it is expected that aromatic compounds contaminating soil would be degraded during the growth of the transgenic plants. The former transgenic plants are utilized as feed and the latter for phytoremediation. Dockerin and cohesin interactions occurring in the cellulase complex, cellulosome, are applied to the construction of artificial enzyme complexes and protein purification by expressing the genes in transformed bacteria and/or silkworms, respectively. In the case of the forced expression of bacterial genes encoding chitinase and/or hydrogenase in the wild-type bacteria, chitin degradation and hydrogen gas production in the transformed bacteria occur at much higher rates than in the wild type.

Okeeffe, B., S. Horn, V. Cope, K. Lavoie, and D. Okeeffe (1996). Phytoremediation of metal-finishing wastes - an on-site study using the water hyacinth (*Echhornia - Crassipes*). Abstracts of Papers of the American Chemical Society. 212:111-AGRO.

Olaveson, M.M., and C. Nalewajko (1995). Poster Abstract: Differential resistance of acidophilic Euglena spp. to elevated iron concentrations. P. 129. In Proceedings/Abstracts of the Fourteenth Annual Symposium, Current Topics in Plant Biochemistry, Physiology, and Molecular Biology - Will Plants Have a Role in Bioremediation?, April 19-22, 1995, Columbia, MO. Interdisciplinary Plant Group, University of Missouri, Columbia, MO.

Olexa, T. J., T. J. Gentry, P. G. Hartel, D. C. Wolf, J. J. Fuhrmann and C. M. Reynolds (2000). Mycorrhizal Colonization and Microbial Community Structure in the Rhizosphere of Annual Ryegrass Grown in Pyrene-Amended Soils. International Journal of Phytoremediation 2(3): 213-231.

Olguin, E. J., D. Rodriguez, et al. (2003). Productivity, protein content and nutrient removal from anaerobic effluents of coffee wastewater in *Salvinia minima* ponds, under subtropical conditions. Acta Biotechnologica. E. J. Olguin. 23: 259. *Salvinia minima* is an aquatic fern which presents several advantages for the phytoremediation of wastewater. However, there is no information available for the operation of *Salvinia*-based systems (SBS) for nutrient removal from organic matter enriched wastewater.

The objective of this work was to establish the optimum range of some key parameters for the operation of *Salvinia minima* ponds treating anaerobic effluents of coffee wastewater (AECWW). Batch cultures were performed outdoors, under subtropical conditions (Xalapa, Veracruz, Mexico). At the first stage, various pH levels were tested. After choosing the optimum pH, two pond depths were evaluated (0.10 m and 0.27 m). It was found that the productivity in AECWW was strongly affected by the pH, as it decreased with the increase in the pH. In fact, growth was completely inhibited at pH 8.0. In contrast, productivity at a pH of 6.0 and a pond depth of 0.27 m during the summer was equivalent to 27.92 ton/ha x year. The percentage of TKN removal increased with the pH value: 51 +- 2.28% at pH 5.0; 78 +- 1.47% at pH 6.0 and. 97 +- 0.80% at pH 8.0. A similar situation was found for the case of NH4-N removal: (55 +- 0.44%, 80 +- 1.1%, 99 +- 0.02%). The depth of the culture had influence on the productivity, protein content and nutrient removal. It was concluded that *Salvinia minima* is an adequate choice for the treatment and recovery of nutrients from AECWW. The pH for optimal operation of this type of pond was 6.0. The depth of the water column should be adjusted to 0.10 m for attaining a maximum relative removal efficiency (in terms of g NH4-nitrogen/l x d), although the productivity would not be at its maximum under these conditions. On the contrary, depth should be adjusted to 0.27 m for reaching the maximum absolute removal efficiency (considering the total volume of the reactor) and the maximum productivity. During the late autumn and winter period, the AECWW should be diluted 1:2 in order to enhance ammonia nitrogen removal.

Oliveira, R. S., M. Vosatka, et al. (2005). Studies on the diversity of arbuscular mycorrhizal fungi and the efficacy of two native isolates in a highly alkaline anthropogenic sediment. Mycorrhiza 16(1): 23-31. A field survey of the arbuscular mycorrhizal status of herbaceous plant species was conducted in a highly alkaline anthropogenic sediment resulting from the disposal of waste from an acetylene and polyvinyl chloride factory. Most plant species found at the site were mycorrhizal and the dominant mycotrophic plant species was *Conyza bilbaoana*. Fungal species richness was assessed by identification of spores extracted from the sediment and from continuously propagated trap pot cultures. All of the six species of arbuscular mycorrhizal fungi (AMF) found were from the genus *Glomus*. *Glomus intraradices* and *G. mosseae* were found in field-collected sediment samples and also occurred most frequently in trap cultures. To test the symbiotic effectiveness of these two fungi, seedlings of *C. bilbaoana* were inoculated with either native *G. intraradices* BEG163 or *G. mosseae* BEG198 and non-native *G. intraradices* BEG75 or *G. mosseae* BEG25 isolates in sterile and non-sterile sediment collected from the study site. All four isolates were able to colonise *C. bilbaoana*. However, AMF native to the target sediments were generally more effective than the non-native fungi in promoting plant establishment and growth under highly alkaline conditions. The non-native *G. intraradices* was, however, more effective than the non-native *G. mosseae*. The results of this study suggest the use of adapted AMF as inoculants for phytorestoration of alkaline anthropogenic-stressed sediments.

Olson, P. and J. Fletcher (2000). Ecological Recovery of Vegetation at a Former Industrial Sludge Basin and Its Implications to Phytoremediation. Environ Soil Pollut. R 7(4): 195-204.

Olson, P. E., J. S. Flechter and P. R. Philp (2001). Natural Attenuation/Phytoremediation in the Vadose Zone of a Former Industrial Sludge Basin. Environ Sci & Pollut Res. 8(4): 243-249.

Olson, P. E., T. Wong, et al. (2003). Allometric modeling of plant root growth and its application in rhizosphere remediation of soil contaminants. Environmental Science & Technology 37(3): 638-643. Allometric curves relating tree trunk diameter to root biomass, depth, and breadth were compiled for mulberry (*Morus* sp.). The curves were based on statistical analyses of measurements made on 29 different-sized trees ranging in age from 2 to 15 yr that had grown from seed in a naturally revegetated former sludge basin containing polyaromatic hydrocarbons. Over a 15-yr period, the curves indicate that the fine root biomass (<1.5 mm diameter) increases 60-fold and, under the right circumstances, can be a part of a root system that reaches a 2-m depth. The fine roots of mulberry were shown to produce several flavonoid compounds at concentrations (ranging from 94 to 525 mug/cm(3)) known to support the growth of organisms capable of degrading xenobiotics. Recognizing the root system as the driver of rhizoremediation, allometry curves presented in this paper can be used to quantify the magnitude of the driver (root system) without damaging plants during the course of a multiyear field study.

Olson, P., and J. Fletcher (1997). The role of phytoremediation in intrinsic bioremediation. The 4th International Petroleum Environmental Conference; Environmental Issues and Solutions in Exploration, Production, and Refining, September 9-12, 1997, San Antonio, TX.

Olson, P., R. Kenneth and E. Pilon-Smits (2003). Rhizosphere Bioremediation of Recalcitrant Organics: Plant-Microbe Interactions and Ecological Perspectives. Phytoremediation.

Olson, R.A. (1994). The transfer of radiocesium from soil to plants and fungi in seminatural ecosystems. Stud. Environ. Sci. 62:265-286.

Olsten, C.J (1992). Bunker hill revegetation - A GIS approach. Pp. 388-400. In L.E. Erickson, S.C. Grant, and J.P. McDonald (eds.), Proceedings of the Conference on Hazardous Waste Research, June 1-2, 1992, Boulder, CO. Engineering Extension, Kansas State University, Manhattan, KS.

Olsthoorn, A.F.M., W.G. Keltjens, B. van Baren, M.C.G. Hopman (1991). Influence of ammonium on fine root development and rhizosphere pH of Douglas-fir seedlings in sand. Plant Soil. 133:75-82.

Omari, K., M. Revitt, et al. (2003). Hydrocarbon removal in an experimental gravel bed constructed wetland. Water Science and Technology 48(5): 275-281. Two outdoor subsurface flow beds (control and experimental, 10 mX1 m) were filled with a substrate of pea gravel (3-6 mm) to a depth of 60 cm. The experimental bed or small-scale constructed wetland was originally planted with *Typha* seedlings at a density of 7.5 plants/m2. Both beds (experimental and control) were treated with the same aqueous concentrations of diesel oil under identical dosing conditions. The average overall hydrocarbon removal efficiencies at the three monitored depths (top, middle and bottom) in the subsurface systems were 80.1+-9.8%, 78.0+-9.1% and 71.6+-10.0% in the experimental bed and 72.3+-11.9%, 69.1+-10.3% and 63.4+-9.4% in the control bed. The differences in the hydrocarbon removal efficiencies between corresponding months in 1999 and 2000 were statistically analysed and are generally not significant. The individual hydrocarbon removal efficiencies exceeded 60% in the top sections of both beds except for C-11 and C-25 with C-23 and C-26 also reduced in the control bed. Overall differences in the removal efficiencies of the planted and the unplanted beds as well as at different depths in both systems, indicate that *Typha* related removal processes complementing adsorption onto the gravel substrate are occurring.

Ona, L. F., A. M. P. Alberto, et al. (2006). Levels of lead in urban soils from selected cities in a central region of the Philippines. Environmental Science and Pollution Research. 13: 177. The objectives of this study were: (1) to determine the levels of Pb in soil from selected urbanized cities in central region of the Philippines; (2) to identify areas with soil Pb concentration values that exceed estimated natural concentrations and allowable limits; and (3) to determine the possible sources that contribute to elevated soil Pb concentration (if any) in the study area. This study was limited to the determination of Pb levels in soils of selected urbanized cities located in central region in the Philippines, namely: Site 1 -- Tarlac City in Tarlac; Site 2 -- Cabanatuan City in Nueva Ecija; Site 3 -- Malolos City in Bulacan; Site 4 -- San Fernando City in Pampanga; Site 5 -- Balanga City in Bataan; and Site 6 -- Olongapo City in Zambales. Soil samples were collected from areas along major thoroughfares regularly traversed by tricycles, passenger jeepneys, cars, vans, trucks, buses, and other motor vehicles. Soil samples were collected from five sampling sites in each of the study areas. Samples from the selected sampling sites were obtained approximately 2 to 3 metres from the road. Analysis of the soil samples for Pb content was conducted using an atomic absorption spectrophotometer. This study was conducted from 2003 to 2004. Since this study assumed that vehicular emission is the major source of Pb contamination in urban soil, other information which the researchers deemed to have bearing on the study were obtained such as relative quantity of each gasoline type disposed in each city within a given period and volume of traffic in each sampling site. A survey questionnaire for gasoline station managers was prepared to determine the relative quantity of each fuel type (diesel, regular gasoline, premium gasoline, and unleaded gasoline) disposed of or sold within a given period in each study area. Analysis of soil samples for Pb content showed the presence of Pb in all the soil samples collected from the 30 sampling sites in the six cities at varying concentrations ranging from 1.5 to 251 mg kg-1. Elevated levels of Pb in soil (i.e. higher than 25 mg kg-1 Pb) were detected in five out of the six cities investigated. Site 4 recorded the highest Pb

concentration (73.9 +- 94.4 mg kg-1), followed by Site 6 (56.3 +- 17.1 mg kg-1), Site 3 (52.0 +- 33.1 mg kg-1), Site 5 (39.3 +- 19.0 mg kg-1), and Site 2 (38.4 +- 33.2 mg kg-1). Soil Pb concentration in Site 1 (16.8 +- 12.2 mg kg-1) was found to be within the estimated natural concentration range of 5 to 25 mg kg-1. Site 1 registered the least Pb concentration. Nonetheless, the average Pb concentration in the soil samples from the six cities studied were all found to be below the maximum tolerable limit according to World Health Organization (WHO) standards. The high Pb concentration in Site 4 may be attributed mainly to vehicular emission. Although Site 4 only ranked 3rd in total volume of vehicles, it has the greatest number of Type B and Type C vehicles combined. Included in these categories are diesel trucks, buses, and jeepneys which are considered the largest contributors of TSP (total suspended particles) and PM10 (particulate matter less than 10 microns) emissions. Only one (San Juan in Site 4) of the thirty sampling sites recorded a Pb concentration beyond the WHO permissible limit of 100 mg kg-1. San Juan in Site 4 had a Pb concentration of > 250 mg kg-1. On the average, elevated Pb concentration was evident in the soil samples from San Fernando, Olongapo, Malolos, Balanga, and Cabanatuan. The average soil Pb concentrations in these cities exceeded the maximum estimated natural soil Pb concentration of 25 mg kg-1. The average soil Pb concentration in Site 1 (16.8 mg kg-1) was well within the estimated natural concentration range of 5 to 25 mg kg-1. Data gathered from the study areas showed that elevated levels of Pb in soil were due primarily to vehicular emissions and partly to igneous activity. The findings of this study presented a preliminary survey on the extent of Pb contamination of soils in urban cities in central region of Philippines Islan .

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O'Neill, W., V. Nzengung. J. Noakes, J. Bender, and P. Phillips (1998). Biodegradation of tetrachloroethylene and trichloroethylene using mixed species microbial mats. Pp. 233-237. In G.B. Wickramanayake and R.E. Hinchee (eds.) Bioremediation and Phytoremediation, Chlorinated and Recalcitrant Compounds. Battelle Press, Columbus, OH.

Orchard, B. J., W. J. Doucette, J. K. Chard and B. Bugbee (2000). A Novel Laboratory System for Determining Fate of Volatile Organic Compounds in Planted Systems. Environmental Toxicology And Chemistry 19(4): 888-894.

Orchard, B. J., W. J. Doucette, J. K. Chard and B. Bugbee (2000). Uptake of Trichloroethylene by Hybrid Poplar Trees Grown Hydroponically in Flow-through Plant Growth Chambers. Environ. Toxicol. Chem. 19(4): 895-903.

O'Riordan, E.G., V.A. Dodd, G.A. Fleming, and H. Tunne (1994). Repeated application of a metal-rich sewage sludge to grassland. 2. Effects on herbage metal levels. Sci. Total. Environ. 121:12-23.

Orlowska, E., P. Ryszka, et al. (2005). Effectiveness of arbuscular mycorrhizal fungal (AMF) strains in colonisation of plants involved in phytostabilisation of zinc wastes. Geoderma. E. Orlowska. 129: 92. The effectiveness of mycorrhizal colonization of four fungal isolates of different origin was tested in roots of *Festuca rubra* L. and *Plantago lanceolata* L. cultivated on three zinc waste substrata of different toxicity. *F. rubra* showed a much better survival rate than *P. lanceolata*. The effectiveness of mycorrhizal colonization varied between the fungal isolates introduced. The highest values of the mycorrhizal parameters were found in roots inoculated with the *Glomus claroideum* strain originating from the industrial waste. Arbuscular richness, assessed in roots stained for viable fungal structures, was demonstrated to be the most sensitive parameter, showing statistically important differences between plants, artificially inoculated and those colonized only by the indigenous mycorrhizal fungi. This parameter was also useful to compare the substrata concerning their toxicity, and the results of the viability tests correlated well with the availability of the heavy metals.

Ortega-Calvo, J. J., A. I. Marchenko, et al. (2003). Chemotaxis in polycyclic aromatic hydrocarbon-degrading bacteria isolated from coal-tar- and oil-polluted rhizospheres. FEMS Microbiology Ecology. J. J.

Ortega-Calvo. 44: 373. The limited mass transfer in polycyclic aromatic hydrocarbon (PAH)-contaminated soils during bioremediation treatments often impedes the achievement of regulatory decontamination end-points. Little is known about bioavailability of these hydrophobic pollutants in phytoremediation systems. This work attempts to evaluate, for the first time, chemotaxis as a bioavailability-promoting trait in PAH-degrading bacteria from the rhizosphere. For this aim, 20 motile strains capable of degrading different PAHs were isolated from rhizosphere soils contaminated with coal tar and oil. Three representative *Pseudomonus* strains were selected, on the basis of their faster growth and/or range of PAHs degraded, for detailed chemotaxis studies with PAHs (naphthalene, phenanthrene, anthracene, and pyrene), bacterial lipopolysaccharide and root exudates from seven different plants. The chemotactic response was quantified with a new densitometric method. The results indicate that chemotaxis is a relevant mobilizing factor for PAH-degrading rhizosphere bacteria.

Orwell, R. L., R. L. Wood, et al. (2004). Removal of benzene by the indoor plant/substrate microcosm and implications for air quality. Water Air and Soil Pollution 157(1-4): 193-207. The quality of the indoor environment has become a major health consideration, since urban-dwellers spend 80-90% of their time indoors, where air pollution can be several times higher than outdoors. 'Indoor' potted-plants can remove air-borne contaminants such as volatile organic compounds (VOCs), over 300 of which have been identified in indoor air. In this study a comparison was made of rates of removal of benzene, as model VOC, by seven potted-plant species/varieties. In static test-chambers, high air-borne doses of benzene were removed within 24 h, once the response had been stimulated ('induced') by an initial dose. Removal rates per pot ranged from 12-27 ppm d(-1) (40 to 88 mg m(-3) d(-1)) (2.5 to 5 times the Australian maximum allowable occupational level). Rates were maintained in light or dark, and rose about linearly with increased dose. Rate comparisons were also made on other plant parameters. Micro-organisms of the potting mix rhizosphere were shown to be the main agents of removal. These studies are the first demonstration of soil microbial VOC degradation from the gaseous phase. With some species the plant also made a measurable contribution to removal rates. The results are consistent with known, mutually supportive plant/soil-micro-organism interactions, and developments in microbially-based 'biofilter reactors' for cleaning VOC-contaminated air. The findings demonstrate the capacity of the potted-plant microcosm to contribute to cleaner indoor air, and lay the foundation for the development of the plant/substrate system as a complementary biofiltration system.

Otte, M. L. and D. L. Jacob (2005). Chemical fingerprinting of plants from contrasting wetlands - Salt marsh, geothermal and mining-impacted. Phyton-Annales Rei Botanicae 45(3): 303-316. The elemental content (up to 57 elements) of sediments and plants (*Phragmites australis*, *Rumex pamiricus* and *Triglochin maritima* from wetlands contrasting in element composition (mining area, geothermal spring, salt marsh) from a wide geographic range (USA, Ireland, Kyrgyz Republic) was investigated. The element composition of the plants did not reflect that of the sediments. Comparison to Markert's 'reference plant' showed that the concentrations of B, Ba, Co, Cu, Ga, Mg, Mn, Pb, Rb, Sr, Y, Zn and most lanthanides were very similar (less than threefold variation) among the three species, regardless of origin. The elements Na, Th and U were accumulated to much higher levels than the 'reference plant' in all three species, indicating their potential for phytoremediation and phytomining purposes.

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Otte, M.L., C.C. Kearns, and M.O. Doyle (1995). Accumulation of arsenic and zinc in the rhizosphere of wetland plants. Bull. Environ. Contam. Toxicol. 55:154-161.

Otte, M.L., M.S. Haarsma, R.A. Broekman, and J. Rozema (1993). Relation between heavy metal concentrations in salt marsh plants and soil. Environ. Pollut. 82(1):13-22.

Ouerdane, L., S. Mari, et al. (2006). Speciation of non-covalent nickel species in plant tissue extracts by electrospray Q-TOFMS/MS after their isolation by 2D size exclusion-hydrophilic interaction LC (SEC-HILIC) monitored by ICP-MS. Journal of Analytical Atomic Spectrometry 21(7): 676-683. An original approach based on successive size-exclusion and hydrophilic interaction HPLC (HILIC) was developed to

purify traces of Ni species from a plant aqueous extract. The degree of purity achieved was for the first time sufficient for the identification, in a natural sample, of a number of non-covalent metal complexes by electrospray Q-TOFMS/MS. Nickel complexes with malate, citrate, histidine, EDTA and nicotianamine (NA) were identified in the roots, xylem, shoots and their protoplasts of a metal hyperaccumulator plant *Thlaspi caerulescens*. The quantitative recovery of the most stable of these complexes (with EDTA and NA) allowed their quantitative determination by SEC-ICP-MS.

Ouyang, Y. (2005). Phytoextraction: simulating uptake and translocation of arsenic in a soil-plant system. International Journal of Phytoremediation. 7: 3. The uptake, transport, and accumulation of metals by plants are functions central to successful phytoextraction. This study investigates the uptake and translocation of arsenic from a contaminated sandy soil by a mature Chinese brake fern (*Pteris vittata* L.). An existing mathematical model for the coupled transport of water, heat, and solutes in the soil-plant-atmosphere continuum (CTSPAC) was modified to examine the flow of water as well as the uptake and translocation of total arsenic in the xylem of the fern. This model was calibrated using greenhouse measurements before its application. Simulation results showed that about 20% of the soil arsenic was removed by the fern in 10 d, of which about 90% of the arsenic was stored in the fronds and 10% in the roots. Although arsenic mass in the plant tissues increased consecutively with time, arsenic concentration in the xylem sap of the root tips has a typical diurnal distribution pattern: increasing during the day and decreasing at night, resulting from daily variations of frond surface water transpiration. The largest difference in simulated arsenic concentration in the root tips between the day and night was about 5%. This study also suggests that the use of transpiration stream concentration factor (TSCF), which is defined as the ratio of chemical concentration in the xylem sap to that in the external solution, to evaluate the translocation efficiency of arsenic for the hyperaccumulator Chinese brake fern (*Pteris vittata* L.) could be limited.

Ouyang, Y., D. Shinde, et al. (2005). Simulation of phytoremediation of a TNT-contaminated soil using the CTSPAC model. Journal of Environmental Quality 34(5): 1490-1496. Knowledge of water movement in the plant-xylem system and contaminant bioavailability in the soil environment is crucial to evaluate the success of phytoremediation practices. This study investigated the removal of 2,4,6-trinitrotoluene (TNT) from a contaminated sandy soil by a single poplar (*Populus* fastigiata) tree through the examinations of temporal variations of xylem water potential, root water uptake, and soil TNT bioavailabiNty. A mathematical model, CTSPAC (Coupled Transport of water, heat, and solutes in the Soil-Plant-Atmosphere Continuum), was modified for the purpose of this study. The model was calibrated using laboratory measurements before its application. Our simulations show that the xylem water potential was high in the roots and low in the leaves with a potential head difference of 3.55 cm H2O, which created a driving force for water flow and chemical transport upward from the roots through the stem to the leaves. The daily average root water uptake rate was 25 cm(3) h(-1) when an equilibrium condition was reached after 24 h. Our simulations further reveal that no TNT was found in the stem and leaves and only about 1% of total TNT mass was observed in the roots due to the rapid biodegradation and transformation of TNT into its daughter products. About 13% of the soil TNT was removed by the poplar tree, resulting mainly from root uptake since TNT is a recalcitrant compound. In general, the soil TNT bioavailability decreased with time due to the depletion of soil solution TNT by the poplar tree. A constant bioavailability (i.e., 3.1 X 10(-6)) was obtained in 14d in which the soil TNT concentration was about 10 mg L-1. Our study suggests that CTSPAC is a useful model to simulate phytoremediation of TNT-contaminated sites.

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Ow, D.W. (1993). Phytochelatin-mediated cadmium tolerance in *Schizosaccaromyces pombe*. In Vitro Cell. Devel. Biol.- J. Tissue Cult. Assoc. 29P:213-219.

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Oyabu, T., K. Takenaka, et al. (2003). Purification characteristics of golden pothos for atmospheric gasoline. International Journal of Phytoremediation 5(3): 267-276. Previous studies have shown that plants have the ability to purify various atmospheric chemicals. Gasoline is one of the more serious pollutants. Soil and atmospheric pollution caused by gasoline is increasing due to the widespread use of automobiles. In this article, the purification characteristic of the pothos plant for atmospheric gasoline is investigated using a tin oxide gas sensor. The purification rate (P-r), defined as the purification ability per hour as described by a differential coefficient, has a maximum value at longer time intervals as the pollutant concentration becomes higher. P-r can be represented by an exponential function of lapsed time and its characteristic in soil is similar. A golden pothos plant growing in a 30-cm diameter pot of was placed in a 300-l experimental chamber to examine its purification ability. P-r had a maximum value 40 h after a 0.04-ml injection of gasoline into the chamber. The total purification ability (P-a) is also used in this study and is derived using the peak value (h) and the full width (t(w)) at half maximum of the tin oxide gas-sensor characteristic, namely P-a = h/t(w) x 100. The P-a of the pothos for gasoline was about 7, with the value decreasing as the pollutant concentration increased.

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