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on
ENVIRONMENTAL BIOTECHNOLOGY

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BACKGROUND

Environmental Information System (ENVIS) is established in the year 1984 as a network of Information Centre. It is planned by the Ministry of Environment and Forest. Aim of this centre is to provide descriptive data and environmental subject related numerical data. Now 75 centres are working under this network on various subjects area in the country. The focal point of this network is at the Ministry of Environmental and Forest, Government of India, New Delhi.

EMCB-ENVIS Centre is established for studies on Environmental Biotechnology as Pollutant Degradation at the University of Kalyani, Department of Environmental Science, Nadia-741235, West Bengal.

The objective of this centre is to collect data, related to the above mentioned subject, from different major libraries in Kolkata with different journals, Annual reviews, Internet and to generate a database and to create a website with this database. View point of this journal abstract is to help the interested research workers, scientist, administrator and the public.

This is the 6th publication of this ENVIS Centre. This contains the abstract of research papers collected in the area of Environmental Biotechnology from various journals published during June 2004 onwards. Here various topics like Bio-engineering, Bio-degradation, Bio-remediation, Bio-transformation etc. are covered. We are grateful to the various libraries and their staff for their extended cooperation in the collection of the articles.

Abstract Format

The format of the abstract is as follows:

Abstract : The abstracts were arranged in alphabetic orders different subheads.

Author : Name of the authors are given in the order in which they appear in the original document. These names are given in succession.

Address of Authors: Address of the author is given in parenthesis at the end of the author name. When the address of any other author is found, it is written after wards delimited by stop(.).

Locus : The name of the journal are followed by the volume number, the issue number, the year of publication and the page no.

GENERAL INFORMATION

Abstract have been taken directly from source document like research report, journals, internet, seminars, proceedings, standards and patents. All the resources published within the year 2004-2005.

Abstract are broadly classified and arranged under the following heads:

Bioaccumulation: It studies address the buildup of bioaccumulative compounds through biomagnification and/or bioconcentration. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted. Understanding the dynamic process of bioaccumulation is very important in protecting human beings and other organisms from the adverse effects of chemical exposure, and it has become a critical consideration in the regulation of chemicals.

Bioremediation: It is a clean-up technology that uses naturally occurring microorganisms to degrade hazardous substances into less toxic or nontoxic compounds. These microorganisms may:

1. Ingest and degrade organic substances as their food and energy source,
2. Degrade organic substances, such as chlorinated solvents or petroleum products, that are hazardous to living organisms, including humans, and degrade the organic contaminants into inert products.

Because the microorganisms already occur naturally in the environment they pose no contamination risk.

Bio-Transformation: This is a process of Biological changes of complex compound to simpler toxic to non-toxic or vice-versa. Several microorganism are capable of transforming a variety of compound founding nature but generally with respect to synthetic compound they are unable to show any appropriate action. Biotransfer appears to be one of the major detoxication method known so far.

Biomarker: It is a biological response to a chemical that gives a measure of exposure and, sometimes, of toxic effect. Biological markers found in crude oils and source rock extracts can provide molecular evidence of the correlation among oils and their sources.

Biofertilizer: To reduce the impact of excess chemical fertilizers in the field of agriculture the biofertilizer is a potential tool, biologically fixed nitrogen is such a source

which can supply an adequate amount of Nitrogen to plants and other nutrients to some extent. Many free living and symbiotic bacteria which fix atmospheric Nitrogen were used as biofertiliser material as a substitute for Nitrogen fertilizer. In general two types of biofertiliser are used

1. Bacterial Biofertilizer
2. Algal Biofertilizer

Biocomposting: It involves combining organic materials under conditions that enables them to decompose more quickly than they would in nature. Think about logs and leaves on the ground in a forest. The leaves will break down and disappear within a year. Logs of course will take much longer to crumble away. Composting involves combining organic materials under conditions that enables them to decompose more quickly than they would in nature.

Biopesticide: pest control by biological antagonism appears to be very useful tool in recent years. Bacterial pesticides are being developed. *Heliothis* complex, which lives in close association with plant roots, consists of two major crop pests budworm and ball worm. Biological insecticides against both these insects are being prepared by transfer of a gene from *Bacillus thuringiensis*

Biodegradation: It is nature's way of recycling wastes, breaking down organic matter into nutrients that can be used by other organisms. "Degradation" means decay, and the "bio-" prefix means that the decay is carried out by a huge assortment of bacteria, fungi, maggots, worms, and other organisms that eat dead material and recycle it into new forms.

In nature, there is no waste because everything gets recycled. The waste products from one organism become the food for others, providing nutrients and energy while breaking down the waste organic matter. Some organic materials will break down much faster than others, but all will eventually decay.

By harnessing these natural forces of biodegradation, people can reduce wastes and clean up some types of environmental contaminants. Through **composting**, we accelerate natural biodegradation and convert organic wastes to a valuable resource.

Biosensor: Biosensor represents biophysical devices which will detect the presence and measure the quantities of specific substances in a variety of environments. These specific substances may include sugars, proteins, or humas and variety of toxins in the industrial effluents. In designing a biosensor an enzyme or an antibody or even microbial cells are associated with microchip devices which are used for quantitative estimate of a substance.

Bioengineering: It is a developing speciality featuring a multidisciplinary approach to the solution of problems in medicine and biology, based on the application of advances in science, engineering and technology. A major focus for bioengineering is to improve the quality of life of people with medical conditions that restrict independent living and integration within the community.

Pollen-Biotechnology: This is a new field of science dealing with the pollen chemistry allergenicity of aerospora. This subject also covers genetic manipulation of pollen development of haploid culture. Such haploid plants have various values in genetic research.

Biotechnology Policy Issue: Biotechnology appears to be an emerging science in present decades. Genetic manipulation and development of genetically modified organisms in human welfare is now showing a potential prospect and risk. Thus researches and application of Biotechnology in diverse fields is a major policy issue in the present decades.

Agricultural Biotechnology: Over the years tremendous success was made in diverse fields of agriculture by applying Biotechnology. It includes development of genetically modified crops, genetic improvement in sericulture practices, improvement in Biofertilizer development and similar other aspects. Crop production against pest and disease stress resistance of crops is also considered to be an emerging area of Agricultural Biotechnology.

Bioenergy: In recent decades, efforts were made for evolving non-polluting bioenergy sources or energy generation from organic waste or biomass. These are all ecofriendly solutions. Biomass energy supply demand balances have become a component of energy sector analysis and planning and assumed greater importance in countries. These are various biological energy sources. Biomass, Biogas, Hydrogen are examples of Bioenergy.

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

Acad	Academy	Chem	Chemistry
Adm	Administration	Chemi	Chemical
Admn	Administrative	Clini	Clinical
Adv	Advance	Co	Company
Agric	Agriculture	Coil	College
Agrici	Agricultural	Comm	Committee
Amer,	American	Commn	Commission
An	Annual	Comp	Comparative
Analyt	Analytical	Conf	Conference
Anat	Anatomy	Conv	Convention
Anim	Animal	Conserv	Conservation
Ann	Annals	Conti	Control
Appt	Applied	Contam	Contamination
Arch	Archives	Corp	Corporation
Archaeo	Archaeology	Coun	Council
Archaeol	Archaeological	Cult	Culture
Architect	Architecture	Cultl	Cultural
Assoc	Association	Curr	Current
Asst	Assistant	Dept	Department
Atom	Atomic	Dev	Development
Bacterio	Bacteriology	Develop	Developmental
Bacteriol	Bacteriological	Dig	Digest
Bd	Board	Div	Division
Bio	Biology	Divl	Divisional
Biochem	Biochemistry	Dte	Directorate
Biochemi	Biochemical	Dy	Deputy
Bioengng	Bioengineering	Eco	Ecology
Biol	Biological	Ecol	Ecological
Biometeo	Biometeorology	Econ	Economics
Biophys	Biophysics	Ecosys	Ecosystem
Biometeol	Biometeorological	Exotoxico	Ecotoxicology
Biotech	Biotechnology(s)	Endocrinol	Endocrinological
Biotechno	Biotechnology	Engng	Engineering
Biotechnol	Biotechnological	Engrs	Engineers
Bidg	Building	Env	Environment
Bot	Botany	Environ	Environmental
Boti	Botanical	Epidemic	Epidemiology
Br	Branch	Epidemiol	Epidemiological
Bull	Bulletin	Estb	Establishment
Cent	Centre	Ethnopharmaco	Ethnopharmacology
Centl	Central	Exot	Experiment

Expti	Experimental	Microbiol	Microbiological
Fac	Faculty	Min	Ministry
Fd	Food	Monit	Monitoring
Fedn	Federation	Myco	Mycology
Fert	Fertiliser	Mycol	Mycological
Fmg	Farming	Nat	Natural
Gaz	Gazette	Natl	National
Genet	Genetics	N-E	North Eastern
Geo	Geology	Nut	Nutrition
Geogr	Geography	No	Number
Geogri	Geographical	Occ	Occassional
Geol	Geological	Occupl	Occupational
Geosci	Geoscience	Oceanogr	Oceanogoraphy
Govt	Government	Org	Organic
Hist	History	Orgn	Organisation
Hlth	Health	Pharmaco	Pharmacology
Hort	Horticulture	Pharmacol	Pharmacological
Hosp	Hospital	Phyl	Physical
Hydro	Hydrology	Patho	Pathology
Hydrol	Hydrological	Pathol	Pathological
Immuno	Immunology	Petrochemi	Petrochemical
Immunol	Immunological	Petro	Petrology
Ind	Industry	PG	Post Graduate
Inf	Information	Phys	Physics
Inst	Institute	Physio	Physiology
Instn	Institution	Phytopath	Phytopathology
Int	International	Phytopathol	Phytopathological
Irrig	Irrigation	Plang	Planning
J	Journal	Polln	Pollution
Lab	Laboratory	Proc	Proceedings
Lett	Letter(s)	Prot	Protection
Ltd	Limited	Pub	Publication
Malario	Malariology	Pvt	Private
Malariol	Malariological	Qlty	Quality
Manag	Management	Qr	Quarter
Med	Medicine	Rad	Radiation
Medl	Medical	Radio	Radiology
Metab	Metabolism	Radiol	Radiological
Metall	Metallurgy	Rd	Road
Metallurg	Metallurgical	Recd	Received
Meteo	Meteorology	Reg	Region
Meteol	Meteorological	Regl	Regional
Microbio	Microbiology		

Rep	Report	Stud	Studies
Reptr	Reporter	Surv	Survey
Res	Research	Syst	System
Rev	Review	Tax	Taxonomy
Sch	School(s)	Techi	Technical
Sci	Sciences(s)	Techno	Technology
Scient	Scientific	Technol	Technological
S-E	South East	Toxico	Toxicology
Sec	Section	Toxicol	Toxicological
Sect	Sector	Trans	Transcations
Semin	Seminar	Trans	Transportation
Ser	Services	Tmg	Training
Soc	Society	Trop	Tropical
Sod	Social	Univ	University
Stat	Statistics	Util	Utilisation
Stati	Statistical	Vet	Veterinary
Stand	Standard(s)	Zoo	Zoology
Std	Study	Zool	Zoological

Bioaccumulation

Watanabe MX, Iwata H, Watanabe M, Tanabe S, Subramanian A, Yoneda K, Hashimoto T. (Center for Marine Environmental Studies, Ehime University, Bunkyo-cho 2-5, Matsuyama 790-8577, Japan.), Bioaccumulation of organochlorines in crows from an indian open waste dumping site: evidence for direct transfer of dioxin-like congeners from the contaminated soil. Environ Sci Technol, 39(12) (2005): 4421-30.

To assess the significance of waste dumping sites as a source of chemical contamination to ecosystems, we analyzed the residue levels of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), and other organochlorines in the breast muscle of crows from a dumping site in the south of Chennai city, South India. Crows from the dumping site contained significantly higher total TEQs (60 +/- 27 pg/g lipid wt) than those from the reference sites (26 +/- 18 pg/g lipid wt). Especially, certain dioxin-like coplanar PCB congeners (Co-PCBs), such as CB-77 and CB-105, whose source is commercial PCBs, were significantly higher in crows from the dumping site than those from the reference sites. Profiles of PCDDs/DFs and Co-PCBs in crows from the dumping site were similar to those of soil at the same site, which was confirmed by principal component analysis. Furthermore, significant positive correlations were obtained between the congener-specific bioconcentration factors (BCFs) of PCDDs/DFs estimated from concentrations in crows and soil from the dumping site and the theoretical BCFs calculated from water-particle and lipid-water partitioning coefficients. On the other hand, the estimated BCFs had significant negative correlations with the molecular weight of PCDDs/DFs, indicating that molecular size limits their bioaccumulation. These results suggest that dioxin-like congeners in the soil of the dumping site were transferred directly to the crows through the ingestion of on-site garbage contaminated with soil, rather than through trophic transfer in the ecosystem. The present study provides insight into the ecological impacts of dumping sites.

Chang P, Kim JY, Kim KW. (Joint Programme on Science and Technology for Sustainability, (UNU/GIST), Gwangju Institute of Science and Technology (GIST), South Korea.), Concentrations of arsenic and heavy metals in vegetation at two abandoned mine tailings in South Korea. Environ Geochem Health, 27(2) (2005): 109-19.

Untreated abandoned mines may result in hazards to ecosystems due to dispersion of various toxic elements such as arsenic (As) and lead (Pb). Phytoremediation is an alternative of remediation for large scale mine dumps. Plant species were sampled from two abandoned gold (Au) mines in South Korea. Plant samples were digested following the guidelines of US EPA Method 3050 (US-EPA, 1996) and analyzed by inductively coupled plasma mass spectrometry (ICP-MS). Concentrations and bioaccumulation factors of plants are reported and out-performing species are summarized. Poplar trees (*Populus davidiana*) growing on the Myoungbong tailings were suggested to be a potential species for revegetation of large scale Au mine tailings. Arsenic accumulations of bracken ferns (*Pteridium aquilinum*) sampled from the Duckum tailings were far lower than those of the reported hyperaccumulators, but the possible chronic adverse effects on residents through daily diet are of concern.

Monperrus M, Point D, Grall J, Chauvaud L, Amouroux D, Bareille G, Donard O. (Laboratoire de Chimie Analytique Bio-inorganique et Environnement, CNRS UMR 5034, Universite de Pau et des Pays de l'Adour, Helioparc, 64053 Pau, France.) Determination of metal and organometal trophic bioaccumulation in the benthic macrofauna of the Adour estuary coastal zone (SW France, Bay of Biscay). J Environ Monit,7(7) (2005): 693-700.

A multidisciplinary approach has been adopted in order to investigate the bioaccumulation of metals and organometals in macrobenthic populations. A complete method coupling a sampling strategy and classification of benthic organisms with a performant analytical procedure for the analysis of both metals and organometals has been developed. A single sample preparation method using a TMAH extraction and species specific isotope dilution makes it possible to analyse metals and organometals in the same extract, which is especially interesting for situations where only a limited amount of sample is available. Low detection limits have been obtained in the range of 12-250 pg g⁻¹ for mercury and butyltin compounds and 0.4-50 ng g⁻¹ for metals with good precision (1-10% RSD) even for a very low mass of sample (0.02 g). This method has been applied for monitoring contamination and bioaccumulation of metals and organometals as well as the biodiversity and trophic structure of the macrobenthic population of the Adour Estuary (South-West, France). The benthic macrofauna diversity indicates that inner estuarine stations are moderately polluted whereas outer estuarine stations are less impacted. However, metals concentrations in both sediment and benthic biomass do not change drastically between stations. Moreover, the bioaccumulation has been determined in relation to the feeding guild of benthic organisms. The results demonstrate that higher bioaccumulation is generally observed for deposit feeders directly impacted by sediment contamination compared to suspensive feeders and predators. Biomagnification along the trophic levels was highlighted for MMHg but no significant trend was observed for the other metallic compounds.

Darling CT, Thomas VG. (Department of Zoology, College of Biological Science, University of Guelph, Guelph, Ontario, Canada N1G 2W1.) Lead bioaccumulation in earthworms, *Lumbricus terrestris*, from exposure to lead compounds of differing solubility. Sci Total Environ, 346(1-3) (2005): 70-80.

This study examined the relative effects of soluble and less soluble Pb compounds on Pb accumulation by *Lumbricus terrestris*. The earthworms were exposed to composted cattle manure contaminated with a range of concentrations of either soluble lead acetate trihydrate (PbAc) (14.5, 72.2, 137, 257, and 603 microg/g) or less soluble lead carbonate (Pb(CO₃)(₂)) (5.09, 171, 575, and 710 microg/g). Relative Pb bioaccumulation rates in earthworms from the PbAc and Pb(CO₃)(₂) lead carbonate trials were compared over time (0, 20, 40, and 60 days). The two molecular forms of Pb were heavily adsorbed onto the organic matter. Relative soluble Pb concentrations in the manure pore water were very low, at 0.049% and 0.022% of total Pb for PbAc and Pb(CO₃)(₂), respectively. There was a significant uptake of lead by earthworms from both the readily soluble and less soluble forms of Pb. Regression surfaces relating organic matter total Pb concentration to exposure time and Pb body burden were compared. For the PbAc trial, the following equation was fitted: Body burden=2.3429+0.0014 x-0.0632 y+0.0008 xy (R(2)=0.8494, p<0.0001). For the Pb(CO₃)(₂) trial, the equation was: Body burden=-2.0760--0.0067 x-0.2297 y-0.0038 y(2)+0.0003 xy (R(2)=0.5686, p<0.0001) (for x=organic matter Pb concentration in microg/g and y=time in days). The Pb bioaccumulation resulting from

the PbAc exposure was significantly higher than that from Pb(CO₃)(₂). Body burdens of earthworms exposed to PbAc were linearly related to exposure time and total Pb concentration. Worms exposed to Pb(CO₃)(₂) had non-linear Pb accumulation over time that suggested a decrease in Pb bioavailability with increasing exposure time. The results indicate that *L. terrestris* feeding on detritus in the upper soil levels can mobilize and accumulate Pb from the principal transformation products of metallic Pb, as at shooting ranges and lead smelter sites.

Gourlay C, Mouchel JM, Tusseau-Vuillemin MH, Garric J. (Cemagref, UR Hydrosystemes et Bioprocedes, Parc de Tourvoie, BP 44, 92163 Antony cedex, France. catherine.gourley@cemagref.fr), Influence of algal and bacterial particulate organic matter on benzo[a]pyrene bioaccumulation in *Daphnia magna*. *Sci Total Environ.*, 346(1-3) (2005): 220-30.

In order to better assess the influence of organic matter on the bioavailability of hydrophobic organic contaminants, the effect of algae and POM of bacterial origin on the bioaccumulation of benzo[a]pyrene in *Daphnia magna* was evaluated. The bioaccumulation was monitored with increasing concentrations of particulate organic matter (POM) and dissolved organic matter (DOM). In all experiments, the presence of POM greatly reduced the bioaccumulation of benzo[a]pyrene. The reduction was more pronounced in the presence of algae, for which we observed a 99%-reduction effect in the presence of 6×10^5 cell/mL (equivalent to 5.3 mg C/L). The bioaccumulation of benzo[a]pyrene was decreased by 49% by organic matter of bacterial origin at 4.7 mg C/L. Assuming that benzo[a]pyrene was partitioned between water, DOM and POM and supposing that *D. magna* accumulated free benzo[a]pyrene via respiration and POM-bound benzo[a]pyrene via ingestion, bioaccumulation data allowed to estimate the dietary uptake rate of benzo[a]pyrene as well as partitioning coefficients K(POC) and K(DOC). Despite the ingestion of contaminated particles, we could not observe any dietary uptake of benzo[a]pyrene in daphnids. We verified, as usually supposed, that the bioaccumulation of benzo[a]pyrene to *D. magna* occurs mainly via direct contact. Very high partitioning coefficients (log K(POC) between 5.2 and 6.2) were estimated. This study pointed out the great influence of biogenic organic matter on the fate and the bioavailability of benzo[a]pyrene in aquatic ecosystems.

Ortiz O, Alcaniz JM. (Centre de Recerca Ecologica i Aplicacions Forestals (CREAF)-Unitat d'Ecologia, Facultat de Ciències, Universitat Autònoma de Barcelona, E08193 Bellaterra, Spain.) Bioaccumulation of heavy metals in *Dactylis glomerata* L. growing in a calcareous soil amended with sewage sludge. *Bioresour Technol.*, (Jun 11, 2005)

The total and DTPA-extractable concentrations of Pb, Ni, Zn, Cu, Cr and Cd were measured in a calcareous soil amended with different doses of sewage sludge under field conditions. The same metals were also measured in the roots and leaves of *Dactylis glomerata* at the end of the first vegetative period after the sludge was added. The root concentrations of all the metals were unrelated to their concentrations in the soil. Leaf concentrations of Zn and Cr correlated with total (Zn) and DTPA-extractable (Zn and Cr) concentrations in the soil. DTPA extraction did not appear to be very useful for evaluating the bioavailability of metals in this kind of soil as it gave very low correlation coefficients with leaf content ($r=0.684$, $P=0.0049$ for Zn and $r=0.557$,

P=0.0249 for Cr). Concentrations of Pb, Ni, Cu, and Cd in roots and leaves of *Dactylis glomerata* were unrelated to the total or DTPA-extractable concentrations in the sludge-amended soil.

Borga K, Bidleman TF. (Norwegian Polar Institute, Polar Environmental Centre, N-9296 Tromsø, Norway. katrine.borga@npolar.no) Enantiomer fractions of organic chlorinated pesticides in arctic marine ice fauna, zooplankton, and benthos. *Environ Sci Technol.*, **39(10) (2005): 3464 -3473.**

Stereoisomers of chiral chlorinated pesticides (α -HCH (HCH = hexachlorocyclohexane), trans- and cis-chlordane, MC5, o,p'-DDT) were quantified in arctic marine invertebrates (ice-associated amphipods *Gammarus wilkitzkii*, pelagic copepods *Calanus hyperboreus*, krill *Thysanoessa inermis*, and amphipods *Themisto libellula*, and benthic amphipods *Paramphithoe hystrix*). Enantiomer fractions (EFs) were calculated to investigate the influence of habitat, geographic area, and diet on selective bioaccumulation of the (-)- or (+)-enantiomer. Depletion of the (+)- α -HCH enantiomer increased from ice fauna to zooplankton to benthos, corresponding to previous reports of EF variations with depth. Chlordanes and o,p'-DDT also showed the strongest enantioselective bioaccumulation in benthic amphipods and less so in zooplankton and ice fauna, which had closer to racemic EFs. Neither diet nor geographic area explained EF differences among samples. Nonracemic EFs in benthos may be related to stereoselective biotransformation, but is most likely reflecting vertical distribution of EFs in the water column and sediments, as demonstrated earlier for α -HCH in the Canadian and European Arctic.

Chen CY, Stemberger RS, Kamman NC, Mayes BM, Folt CL. (Department of Biological Sciences, Dartmouth College Hanover, NH 03755, USA. celia.chen@dartmouth.edu), Patterns of Hg bioaccumulation and transfer in aquatic food webs across multi-lake studies in the northeast US. *Ecotoxicology.*, **14(1-2) (2005): 135-47.**

The northeastern USA receives some of the highest levels of atmospheric mercury deposition of any region in North America. Moreover, fish from many lakes in this region carry Hg burdens that present health risks to both human and wildlife consumers. The overarching goal of this study was to identify the attributes of lakes in this region that are most likely associated with high Hg burdens in fish. To accomplish this, we compared data collected in four separate multi-lake studies. Correlations among Hg in fish (4 studies) or in zooplankton and fish (2 studies) and numerous chemical, physical, land use, and ecological variables were compared across more than 150 lakes. The analysis produced three general findings. First, the most important predictors of Hg burdens in fish were similar among datasets. As found in past studies, key chemical covariates (e.g., pH, acid neutralizing capacity, and SO₄) were negatively correlated with Hg bioaccumulation in the biota. However, negative correlations with several parameters that have not been previously identified (e.g., human land use variables and zooplankton density) were also found to be equally important predictors. Second, certain predictors were unique to individual datasets and differences in lake population characteristics, sampling protocols, and fish species in each study likely explained some of the contrasting results that we found in the analyses. Third, lakes with high rates of Hg bioaccumulation and trophic transfer have low pH and low productivity with relatively undisturbed watersheds suggesting that atmospheric

deposition of Hg is the dominant or sole source of input. This study highlights several fundamental complexities when comparing datasets over different environmental conditions but also underscores the utility of such comparisons for revealing key drivers of Hg trophic transfer among different types of lakes.

Mitrovic SM, Allis O, Furey A, James KJ. (PROTEOBIO Mass Spectrometry Centre for Proteomics and Biotxin Research, Department of Chemistry, Cork Institute of Technology, Rossa Ave, Bishopstown, Cork, Ireland. simon.mitrovic@dipnr.nsw.gov.au), Bioaccumulation and harmful effects of microcystin-LR in the aquatic plants *Lemna minor* and *Wolffia arrhiza* and the filamentous alga *Chladophora fracta*. *Ecotoxicol Environ Saf.*,61(3) (2005): 345-52.

Although the toxic effects of cyanotoxins on animals have been examined extensively, little research has focused on their effects on higher plants and macroalgae, and the potential for bioaccumulation in the food web through plants. Two aquatic plants, *Lemna minor* and *Wolffia arrhiza*, and one filamentous alga, *Chladophora fracta*, were exposed to the cyanotoxin microcystin-LR. Growth of *L. minor* (as weight and frond number) and root length were significantly reduced and peroxidase activity was significantly increased after 5 days of exposure to concentrations of 10 and 20 microg mL⁻¹ microcystin-LR. Growth of *W. arrhiza* (as frond number) was significantly reduced after 5 days of exposure to 15 microg mL⁻¹ microcystin-LR. Growth and peroxidase activity of *C. fracta* were not affected by microcystin-LR at concentrations up to 10 microg mL⁻¹. *L. minor* also accumulated microcystin-LR up to a concentration of 0.288 +/- 0.009 ng mg⁻¹ wet wt. plant material over the 5 days of the experiment, equivalent to an accumulation rate of 0.058 ng mg⁻¹ day⁻¹. *C. fracta* accumulated a microcystin-LR concentration of 0.042 +/- 0.015 ng mg⁻¹ wet wt. plant material over the 5 days of the experiment, equivalent to an accumulation rate of 0.008 ng mg⁻¹ day⁻¹.

Satyanarayan S, Ramakant, Satyanarayan A. (National Environmental Engineering Research Institute, Nagpur, India. dr_shantasa@rediffmail.com), Bioaccumulation studies of organochlorinated pesticides in tissues of *Cyprinus carpio*. *J Environ Sci Health B.*, 40(3) (2005): 397-412.

Freshwater fish *Cyprinus carpio* was selected for the study of bioaccumulation of organochlorinated pesticides in tissues like gills, muscle, intestine, kidney, and liver in a continuous fed system. The pesticides used were Aldrin, Dieldrin, BHC, and DDT. The bioaccumulation of Dieldrin was maximum of 85.0 microg g⁻¹ wet weight in liver tissue while minimum of 7.30 microg g⁻¹ wet weight for DDT at 30 days exposure time. Bioconcentration factor (BCF) has followed the same trend in liver tissue for Dieldrin and DDT. The rate of bioaccumulation was found to be maximum of 4.3879 microg g⁻¹ wet weight in liver tissue and minimum of 0.0021 microg g⁻¹ wet weight in gill tissue for 30 days exposure. As evidenced by the increasing values of BCF, pesticide uptake also showed increased trend with the increase in exposure time. A high correlation coefficient ranging between 0.7247 and 0.9616 between the pesticide concentration and exposure time was observed. Based on actual BCF values, log Kow were calculated and the values are well within the reported values of 6.5

indicating efficient relationship between BCF and log Kow because beyond the 6.5 the bioconcentration levels off.

Xie L, Xie P, Guo L, Li L, Miyabara Y, Park HD. (Department of Environmental Science, Faculty of Science, Shinshu University, Matsumoto 390-8621, Japan.), Organ distribution and bioaccumulation of microcystins in freshwater fish at different trophic levels from the eutrophic Lake Chaohu, China. Environ Toxicol., 20(3) (2005): 293-300.

This article reports the organ distribution and bioaccumulation of hepatotoxic microcystins (MCs) in freshwater fishes at different trophic levels from the large, shallow, eutrophic Lake Chaohu in September 2003, when there were heavy surface blooms of toxic cyanobacteria. Among all fish, intestines and blood had the highest average content of MC-RR + MC-LR (22.0 and 14.5 microg g(-1) DW, respectively), followed by liver, bile, and kidney (7.77, 6.32, and 5.81 microg g(-1) DW, respectively), whereas muscle had the least (1.81 microg g(-1) DW). MC content in muscle was highest in carnivorous fish (*Culter ilishaeformis*, 2.22 microg g(-1) DW) and omnivorous fish (*Carassius auratus*, 1.96 microg g(-1) DW) and was lowest in phytoplanktivorous fish (*Hypophthalmichthys molitrix*, 1.65 microg g(-1) DW) and herbivorous fish (*Parabramis pekinensis* 0.660 microg g(-1) DW). However, the amount of MC in the gut of *H. molitrix* (137 microg g(-1) DW) was more than 20 times that in the other fish (<6.50 microg g(-1) DW). The MCs showed a tendency to accumulate up the food chain, and piscivorous fish at the top of the food chain were at high risk of exposure to MCs in Lake Chaohu. Our study is the first to report MC concentrations in the bile and blood of wild fish. One hundred grams of fish muscle would contain 2.64-49.7 microg of MC-LR equivalent, or about 1.3-25 times the recommended tolerable daily intake of MC-LR by humans, indicating that fish are already severely contaminated by MCs and that the local authorities should warn the public of the risk of poisoning by eating the contaminated fish. (c) 2005 Wiley Periodicals, Inc.

Dusek L, Svobodova Z, Janouskova D, Vykusova B, Jarkovsky J, Smid R, Pavlis P. (RECETOX, Faculty of Science, Masaryk University, Kamenice 126/3, 625 00 Brno, Czech Republic. dusek@cba.muni.cz), Bioaccumulation of mercury in muscle tissue of fish in the Elbe River (Czech Republic): multispecies monitoring study 1991-1996. Ecotoxicol Environ Saf., 61(2) (2005): 256-67.

The study monitored mercury (Hg) contamination of fish muscle tissue at 13 geographical sites that can be regarded as crucial points for an ecotoxicological assessment of the Czech Republic section of the Elbe River. The descriptive part of the study was primarily aimed at comparative evaluation of the Hg load during the period 1991-1996. The conclusions were supported by multivariate statistical analyses of the content of Hg in the muscle tissue of 1251 fish belonging to 23 species with four dominant indicator species: *Perca fluviatilis* (n=163), *Abramis brama* (n=173), *Rutilus rutilus* (n=148), and *Leuciscus cephalus* (n=166). Considering data from 3- to 5-year-old fish, significantly increased contamination was detected in typical predators compared to the other fish species in all sites (P<0.001). On the other hand, omnivorous and planctivorous species were ranked as the least sensitive for Hg pollution. Perch appeared to be the most contaminated species in the sample with muscle Hg concentration in the range of 0.840-1.398 mg Hg kg(-1). Although less contaminated than perch, muscle contamination of bream

sensitively separated differently contaminated sites; the highest load ranged from 0.368 to 0.543 mg Hg kg⁻¹. Time-related comparison of sampling campaigns revealed no significant trend changes, in either sediment samples or fish tissue. Thus, the analyses documented an evidently rather stabilized total Hg pollution in the Elbe River environment. Multivariate multispecies analyses found the age of analyzed individuals and the feeding strategy of a given species as the most important, however mutually interactive, covariates for Hg accumulation in muscle tissue. The analyses revealed decreasing sensitivity of older predator individuals to differentiate highly and moderately contaminated sites. Benthophagous species mostly kept their discrimination capacity toward contaminated sites in all age categories, with the exception of bream that was rather linked to the pattern typical for predator species. The unclear position of omnivorous species, represented namely by roach, corresponded with their weak bioindicator power, mainly in the young age categories.

Fraser AJ, Cahill TM, Lasenby DC, Mackay D, Milford L. (Canadian Environmental Modelling Centre, Trent University, Peterborough, Ontario K9J 7B8, Canada.), The role of cannibalism and contaminant source on bioaccumulation in aquatic food webs. *Environ Toxicol Chem.*, 24(4) (2005): 909-15.

Two aspects of bioaccumulation in an aquatic food web are explored. First, the possible implications of cannibalism, including the scavenging of conspecifics, as a factor influencing food web bioaccumulation and biomagnification are explored by examining the behavior of total polychlorinated biphenyls (PCBs) in a simple aquatic food web consisting of plankton, juvenile and adult *Mysis relicta*, *Diporeia*, and alewife. From an analysis of trophic transfer efficiencies and food consumption rates, it is concluded that, for *M. relicta*, a maximum extent of cannibalism in a population is about 10%, although certain individuals may be more cannibalistic. The model suggests that cannibalism and scavenging of dead conspecifics generally result in an increase in concentration by self-biomagnification, but the effect is small and unlikely to exceed 5% on the average. Concentration differences also are likely to result from changes in the relative amounts of the dietary components. Highly cannibalistic individuals may achieve higher levels of bioaccumulation. In extreme cases, the food web model becomes mathematically unstable because of excessive feedback of high concentrations. A major implication is that differences in extent of cannibalism and scavenging probably contribute significantly to natural concentration variation in a population. Second, and more important, is the effect of benthic versus pelagic sources, especially when significant fugacity differences exist between these zones. A simple method is described by which the separate contributions from these sources can be estimated for organisms at higher trophic levels.

Vandecasteele B, Laing GD, Quataert P, Tack FM. (Institute for Forestry and Game Management, Ministry of the Flemish Community, Gaverstraat 4, B-9500 Geraardsbergen, Belgium. Bart.Vandecasteele@lin.vlaanderen.be), Differences in Cd and Zn bioaccumulation for the flood-tolerant *Salix cinerea* rooting in seasonally flooded contaminated sediments. *Sci Total Environ.*, 341(1-3) (2005): 251-63.

Several authors suggest that a hydrological regime aiming at wetland creation is a potential management option that favours reducing bioavailability for metal-contaminated sites. The

hydrological conditions on a site constitute one of the many factors that may affect the availability of potentially toxic trace metals for uptake by plants. Bioavailability of Cd, Mn and Zn on a contaminated dredged sediment landfill (DSL) with variable duration of submersion was evaluated by measuring metal concentrations in the wetland plant species *Salix cinerea* in field conditions. Longer submersion periods in the field caused lower Cd and Zn concentrations in the leaves in the first weeks of the growing season. Foliar Cd and Zn concentrations at the end of the growing season were highest on the initially flooded plot that emerged early in the growing season. Foliar Zn concentrations were also high at a sandy-textured oxic plot with low soil metal concentrations. Zn uptake in the leaves was markedly slower than Cd uptake for trees growing on soils with prolonged waterlogging during the growing season, pointing at a different availability. Zn availability was lowest when soil was submerged, but metal transfer from stems and twigs to leaves may mask the lower availability of Cd in submerged soils. Especially for Cd, a transfer effect from one growing season to the next season was observed: oxic conditions at the end of the previous growing season seem to determine at least partly the foliar concentrations for *S. cinerea* through this metal transfer mechanism. Duration of the submersion period is a key factor for bioavailability inasmuch as initially submerged soils emerging only in the second half of the growing season resulted in elevated Cd and Zn foliar concentrations at that time.

Zimmermann S, Messerschmidt J, von Bohlen A, Sures B. (Zoological Institute I, Ecology-Parasitology, University of Karlsruhe, Geb. 07.01, D-76128 Karlsruhe, Germany. Sonja.Zimmerman@bio.uka.de), Uptake and bioaccumulation of platinum group metals (Pd, Pt, Rh) from automobile catalytic converter materials by the zebra mussel (*Dreissena polymorpha*). *Environ Res.*, 98(2) (2005): 203-9.

The uptake and bioaccumulation of the platinum group metals (PGM) platinum (Pt), palladium (Pd), and rhodium (Rh) by the zebra mussel (*Dreissena polymorpha*) were investigated in exposure studies using ground material from unused automobile catalytic converters as metal source. The mussels were exposed to the metals in tap water or humic water. In the soft tissue samples of exposed mussels mean Pt levels ranged in dependence on the type of tank water and the exposure period (6, 9, or 18 weeks) between 780 and 4300 ng/g, the Pd levels ranged between 720 and 6300 ng/g, and the Rh levels ranged between 270 and 1900 ng/g. In contrast, the control mussels had metal concentrations of <20 ng/g (Pt), <50 ng/g (Pd), and <40 ng/g (Rh). Considerably higher PGM levels were found in the exposed mussels of the humic water group than in those of the tap water group. Although there is a cumulative increase of the PGM concentrations in the environment since the introduction of the automobile catalyst more than 20 years ago, only little information about the PGM contamination in the biosphere, especially the fauna, is available. Due to the high capacity of *D. polymorpha* to accumulate PGM, this bivalve could be used as a potential sentinel for monitoring the noble metals in aquatic ecosystems.

Ruus A, Schaanning M, Oxnevad S, Hylland K. (Norwegian Institute for Water Research (NIVA), Brekkeveien 19, PO Box 173, Kjelsas, N-0411 Oslo, Norway. anders.ruus@niva.no), Experimental results on bioaccumulation of metals and organic contaminants from marine sediments. *Aquat Toxicol.*, 72(3) (2005): 273-92.

A test-system for the assessment of bioavailability and bioaccumulation of metals and organic contaminants in marine benthic organisms is described and results from studies where this system has been applied are assessed. Sediments tested were polluted harbour sediment (from Norway), and clean sediments spikes with metal containing weight materials for drilling muds. Contaminants that may bioaccumulate under relevant conditions are indicated. The test-system uses two species of ecological relevance (*Nereis diversicolor* and *Hinia reticulata*). Interspecies differences in bioaccumulation were found for several compounds, which show the importance of using species with different modes of living in such tests. Compared to other PAHs, pyrene was found to bioaccumulate to a high degree (BioAccumulation Ratio, BAR=213.5>sediment concentration ratio, SCR=97.4; bioaccumulation factor, organism dw. conc. to sediment dw. conc., BAF=1.02), which shows that extrapolating bioaccumulation results between different substances is difficult. When assessing bioavailability of specific compounds, it is most adequate to perform direct measurements on exposed organisms, such as the experiments described here. The high bioaccumulation of compounds such as pyrene and nickel may in some cases be attributed to manipulation of the sediments and (for pyrene) lack of subsequent aging, thereby overestimating bioavailability.

Fournier E, Adam C, Massabuau JC, Garnier-Laplace J. (Laboratoire de Radioecologie et Ecotoxicologie, Institut de Radioprotection et de Surete Nucleaire Bat 186, BP 3, 13115 Saint-Paul-Lez-Durance cedex, France. elodie.fournier@irsn.fr), Bioaccumulation of waterborne selenium in the Asiatic clam *Corbicula fluminea*: influence of feeding-induced ventilatory activity and selenium species. *Aquat Toxicol.*, 72(3) (2005): 251-60.

A set of experiments was performed to investigate the bioavailability and the effect of Se on the ventilatory activity of the bivalve *Corbicula fluminea*, under different conditions of both algal cell densities and dissolved Se chemical forms and concentrations. A first set of experiments was conducted without selenium to investigate the changes in the ventilatory flow rate as a function of the concentration of the unicellular alga *Chlamydomonas reinhardtii* (10^5 - 10^6 cells mL⁻¹). For algal concentrations below $2-3 \times 10^5$ cells mL⁻¹, ventilatory activity was highly stimulated whereas it was independent of algal densities for higher values (up to 10^6 cells mL⁻¹). To investigate the influence of this first ventilatory drive on selenium contamination process, bivalves were exposed to waterborne selenium at two different algal concentrations, selected to provide contrasting reference ventilatory activities. Three different selenium forms were studied [selenite Se(+IV), selenate Se(+VI) and selenomethionine SeMet] and were added into the water at concentrations of 50 and/or 500 microg L⁻¹. Each selenium form induced a specific behavioural response, an increase, a decrease or no change of ventilation being observed for Se(+IV), SeMet and Se(+VI), respectively. Selenium accumulation by the organisms was investigated at the organ level for the different exposure conditions. Selenomethionine was the most bioaccumulated form, followed by selenate and selenite, respectively. Despite the bivalves displaying different ventilatory behaviours at low or high algal density, there was no evidence showing reduction or enhancement of Se uptake in the chemical domain investigated.

Marino A, Lombardo L, Fiorentino C, Orlandella B, Monticelli L, Nostro A, Alonzo V. (Pharmaco-Biological Department, Microbiology Section, University of Messina, Contrada Annunziata, 98168 Messina, Italy), Uptake of *Escherichia coli*, *Vibrio cholerae* non-O1 and

Enterococcus durans by, and depuration of mussels (*Mytilus galloprovincialis*). Int J Food Microbiol., 99(3) (2005): 281-6.

The uptakes of *Escherichia coli*, *Vibrio cholerae* non-O1 and *Enterococcus durans* by mussels (*Mytilus galloprovincialis*) and the times for depuration were investigated in order to determine the most useful indicator of vibrio contamination. The mussels were maintained in tanks of static seawater contaminated with bacteria at 5 log₁₀ CFU/ml for bioaccumulation. Depuration was carried out by circulating fresh seawater through the tanks. Each organism was presented alone and with others to mussels, at temperatures of 14 and 21 degrees C. In water contaminated with either single or mixed organisms, the bacteria accumulated rapidly in the mussels reaching high concentrations after 1 h. With both single and mixed organisms, the maximum numbers of *E. coli* in mussels were 6.6 log₁₀ CFU/g at 14 degrees C and 5.4 log₁₀ CFU/g at 21 degrees C. Both *V. cholerae* non-O1 and *E. durans* alone or with other organisms reached a number ranging from 6.5 to 7 log₁₀ CFU/g at both temperatures. During depuration the numbers of all the organisms slowly decreased, with *E. coli* alone, numbers ranged from 2.8 to 2 log₁₀ CFU/g after 72 h at both 14 and 21 degrees C, and the organisms were undetectable after 144 h. With mixed organisms at 14 degrees C *E. coli* became undetectable after 168 h but at 21 degrees C no *E. coli* were recovered after 72 h. At 14 degrees C *V. cholerae* non-O1 alone also was undetectable after 168 h, but at 21 degrees C and with mixed organisms at both temperatures. *V. cholerae* was recovered after 168 h at numbers about 1 log₁₀ CFU/g. After 168 h numbers of *E. durans* alone ranged from 2.6 log₁₀ CFU/g at 14 degrees C to 1.5 log₁₀ CFU/g at 21 degrees C, and with mixed organisms the numbers ranged from 2.3 to 2.0 log₁₀ CFU/g at both temperatures. Of the three bacteria of faecal origin, *E. durans* is quickly acquired by mussels and released more slowly than the others, while *E. coli* quickly becomes undetectable. The results suggest that, for this kind of seafood, enterococci may be a more appropriate indicator than *E. coli* of risks to consumers from vibrios.

Xiong ZT, Wang H. (Department of Environmental Sciences, Wuhan University, Wuhan, Hubei 430079, People's Republic of China. ztxiong@whu.edu.cn), Copper toxicity and bioaccumulation in Chinese cabbage (*Brassica pekinensis* Rupr.) Environ Toxicol. 20(2) (2005): 188-94.

Copper is among the major heavy metal contaminants in the environment with various anthropogenic and natural sources. Human health risk from heavy metal bioaccumulation in vegetables has been a subject of growing concern in recent years. To investigate Cu phytotoxic effects and bioaccumulation in the popular vegetable Chinese cabbage (*Brassica pekinensis* Rupr) as well as the implications for human health due to Cu in the vegetable supply, seed germination and pot culture experiments with this vegetable were carried out. Six levels (0, 0.008, 0.031, 0.125, 0.5, and 2.0 mM/L) and 3 levels (0, 0.2, and 1.0 mM/kg) of Cu treatments were performed for the seed germination and pot culture experiments, respectively. The LC(50) of Cu for seed germination of Chinese cabbage was 0.348 mM/L. In the pot culture experiments, Cu treatments significantly increased electrolyte leakage and peroxidase activity of shoot tissues, demonstrating Cu phytotoxicity to the plants. On the other hand, Cu treatments significantly stimulated, instead of reduced, chlorophyll content. Cu treatments did not show a significant effect on shoot biomass. Compared to the control, Cu treatments significantly elevated the Cu content of the shoots-9.9, 42.5, and 119.0 mg/kg (DW) of Cu were detected in the 0, 0.2, and 1.0

mM/kg treatments, respectively. These results showed that although the plants accumulated an elevated copper content and suffered damage to some extent under Cu treatment, they looked healthy. It was suggested that Chinese cabbage with an elevated Cu content and without showing visible symptoms of damage possibly could cause a risk to human health from the transfer of the metal in food.

Kelsey JW, Colino A, White JC. (Program in Environmental Science, Department of Chemistry, Muhlenberg College, Allentown, Pennsylvania 18104, USA. kelsey@muhlenberg.edu), Effect of species differences, pollutant concentration, and residence time in soil on the bioaccumulation of 2,2-bis (p-chlorophenyl)-1,1-dichloroethylene by three earthworm species. Environ Toxicol Chem. 24(3) (2005):703-8.

Laboratory experiments were conducted to study the effects of species differences, soil concentration, and contaminant-residence time in soil on the bioaccumulation factor (BAF; dry-weight ratio of contaminant concentration in the tissue to that in the soil) of 2,2-bis (p-chlorophenyl)-1,1-dichloroethylene (p,p'-DDE) for three species of earthworms. In four field-weathered soils, the BAF for *Eisenia foetida*, an epigeic species (surface habitat), was approximately 10-fold higher than those for *Lumbricus terrestris*, an anecic species (deep habitat) and *Aporrectodea caliginosa*, an endogeic species (habitat within the soil profile). Preliminary analysis indicates that BAF may decline with increasing pollutant concentration in soil. With regard to contaminant-residence time, the BAF for *E. foetida* was lower in weathered soils relative to that in freshly amended soils, but age of p,p'-DDE did not significantly alter the BAF for *A. caliginosa*. These data suggest total chemical concentration alone is not a reliable indicator of the toxicological significance of a contaminated soil and that species-specific differences and environmental factors significantly impact overall exposure and risk.

Gerecke AC, Hartmann PC, Heeb NV, Kohler HP, Giger W, Schmid P, Zennegg M, Kohler M. (Laboratory of Organic Chemistry, Swiss Federal Institute for Materials Science and Technology (Empa), Uberlandstrasse 129, 8600 Dubendorf, Switzerland. andreas.gerecke@empa.ch) Anaerobic degradation of decabromodiphenyl ether. Environ Sci Technol., 39(4) (2005): 1078-83.

The environmental safety of decabromodiphenyl ether (BDE-209), a widely used flame retardant, has been the topic of controversial discussions during the past several years. Degradation of BDE-209 into lower brominated diphenyl ether congeners, exhibiting a higher bioaccumulation potential, has been a critical issue. Here, we report on the degradation of BDE-209 and the formation of octa- and nonabromodiphenyl ether congeners under anaerobic conditions. Sewage sludge collected from a mesophilic digester was used as the inoculum and incubated up to 238 days with and without a set of five primers. Following Soxhlet extraction and a liquid chromatography cleanup procedure, parent compounds and debromination products were analyzed by GC/HRMS. In experiments with primers, concentrations of BDE-209 decreased by 30% within 238 days. This corresponds to a pseudo-first-order degradation rate constant of $1 \times 10^{-3} \text{ d}^{-1}$. Without primers, the degradation rate constant was 50% lower. Formation of two nonabromodiphenyl ether and six octabromodiphenyl ether congeners proved that BDE-209 underwent reductive debromination in these experiments. Debromination occurred

at the para and the meta positions, whereas debromination at the ortho position was not statistically significant. All three nonabromodiphenyl ether congeners (BDE-206, BDE-207, and BDE-208) were found to undergo reductive debromination as well. No significant change of the BDE-209 concentration and no formation of lower brominated congeners was observed in sterile control experiments. To our knowledge, this is the first report demonstrating microbially mediated reductive debromination of BDE-209 under anaerobic conditions.

Pickhardt PC, Folt CL, Chen CY, Klaue B, Blum JD. (Department of Biological Sciences, Dartmouth College, Hanover, NH 03755, USA. paul.pickhardt@stonybrook.edu) Impacts of zooplankton composition and algal enrichment on the accumulation of mercury in an experimental freshwater food web. *Sci Total Environ.*, 339(1-3) (2005): 89-101.

There is a well documented accumulation of mercury in fish to concentrations of concern for human consumption. Variation in fish Hg burden between lakes is often high and may result from differences in Hg transfer through lower levels of the food web where mercury is bioconcentrated to phytoplankton and transferred to herbivorous zooplankton. Prior research derived patterns of mercury accumulation in freshwater invertebrates from field collected animals. This study provides results from controlled mesocosm experiments comparing the effects of zooplankton composition, algal abundance, and the chemical speciation of mercury on the ability of zooplankton to accumulate mercury from phytoplankton and transfer that mercury to planktivores. Experiments were conducted in 550-L mesocosms across a gradient of algal densities manipulated by inorganic nutrient additions. Enriched, stable isotopes of organic ($\text{CH}_3(200\text{HgCl})$) and inorganic (201HgCl_2) mercury were added to mesocosms and their concentrations measured in water, seston, and three common zooplankton species. After 2 weeks, monomethylmercury (MMHg) concentrations were two to three times lower in the two copepod species, *Leptodiaptomus minutus* and *Mesocyclops edax* than in the cladoceran, *Daphnia mendotae*. All three zooplankton species had higher MMHg concentrations in mesocosms with low versus high initial algal abundance. However, despite higher concentrations of inorganic mercury (HgI) in seston from low nutrient mesocosms, there were no significant differences in the HgI accumulated by zooplankton across nutrient treatments. Bioaccumulation factors for MMHg in the plankton were similar to those calculated for plankton in natural lakes and a four-compartment (aqueous, seston, macrozooplankton, and periphyton/sediments) mass balance model after 21 days accounted for approximately 18% of the $\text{CH}_3(200\text{Hg})$ and approximately 33% of the 201Hg added. Results from our experiments corroborate results from field studies and suggest the importance of particular zooplankton herbivores (e.g., *Daphnia*) in the transfer of Hg to higher trophic levels in aquatic food webs.

Danis B, Cotret O, Teyssie JL, Bustamante P, Fowler SW, Warnau M. (Laboratoire de Biologie Marine, CP 160/15, Universite Libre de Bruxelles, 50, Av. F.D. Roosevelt, B-1050 Brussels, Belgium. bdanis@ulb.ac.be), Bioaccumulation of PCBs in the sea urchin *Paracentrotus lividus*: seawater and food exposures to a ^{14}C -radiolabelled congener (PCB#153). *Environ Pollut.* 135(1) (2005): 11-19.

Adult *Paracentrotus lividus* were exposed to a ^{14}C -labelled PCB congener (PCB#153) using two different exposure modes: (1) the surrounding sea water and (2) the food (viz. the phanerogam

Posidonia oceanica and the brown alga Taonia atomaria). Uptake kinetics from water and loss kinetics after single feeding were followed in four body compartments of the sea urchins (body wall, spines, gut and gonads). Results indicate that PCB bioaccumulation in *P. lividus* varies from one body compartment to another, with the exposure mode and the nature of the food. The echinoids accumulate PCB#153 more efficiently when exposed via water than via the food (the transfer efficiency is higher by one order of magnitude). Target body compartments of PCB#153 were found to be body wall and spines when individuals were exposed via water, and gut when they were exposed via food. It is concluded that *P. lividus* is an efficient bioaccumulator of PCB and that it could be considered as an interesting indicator for monitoring PCB contamination in the marine environment.

Belden JB, Ownby DR, Lotufo GR, Lydy MJ. (Fisheries and Illinois Aquaculture Center and Department of Zoology, Southern Illinois University, Carbondale, IL 62901-6511, USA.) Accumulation of trinitrotoluene (TNT) in aquatic organisms: part 2- Bioconcentration in aquatic invertebrates and potential for trophic transfer to channel catfish (*Ictalurus punctatus*). Chemosphere. 58(9) (2005):1161-8.

The potential of TNT to accumulate in aquatic organisms was assessed by determining bioconcentration factors for TNT and TNT biotransformation products using two benthic invertebrates (*Chironomus tentans* and *Lumbriculus variegatus*), and by determining the bioaccumulation factor of TNT and TNT biotransformation products due to TNT exposure via feeding for channel catfish (*Ictalurus punctatus*). In all three species, TNT was rapidly biotransformed resulting in minimal accumulation. The bioconcentration factors for parent TNT ranged from 3 to 4 ml g⁻¹ for the invertebrates studied, while the TNT bioaccumulation factor for catfish via oral exposure of food pellets was 2.4x10⁻⁵ g g⁻¹ based on the concentration of TNT in the food pellet. As indicated by this small bioaccumulation factor, TNT accumulation in channel catfish through trophic transfer would be negligible compared to aqueous exposure (previously reported BCF of 0.79 ml g⁻¹). TNT extractable biotransformation products accumulated to a greater degree than parent TNT for all three species. In addition, a large fraction of the radioactivity within all three species resisted solvent extraction. The highest bioconcentration factors occurred in *L. variegatus* with extractable radioactivity measuring 76 ml g⁻¹ and total radioactivity measuring 216 ml g⁻¹. Because the bioaccumulation of TNT is very low compared to the bioaccumulation of its biotransformation products, further research including identifying and determining the relative toxicities of these biotransformation products is necessary to fully evaluate the environmental risk posed by exposure to TNT.

Jager T, van der Wal L, Fleuren RH, Barendregt A, Hermens JL.(Vrije Universiteit Amsterdam, Department of Theoretical Biology, De Boelelaan 1085, Amsterdam, The Netherlands. tjalling@bio.vu.nl), Bioaccumulation of organic chemicals in contaminated soils: evaluation of bioassays with earthworms. Environ Sci Technol. 39(1) (2005):293-8.

Earthworms live in close contact with the soil and can thus be considered representative for the bioavailability of chemicals at contaminated sites. Bioavailability can either be assessed by analyzing earthworms from contaminated locations or by exposing laboratory-reared specimens to soil samples from the field (bioassays). In this study, we investigate the relevance of bioassays

by using an extended experimental design (to identify signs of depletion of the bioavailable phase by the earthworms) and by using two species of earthworm (the standard test species *Eisenia andrei* and the field-relevant *Aporrectodea caliginosa*). Furthermore, bioassay results are compared to body residues of worms collected from the field site: a heavily polluted polder, amended with dredge spoil. We focused on telodrin, dieldrin, hexachlorobenzene, and eight PCBs. With our bioassay design, it was shown that depletion was unlikely, although more subtle effects could have occurred (e.g., changes in sorption during the experiments). *E. andrei* is a good choice for bioassays because its body residues correlate well to those in *A. caliginosa*, as well as to those in the field-collected worms. Nevertheless, *E. andrei* accumulated slightly more than the other species and appeared to be more sensitive to the conditions in soil from one of our sites.

Jabusch TW, Swackhamer DL. (Environmental Health Sciences, School of Public Health, University of Minnesota, MMC 807, 420 Delaware Street Southeast, Minneapolis, Minnesota 55455, USA.), Subcellular accumulation of polychlorinated biphenyls in the green alga *Chlamydomonas reinhardtii*. Environ Toxicol Chem., 23(12) (2005): 2823-30.

In this study, the subcellular accumulation of 13 polychlorinated biphenyl (PCB) congeners was investigated in the green alga *Chlamydomonas reinhardtii*. Two main arguments pertaining to the mechanism of bioaccumulation of persistent bioaccumulative toxic chemicals (PBTs) in phytoplankton were evaluated, including the controversy of whether the limitation of uptake of ultra-hydrophobic pollutants is kinetic or due to a physical barrier presented by the membrane that prevents transfer into the internal parts of the cell, and second, the role of surface adsorption for the bioaccumulation process. The first argument was addressed by studying the time-dependent subcellular uptake of PCBs into thylakoids (photosynthetic membranes) as representative internal membranes. The second issue was addressed by investigating the role of the algal cell wall as a potential extracellular sorbate. Accumulation of PCBs in thylakoids was found to be limited kinetically and slow compared to total accumulation in the alga. Super-hydrophobic PCBs with $K_{ow} > 6$ were not restricted from entering the cell. Sorption to the cell wall was found to be less than 10% and insignificant compared to total bioaccumulation in *C. reinhardtii*. To our knowledge, this is the first study in which the subcellular uptake of a class of PBTs was investigated directly. The results offer a mechanistic framework for improving kinetic modeling of PBT bioaccumulation in phytoplankton.

Emmanuel E, Perrodin Y, Keck G, Blanchard JM, Vermande P. (Laboratoire des Sciences de l'Environnement, Ecole Nationale des Travaux Publics de l'Etat, Rue Maurice Audin, 69518 Vaulx-en-Velin, France. evemm1@yahoo.com.fr) Ecotoxicological risk assessment of hospital wastewater: a proposed framework for raw effluents discharging into urban sewer network. J Hazard Mater, 117(1) (2005): 1-11.

In hospitals a large variety of substances are in use for medical purposes such as diagnostics and research. After application, diagnostic agents, disinfectants and excreted non-metabolized pharmaceuticals by patients, reach the wastewater. This form of elimination may generate risks for aquatic organisms. The aim of this study was to present: (i) the steps of an ecological risk assessment and management framework related to hospital effluents evacuating into wastewater

treatment plant (WWTP) without preliminary treatment; and (ii) the results of its application on wastewater from an infectious and tropical diseases department of a hospital of a large city in southeastern France. The characterization of effects has been made under two assumptions, which were related to: (a) the effects of hospital wastewater on biological treatment process of WWTP, particularly on the community of organisms in charge of the biological decomposition of the organic matter; (b) the effects on aquatic organisms. COD and BOD5 have been measured for studying global organic pollution. Assessment of halogenated organic compounds was made using halogenated organic compounds absorbable on activated carbon (AOX) concentrations. Heavy metals (arsenic, cadmium, chrome, copper, mercury, nickel, lead and zinc) were measured. Low most probable number (MPP) for faecal coliforms has been considered as an indirect detection of antibiotics and disinfectants presence. For toxicity assessment, bioluminescence assay using *Vibrio fischeri* photobacteria, 72-h EC50 algae growth *Pseudokirchneriella subcapitata* and 24-h EC50 on *Daphnia magna* were used. The scenario allows to a semi-quantitative risk characterization. It needs to be improved on some aspects, particularly those linked to: long term toxicity assessment on target organisms (bioaccumulation of pollutants, genotoxicity, etc.); ecotoxicological interactions between pharmaceuticals, disinfectants used both in diagnostics and in cleaning of surfaces, and detergents used in cleaning of surfaces; the interactions into the sewage network, between the hospital effluents and the aquatic ecosystem.

Bioremediation

Goulet RR, Lalonde JD, Munger C, Dupuis S, Dumont-Frenette G, Premont S, Campbell PG. (Environment Canada, Assessment Division, Existing Substances Branch, Place Vincent Massey, 20th floor, 351 St. Joseph, Gatineau, Quebec, Canada K1A 0H3. richard.goulet@ec.gc.ca), Phytoremediation of effluents from aluminum smelters: a study of Al retention in mesocosms containing aquatic plants. *Water Res.* 39(11) (2005): 2291-300.

Four mesocosms were exposed to circumneutral and aluminum (Al)-rich wastewater during two successive summers (2000, 2001). The goals of the study were to measure the bioaccumulation of dissolved Al by the aquatic plants *Typha latifolia*, *Lemna minor*, *Nuphar variegatum* and *Potamogeton epihydrus*, and to evaluate their importance in the retention of Al by the mesocosms. In 2000, inlet concentrations of total monomeric Al were reduced by 56% and 29% at the Arvida and Laterriere mesocosms, respectively, whereas in 2001 inlet dissolved Al concentrations in the inlet decreased by 40% and 33%. *L. minor* had the highest Al uptake rate (0.8--17 mg Al g(-1)d(-1)). However, because *T. latifolia* (cattails) yielded the highest biomass, it was responsible for 99% of the Al uptake, largely in its root tissue. In 2001, Al uptake by macrophytes accounted for 2--4% and 15--54% of the total Al retained by the Laterriere and Arvida mesocosms, respectively. In the Laterriere mesocosms, Al uptake by cattails could account for 12% and 18% of the dissolved Al retained by both mesocosms. In contrast, dissolved Al was not significantly reduced in the Arvida enclosures, yet cattails did accumulate Al in their

roots. Further research is needed to identify the species community composition that would optimize dissolved Al retention.

Mkandawire M, Taubert B, Dudel EG. (Dresden University of Technology, Institute of General Ecology and Environmental Protection, Tharandt, Germany. mkanda@forst.tu-dresden.de), Capacity of Lemna gibba L. (duckweed) for uranium and arsenic phytoremediation in mine tailing waters. Int J Phytoremediation. 6(4) (2004):347-62.

The potential of *Lemna gibba* L. to clean uranium and arsenic contamination from mine surface waters was investigated in wetlands of two former uranium mines in eastern Germany and in laboratory hydroponic culture. Water and plants were sampled and *L. gibba* growth and yield were monitored in tailing ponds from the field study sites. Contaminant accumulation, growth and yield experiments were conducted in the laboratory using synthetic tailing water. Mean background concentrations of the surface waters were 186.0±81.2 µg l⁻¹ uranium and 47.0±21.3 µg l⁻¹ arsenic in Site one and 293.7±121.3 µg l⁻¹ uranium and 41.37±24.7 µg l⁻¹ arsenic in Site two. The initial concentration of both uranium and arsenic in the culture solutions was 100 µg l⁻¹. The plant samples were either not leached, leached with deionized H₂O or ethylenediaminetetracetic (EDTA). The results revealed high bioaccumulation coefficients for both uranium and arsenic. Uranium and arsenic content of *L. gibba* dry biomass of the field samples were as follows: nonleached samples > deionized H₂O leached (insignificant ANOVA $p = 0.05$) > EDTA leached. The difference in both arsenic and uranium enrichment were significantly high between the nonleached and the other two lead samples tested at ANOVA $p > 0.001$. Estimated mean *L. gibba* density in surface water was 85,344.8±1843.4 fronds m⁻² (approximately 1319.7 g m⁻²). The maximum specific growth rate was 0.47±0.2 d⁻¹, which exceeded reported specific growth rates for *L. gibba* in the literature. Average yield was estimated at 20.2±6.7 g m⁻² d⁻¹, giving approximately 73.6±21.4 t ha⁻¹ y⁻¹ as the annual yield. The highest accumulations observed were 896.9±203.8 mg kg⁻¹ uranium and 1021.7±250.8 mg kg⁻¹ arsenic dry biomass for a 21-d test period in the laboratory steady-state experiments. The potential extractions from surface waters with *L. gibba* L. were estimated to be 662.7 kg uranium ha⁻¹ yr⁻¹ and 751.9 kg arsenic ha⁻¹ yr⁻¹ under the above conditions.

Lunney AI, Zeeb BA, Reimer KJ., (Environmental Sciences Group, Royal Military College of Canada, Station Forces, Kingston, Ontario K7K 7B4, Canada.) Uptake of weathered DDT in vascular plants: potential for phytoremediation. Environ Sci Technol. 38(22) (2004) :6147-54.

Since the discovery of its insecticidal properties and its subsequent widespread use, DDT [2,2-bis(chlorophenyl)-1,1,1-trichloroethane] has accumulated in the environment, having a wide range of adverse effects on nontarget species. Due to their hydrophobicity, DDT and other persistent organic pollutants are difficult to remove from contaminated soils, and increasingly so through time as weathering occurs. Phytoremediation is an emerging plant-based technology that may be used to cost-effectively remove or neutralize contaminants in the environment. For some phytoremediation strategies, it must first be possible to translocate hydrophobic chemicals across the root and through the shoot via an aqueous transpiration stream. The objective of this study

was to compare the ability of five plant varieties (zucchini, tall fescue, alfalfa, rye grass, and pumpkin) to mobilize and translocate DDT. Plants were grown in the greenhouse in soil contaminated with DDT and its metabolites, DDD and DDE (sigmaDDT refers to all of DDT, DDD, and DDE) at two concentrations (high approximately 3700 ng/g, and low approximately 150 ng/g). All trays were covered with laboratory Parafilm to limit volatilization. Cucurbita pepo species (pumpkin and zucchini) achieved the highest translocation and bioaccumulation factors, and also extracted the highest absolute amounts of sigmaDDT from both the high and low sigmaDDT soils. In the high sigmaDDT soil treatment, pumpkin accumulated 1519 ng of sigmaDDT in the roots and 57,536 ng of sigmaDDT in the shoots, and zucchini accumulated 2043 ng of sigmaDDT in the roots and 35,277 ng of sigmaDDT in the shoots. With the exception of alfalfa and pumpkin, principal component analysis detected no preferential translocation or transformation of sigmaDDT compounds within the plant. The success of the Cucurbita pepo species in this study to extract and translocate such hydrophobic molecules may be related to their high transpiration volume, large above-ground biomass, and composition of root exudates. This suggests potential for their application in phytoremediation.

Stallwood B, Shears J, Williams PA, Hughes KA. (School of Biological Sciences, University of Wales, Bangor, Wales, UK.). Low temperature bioremediation of oil-contaminated soil using biostimulation and bioaugmentation with a Pseudomonas sp. from maritime Antarctica. J Appl Microbiol. 99(4) (2005):794-802.

Aims: To identify native Antarctic bacteria capable of oil degradation at low temperatures. Methods and Results: Oil contaminated and pristine soils from Signy Island (South Orkney Islands, Antarctica) were examined for bacteria capable of oil degradation at low temperatures. Of the 300 isolates cultured, Pseudomonas strain ST41 grew on the widest range of hydrocarbons at 4 degrees C. ST41 was used in microcosm studies of low temperature bioremediation of oil-contaminated soils. Microcosm experiments showed that at 4 degrees C the levels of oil degradation increased, relative to the controls, with (i) the addition of ST41 to the existing soil microbial population (bioaugmentation), (ii) the addition of nutrients (biostimulation) and to the greatest extent with (iii) a combination of both treatments (bioaugmentation and biostimulation). Addition of water to oil contaminated soil (hydration) also enhanced oil degradation, although less than the other treatments. Analysis of the dominant species in the microcosms after 12 weeks, using temporal temperature gradient gel electrophoresis, showed Pseudomonas species to be the dominant soil bacteria in both bioaugmented and biostimulated microcosms. Conclusions: Addition of water and nutrients may enhance oil degradation through the biostimulation of indigenous oil-degrading microbial populations within the soil. However, bioaugmentation with Antarctic bacteria capable of efficient low temperature hydrocarbon degradation may enhance the rate of bioremediation if applied soon after the spill. Significance and Impact of the Study: In the future, native soil bacteria could be of use in bioremediation technologies in Antarctica.

Mphekgo P. Maila¹ and Thomas E. Cloete² (Council for Scientific and Industrial Research, P O Box 395, Pretoria, 0001, South Africa; Department of Microbiology and Plant Pathology, University of Pretoria, Pretoria, South Africa). Bioremediation of petroleum hydrocarbons through landfarming: Are simplicity and cost-effectiveness the only advantages? Reviews in Environmental Science and Biotechnology , 3(4) (2004): 349 – 360.

The biological removal of petroleum products using landfarming has been applied commercially in large scale with relative success. The technology has been widely used due to its simplicity and cost-effectiveness. However, together with these advantages, there are physical, chemical and biological aspects of the technology that can hamper the remediation process. The dominant pollutant removal mechanisms involved in landfarming are volatilisation of low molecular weight volatile compounds during the early days of contamination or treatment, biodegradation and adsorption. However, volatilisation, leaching of the petroleum products and the remaining recalcitrant hydrocarbon residues present both health and environmental challenges to the rehabilitation practitioners when designing the landfarming technology. Bioaugmentation and biostimulation are promising bioremediation approaches involving landfarming. However, due to the inherent problems related to bioaugmentation such as poor survival of augmented strains, biostimulation should be preferred in contaminated sites with indigenous pollutant-degrading bacteria. Although simplicity and cost-effectiveness are the major advantages for using landfarming, other factors generally regarded as disadvantageous to implementing the technology can be addressed. These includes requirements for large land area for treatment, availability of the pollutant degrading bacteria, effectiveness of the technology at high constituent concentration (more than 50,000 ppm), improved concentration reductions in cases requiring more than 95% of pollution reduction and the flexibility of the technology in integrating the removal of petroleum hydrocarbons with other contaminants that may occur with the petroleum products.

Monika Walter^a, Kirsty Boyd-Wilson^a, Lawrence Boul^{b, 1}, Chris Ford^c, Derek McFadden^{d, 2}, Bob Chong^c and James Pinfold^e. (^aHort Research, Environment and Risk Management Group, Gerald Street, PO Box 51, Lincoln, New Zealand, ^bCanesis, Private Bag 4749, Christchurch, New Zealand, ^cMassey University, Biotechnology Group, Private Bag 11 222, Palmerston North, New Zealand, ^dURS New Zealand Ltd., 287 Durham St., Christchurch, New Zealand, ^eHortResearch, BioEngineering Group, Private Bag 3123, Hamilton, New Zealand). **Field-scale bioremediation of pentachlorophenol by *Trametes versicolor*. International Biodeterioration & Biodegradation, 56(1) (2005): 51-57.**

Engineered soil cells were designed to develop proof-of-concept biopiles for white-rot bioremediation of aged PCP-contaminated soil from a former timber treatment site. Soil cells were constructed to allow for forced aeration, irrigation, leachate collection and monitoring of temperature and soil humidity. In experiments setup in January 2000 and monitored at regular intervals for 2.5 years, parameters studied were the effect of a New Zealand white-rot fungus *Trametes versicolor* isolate on PCP degradation, the effect of fungal inoculum concentration on PCP degradation and reproducibility of the experiments. PCP degradation and fungal survival were monitored at regular intervals for 2.5 years. There was no effect of inoculum concentration, and treatment effects were reproducible. PCP residues declined from 800–1000 mg kg⁻¹ to 4 (0–9.4 mg kg⁻¹) according to first-order kinetics. Irrigation was neither required during the 2.5 years of the study, nor did leachate form. The soil cells did not exceed average daily temperatures of 35 °C. The results support the conclusion that the isolate of the *T. versicolor* can biodegrade PCP from aged soils in a field situation.

Monika Walter^a, Kirsty S.H. Boyd-Wilson^a, Don McNaughton^b and Grant Northcott^b. (^aHortResearch, Environment and Risk Management, Gerald Street, PO Box 51, Lincoln,

New Zealand, ^bHortResearch, Biological Chemistry, Private Bag 3123, Hamilton, New Zealand). Laboratory trials on the bioremediation of aged pentachlorophenol residues. *International Biodeterioration & Biodegradation*, 55(2) (2005): 121-130.

The variable nature of field-contaminated soil requires reliable assessments or treatability studies to optimise the bioremediation process in the field. In a series of laboratory-based studies, experiments were developed and conducted to determine fungal isolate variations, optimum fungal inoculum concentration, optimum treatable contaminant concentration and predict pentachlorophenol (PCP) degradation over time. Generally, biodegradation of PCP in old (>30 years) field-contaminated soil (i.e. aged residues) was similar between New Zealand native isolates compared to the American isolates of *Phanerochaete chrysosporium* or *P. sordida*. A concentration of up to 2786 mg freshly added PCP kg⁻¹-soil was readily biodegraded if augmented with live or dead white-rot isolates. However, no biodegradation or soil colonisation was observed at these high PCP concentrations when aged residues were used. Increasing the amount of fungal inoculum (>30%; v/v) for soil augmentation with white-rot fungi did not improve colonisation of field-contaminated PCP soil. Generally, soil colonisation by white-rot fungi did not correlate with PCP decline. However, soil colonisation and PCP biodegradation were isolate dependent. When aged residues were used, the variation between repeated residue analyses was high and similar to the variance among isolates and among isolates within sampling dates. Therefore stratified sampling protocols were developed for PCP residue analysis to be able to determine differences between fungal treatments. The results of the described experiments were then used to standardise treatability studies.

Irma Susana Morelli, María Teresa Del Panno, Graciela Liliana De Antoni and María Teresa Paineira. (Laboratorio de Biodegradación Microbiológica de Hidrocarburos, Facultad de Ciencias Exactas, Universidad Nacional de La Plata, Calle 47 y 115 (1900), La Plata, Buenos Aires, Argentina). Laboratory study on the bioremediation of petrochemical sludge-contaminated soil. *International Biodeterioration & Biodegradation*, 55(4) (2005): 271-278.

This study evaluated by biological and chemical analyses the effectiveness of bioremediation of sludge from the petrochemical industry in systems containing artificially contaminated soil. The sludge-soil systems were prepared with three different initial concentrations of sludge, and during bioremediation 86–95% of the hydrocarbons was eliminated. Simultaneously, soil bacterial populations and inhibition of seed germination by aqueous extracts increased in all sludge-soil systems during the first 180 days of treatment. After 1 year of bioremediation, a loss in the catabolic capacity of the Gram-negative bacterial population was observed, but was not dependent on the initial sludge concentration. Furthermore, residual levels of hydrocarbons and seed germination inhibitory effect decreased sharply, but some level of toxicity remained in the systems containing the highest initial sludge concentration. Independent of the initial sludge concentration, the contaminated soils did not re-establish their original features even when residual hydrocarbon concentrations suggested the end of the process.

Nanqi Ren^a, Zhaobo Chen^a, Aijie Wang^a and Dongxue Hu^b. (^aSchool of Municipal and Environmental Engineering, Harbin Institute of Technology, Harbin 150090, China,

^bSchool of Mathematics and Computer Science, Harbin Normal University, Harbin 150080, China). Removal of organic pollutants and analysis of MLSS–COD removal relationship at different HRTs in a submerged membrane bioreactor. *International Biodeterioration & Biodegradation*, 55(4) (2005): 279-284.

In order to investigate the influence of hydraulic retention time (HRT) on organic pollutant removal in a submerged membrane bioreactor (SMBR), a laboratory-scale experiment was conducted using domestic sewage as influent. The dissolved oxygen (DO) concentration was controlled at 2.0–3.0 mg L⁻¹ during the experimental period. The experiments demonstrated that when HRT was 3, 2 and 1 h, the reduction of chemical oxygen demand (COD) was 89.3–97.2, 88.5–97.3 and 80–91.1%, and the effluent COD was 38.9–11.2, 41.6–10.8 and 63.4–35.8 mg L⁻¹, respectively. It is suggested that an HRT of 1 h could meet the normal standard of discharged domestic sewage, and an HRT of 2 h could meet that of water reclamation. In addition, we use mathematical software MATLAB to analyse the relation of mixed liquor suspended solids (MLSS) and COD removal. The results showed that the optimum MLSS concentration should be maintained at around 6000 mg L⁻¹ in the SMBR. The results also showed that the COD removal was related to HRT (τ), influent concentration (S_0) and sludge loading rate for COD removal (N_S). Moreover, the high COD removal could be achieved through adjusting τ , S_0 and N_S .

Goulet RR, Lalonde JD, Munger C, Dupuis S, Dumont-Frenette G, Premont S, Campbell PG. (Environment Canada, Assessment Division, Existing Substances Branch, Place Vincent Massey, 20th floor, 351 St. Joseph, Gatineau, Quebec, Canada K1A 0H3. richard.goulet@ec.gc.ca), Phytoremediation of effluents from aluminum smelters: a study of Al retention in mesocosms containing aquatic plants. *Water Res.* 39(11) (2005): 2291-300.

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Mkandawire M, Taubert B, Dudel EG. (Dresden University of Technology, Institute of General Ecology and Environmental Protection, Tharandt, Germany. mkanda@forst.tu-

dresden.de), Capacity of Lemna gibba L. (duckweed) for uranium and arsenic phytoremediation in mine tailing waters. Int J Phytoremediation. 6(4) (2004): 347-62.

The potential of *Lemna gibba* L. to clean uranium and arsenic contamination from mine surface waters was investigated in wetlands of two former uranium mines in eastern Germany and in laboratory hydroponic culture. Water and plants were sampled and *L. gibba* growth and yield were monitored in tailing ponds from the field study sites. Contaminant accumulation, growth and yield experiments were conducted in the laboratory using synthetic tailing water. Mean background concentrations of the surface waters were 186.0±81.2 µg l⁻¹ uranium and 47.0±21.3 µg l⁻¹ arsenic in Site one and 293.7±121.3 µg l⁻¹ uranium and 41.37±24.7 µg l⁻¹ arsenic in Site two. The initial concentration of both uranium and arsenic in the culture solutions was 100 µg l⁻¹. The plant samples were either not leached, leached with deionized H₂O or ethylenediaminetetraacetic (EDTA). The results revealed high bioaccumulation coefficients for both uranium and arsenic. Uranium and arsenic content of *L. gibba* dry biomass of the field samples were as follows: nonleached samples > deionized H₂O leached (insignificant ANOVA $p = 0.05$) > EDTA leached. The difference in both arsenic and uranium enrichment were significantly high between the nonleached and the other two lead samples tested at ANOVA $p > 0.001$. Estimated mean *L. gibba* density in surface water was 85,344.8±1843.4 fronds m⁻² (approximately 1319.7 g m⁻²). The maximum specific growth rate was 0.47±0.2 d⁻¹, which exceeded reported specific growth rates for *L. gibba* in the literature. Average yield was estimated at 20.2±6.7 g m⁻² d⁻¹, giving approximately 73.6±21.4 t ha⁻¹ y⁻¹ as the annual yield. The highest accumulations observed were 896.9±203.8 mg kg⁻¹ uranium and 1021.7±250.8 mg kg⁻¹ arsenic dry biomass for a 21-d test period in the laboratory steady-state experiments. The potential extractions from surface waters with *L. gibba* L. were estimated to be 662.7 kg uranium ha⁻¹ yr⁻¹ and 751.9 kg arsenic ha⁻¹ yr⁻¹ under the above conditions.

Stallwood B, Shears J, Williams PA, Hughes KA. (School of Biological Sciences, University of Wales, Bangor, Wales, UK.). Low temperature bioremediation of oil-contaminated soil using biostimulation and bioaugmentation with a *Pseudomonas* sp. from maritime Antarctica. J Appl Microbiol. 99(4) (2005): 794-802.

Aims: To identify native Antarctic bacteria capable of oil degradation at low temperatures. **Methods and Results:** Oil contaminated and pristine soils from Signy Island (South Orkney Islands, Antarctica) were examined for bacteria capable of oil degradation at low temperatures. Of the 300 isolates cultured, *Pseudomonas* strain ST41 grew on the widest range of hydrocarbons at 4 degrees C. ST41 was used in microcosm studies of low temperature bioremediation of oil-contaminated soils. Microcosm experiments showed that at 4 degrees C the levels of oil degradation increased, relative to the controls, with (i) the addition of ST41 to the existing soil microbial population (bioaugmentation), (ii) the addition of nutrients (biostimulation) and to the greatest extent with (iii) a combination of both treatments (bioaugmentation and biostimulation). Addition of water to oil contaminated soil (hydration) also enhanced oil degradation, although less than the other treatments. Analysis of the dominant species in the microcosms after 12 weeks, using temporal temperature gradient gel electrophoresis, showed *Pseudomonas* species to be the dominant soil bacteria in both bioaugmented and biostimulated microcosms. **Conclusions:** Addition of water and nutrients may enhance oil degradation through the biostimulation of indigenous oil-degrading microbial

populations within the soil. However, bioaugmentation with Antarctic bacteria capable of efficient low temperature hydrocarbon degradation may enhance the rate of bioremediation if applied soon after the spill. Significance and Impact of the Study: In the future, native soil bacteria could be of use in bioremediation technologies in Antarctica.

Biotransformation

Maria C. Romero¹, Elke Hammer², Renate Hanschke², Angelica M. Arambarri¹ and Frieder Schauer² (¹Instituto Botanica Spegazzini, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina; ²Institut für Mikrobiologie, Ernst-Moritz-Arndt-Universität Greifswald, F.-L.-Jahn-Str. 15, Greifswald, 17487, Germany) **Biotransformation of biphenyl by the filamentous fungus *Talaromyces helicus*, World Journal of Microbiology and Biotechnology, 21(2) (2005) : 101 – 106.**

The filamentous fungus *Talaromyces helicus*, isolated from oil-contaminated sludge, oxidizes biphenyl via 4-hydroxybiphenyl to the dihydroxylated derivatives 4,4'-dihydroxybiphenyl and 3,4-dihydroxybiphenyl, which, to a certain extent, are converted to glycosyl conjugates. The sugar moiety of the conjugate formed from 4,4'-dihydroxybiphenyl was identified as glucose. Further metabolites: 2-hydroxybiphenyl, 2,5-dihydroxylated biphenyl, and the ring cleavage product 4-phenyl-2-pyrone-6-carboxylic acid accumulated only in traces. From these results the main pathway for biotransformation of biphenyl in *T. helicus* could be proposed to be the excretion of dihydroxylated derivatives (>75%) and their glucosyl conjugates (<25%).

M. Miyazawa, A. Sugawara. (Department of Applied Chemistry, Faculty of Science of Engineering, Kinki University Kowakae, Higashiosakahi, Osaka, 577-8502, Japan). **Biotransformation of alpha-bulnesene using a plant pathogenic fungus, *Glomerella cingulata* as a biocatalyst. Natural Product Research, 19(2) (2005): 111-115.**

Bulnesene was isolated from essential oils of Zygophyllaceae plant *Bulnesia sarmienti* (guaiac wood oil). The biotransformation of a sesquiterpene having a guaiane skeleton namely (plus)-alpha-bulnesene was investigated using the plant pathogenic fungus, (*Glomerella cingulata*) as a biocatalyst. (plus)-alpha-Bulnesene was oxidized at the double bond of the isopropenyl group and hydroxylated at the allylic methyl group to (4S, 5S, 7R)-1(10-guaien- 11, 12, 15- triol).

Roberta Mustacchi¹, Christopher J. Knowles¹, Hong Li¹, Ian Dalrymple², Garry Sunderland², Wolfgang Skibar², Simon A. Jackman^{1*}. (¹Department of Earth Sciences, University of Oxford, 62, Banbury Road, Oxford OX2 6PN, United Kingdom and NERC Centre for Ecology and Hydrology, Mansfield Road, Oxford OX1 3SR, United Kingdom, ²C-Tech Innovation Ltd., Capenhurst Technology Park, Capenhurst, Chester, CH1 6EH, United Kingdom, email: Simon A. Jackman (simon.jackman@earth.ox.ac.uk)). **Enhanced biotransformations and product recovery in a membrane bioreactor through application of a direct electric current. Biotechnology and Bioengineering, 89(1) (2004): 18 – 23**

The simultaneous enhancement of biotransformation coupled to product recovery, purification and concentration is presented. The nitrilase of *Rhodococcus rhodochrous* LL100-21 catalyses the single-step hydrolytic biotransformation of benzonitrile to benzoic acid and ammonia. When a direct electric current is applied across a bioreactor containing the bacterium and benzonitrile, the charged product (benzoic acid) can be removed in situ across an anion exchange membrane and recovered in a separate compartment. Over the course of a 24-hour biotransformation, benzonitrile was converted to benzoic acid which was completely removed from the bioreactor chamber and concentrated 3-fold in a separate chamber. The rate of production of benzoic acid increased by 42% when the current was applied (0.044 mmol/min/g dry cell weight in the presence of current as compared to 0.03 mmol/min/g dry cell weight in its absence). The enhanced reaction rate was achieved irrespective of product separation and therefore appears to be a direct effect upon the bacterial cells. This process has potential for enhanced productivity from biotransformations through a simultaneous increase in metabolic activity and in situ product recovery.

Biomarker

Rac M, Safranow K, Jakubowska K, Chlubek D, Machoy Z. (Department of Biochemistry and Chemistry, Pomeranian Medical University, Szczecin, Poland. carmon@sci.pam.szczecin.pl). Adenine nucleotides in snail muscles as one of biomarkers of fluoride toxicity. J Environ Monit. 7(6) (2005): 631-4.

The aim of this work was to determine the extent of bioaccumulation of fluorides in tissues of *Helix aspersa maxima*. The toxicity of fluorides administered orally on the energy balance of the snail's foot was investigated based on measurements of concentrations of adenine nucleotides and their metabolism degradation products. Quantitation of fluoride levels was done in soft tissues (foot, hepatopancreas) and shells of mature snails. Qualitative and quantitative analysis of purine compounds was performed in slices of foot from mature snails. Fluoride concentrations in pulverized shells were measured using an ion-selective electrode. Gas chromatography was used to determine fluoride concentrations in soft tissues (hepatopancreas and foot). Purines were measured in foot muscle slices with high-performance liquid chromatography (HPLC). Fluoride levels in soft tissues of the snail cannot serve as an indicator for biomonitoring purposes as no significant accumulation was observed during exposure to maximum allowable concentrations of fluoride in drinking water. Contrary to this, levels of fluoride in the shell rose significantly with this concentration of fluoride in drinking water. The effect of fluorides on energy metabolism of foot muscle was evidenced by elevated AMP levels, increased adenine nucleotide pool and reduced conversion of ADP to ATP. Exposure to rising F(-) concentrations was accompanied by decreasing values of the adenylate energy charge AEC. Determination of AMP or AEC in foot muscle of exposed snails seems to be a useful indicator of fluoride effects on metabolic activity.

Olinda Canhoto^a, Flavia Pinzari^b, Corrado Fanelli^c and Naresh Magan^a . (^a Applied Mycology Group, Cranfield Biotechnology Centre, Cranfield University at Silsoe, Bedford MK43 0AL, UK, ^b Istituto Centrale per la Patologia and Biologia del Libro, Rome, Italy, ^c Università degli Studi di Roma, La Sapienza, Dip. Biologia Vegetale, Rome, Italy). Application of electronic nose technology for the detection of fungal contamination in library paper. International Biodeterioration & Biodegradation, 54(4) (2004): 303-309

Studies were carried out in vitro on a cellulose based agar at two water activities (a_w , 0.975, 0.995) and on three types of paper at two relative humidities (75, 100% RH) for the potential for differentiation of contamination and colonisation by *Aspergillus terreus*, *A. holandicus* and *Eurotium chevalieri*. In vitro studies showed that conducting polymer sensor array gave different responses to each of these species when grown on cellulose agar at both a_w levels. Discriminant function analyses of the data showed differentiation of the controls from the spoilage fungi. Cluster analysis gave a significant ($P=0.05$) separation of the control and each spoilage fungus. In situ studies on three types of paper showed that using natural substrates the volatile patterns produced by each of these fungi was different from each other and from the control. The results obtained were better at the higher humidity. The three paper types could be successfully differentiated into clusters. For a single paper type, differentiation of controls from spoilage fungal treatments was better at the higher humidity. This study has shown that this technology has potential for the early detection of fungal contamination in library materials and archives for the improved protection of cultural heritage.

M.S. Rakotonirainy and B. Lavédrine. (Centre de Recherches sur la Conservation des Documents Graphiques (CRCDG), MNHN-MCC-CNRS FRE K 2743, 36 rue Geoffroy Saint-Hilaire, 75005 Paris, France). Screening for antifungal activity of essential oils and related compounds to control the biocontamination in libraries and archives storage areas. International Biodeterioration & Biodegradation, 55(2) (2005): 141-147

The vapours of nine essential oils and five of their major constituents were investigated for their antifungal activity against a range of mould species commonly found on library and archival materials. The different compounds were preliminarily screened by a microatmosphere method. The inhibitory activities of vapour phase of essential oils of armoise, clove, boldo, eucalyptus, ravensare, lavender, tea tree, thuya, wormseed and their main components against the fungal species tested were demonstrated. The action of linalool appeared the most interesting. In a second series of experiments, the preventive and curative action of linalool on inoculated books was investigated. Results indicated that the action of linalool is fungistatic rather than fungicidal at the tested concentrations. The potential use of linalool as an alternative to chemical fungicide to disinfect mouldy documents is difficult to assess, but its use may be beneficial as a complement to controlled environment measures in preventing fungal contamination in storage areas of cultural properties. Linalool vapours did not affect the brightness of two types of paper tested or the degree of polymerisation of cellulose, but did reduce the pH of the paper.

May KM, Vogt A, Bachas LG, Anderson KW., (Department of Chemical and Materials Engineering, University of Kentucky, Lexington, KY 40506, USA.), Vascular endothelial growth factor as a biomarker for the early detection of cancer using a whole cell-based biosensor. Anal Bioanal Chem. 382(4) (2005): 1010-6.

Vascular endothelial growth factor (VEGF) is a cytokine and endothelial cell (EC) mitogen that has been studied for its role in angiogenesis of malignant tumors. Elevated quantities of VEGF in the serum and plasma of patients have been correlated with the presence of cancer and metastasis. Since VEGF induces hyperpermeability of EC monolayers, this protein can be detected in vitro with a whole cell-based biosensor. This biosensor consists of a confluent monolayer of human umbilical vein endothelial cells (HUVECs) attached to a cellulose triacetate

(CTA) membrane of an ion-selective electrode (ISE). Previous studies regarding this biosensor have shown that when the biosensor was exposed to a model toxin, such as histamine, the response of the biosensor served as an indirect measurement of the presence of histamine. Similarly, the biosensor responds to the presence of VEGF, but is much more sensitive because VEGF is known to be 50,000-fold more potent than histamine when inducing EC hyperpermeability. The ISE response increased with increasing VEGF concentration. Since lower concentrations required more exposure time, the detection limit was established as a function of exposure time (2-10 h). The practical applicability of the biosensor was also established with cultured human melanoma cells WM793 (nonmetastatic) and 1205LU (metastatic). The resultant change in the potential values revealed significant production of VEGF from the 1205LU cells. A VEGF ELISA was performed to confirm the VEGF concentration in each sample. The biosensor closely predicted the concentrations determined through the ELISA. These results support the use of a cell-based ISE as a quick screening method for the presence of VEGF.

Biofertilizer

Giri S, Pati BR. (Microbiology Laboratory, Department of Botany and Forestry, Vidyasagar University Midnapore-721102, West Bengal, India.), **A comparative study on phyllosphere nitrogen fixation by newly isolated *Corynebacterium* sp. & *Flavobacterium* sp. and their potentialities as biofertilizer.** *Acta Microbiol Immunol Hung.*, 51(1-2) (2004): 47-56.

A number of nitrogen fixing bacteria has been isolated from forest phyllosphere on the basis of nitrogenase activity. Among them two best isolates are selected and identified as *Corynebacterium* sp. AN1 & *Flavobacterium* sp. TK2 able to reduce 88 and 132 n mol of acetylene (10(8)cells(-1)h(-1)) respectively. They were grown in large amount and sprayed on the phyllosphere of maize plants as a substitute for nitrogenous fertilizer. Marked improvements in growth and total nitrogen content of the plant have been observed by the application of these nitrogen-fixing bacteria. An average 30-37% increase in yield was obtained, which is nearer to chemical fertilizer treatment. Comparatively better effect was obtained by application of *Flavobacterium* sp.

Kumar RS, Ayyadurai N, Pandiaraja P, Reddy AV, Venkateswarlu Y, Prakash O, Sakthivel N. (Department of Biotechnology, Pondicherry University, Kalapet, Pondicherry, India.), **Characterization of antifungal metabolite produced by a new strain *Pseudomonas aeruginosa* PUPa3 that exhibits broad-spectrum antifungal activity and biofertilizing traits.** *J Appl Microbiol.*, 98(1) (2005):145-54.

AIM: To study the antifungal activity and plant beneficial traits of a broad-spectrum antagonistic fluorescent pseudomonad strain, PUPa3. METHODS AND RESULTS: Strain PUPa3 was isolated from the rhizosphere soil of rice and identified as *Pseudomonas aeruginosa* on the basis of biochemical tests and by comparison of 16S rDNA sequences. This bacterium exhibits a

broad-spectrum antifungal activity towards phytopathogenic fungi. The antifungal metabolite by PUPa3 was extracted, purified and characterized using nuclear magnetic resonance (NMR) and mass spectroscopy (MS). Production of indole-3-acetic acid (IAA), siderophores, phosphatase and protease in PUPa3 was determined. Strain PUPa3 did not produce hydrogen cyanide, cellulase and pectinase. **CONCLUSION:** The antifungal metabolite produced by PUPa3 has been identified as phenazine-1-carboxamide (PCN) on the basis of NMR and MS data. Strain PUPa3 showed a broad-spectrum antifungal activity towards a range of phytopathogenic fungi. This bacterium also showed several plant growth-promoting traits but did not show the traits attributed to deleterious rhizobacteria. **SIGNIFICANCE AND IMPACT OF THE STUDY:** Present study reports the production of PCN as well as IAA for the first time by a saprophytic *P. aeruginosa* strain PUPa3. Because of the production of siderophore, growth hormone, protease and phosphatase and its innate fungicidal potential, this strain can be used as biofertilizer and antagonist against a range of phytopathogenic fungi that infect rice, groundnut, tobacco, chili, mango, sugarcane, tea, cotton and banana.

Jayaraj J, Muthukrishnan S, Liang GH. (Department of Biochemistry, Kansas State University, Manhattan 66506, USA. jaya@sfu.ca), Transfer of a plant chitinase gene into a nitrogen-fixing Azospirillum and study of its expression. Can J Microbiol. 50(7) (2004): 509-13.

Azospirillum is used extensively in rice and other cereal crops as a biofertilizer. There is a substantial opportunity to improve the efficiency of this bacterium through the transfer of genes of agricultural importance from other organisms. Chitinases are antifungal proteins, and expression of chitinase genes in Azospirillum would help to develop strains with potential antifungal activities. So far there are no reports about transfer of plant genes into Azospirillum and their expression. The present study was aimed at expressing an antifungal gene (a rice chitinase) of plant origin in Azospirillum brasilense. A rice chitinase cDNA (RC 7) that codes for a 35 kDa protein was subcloned into a broad host range plasmid pDSK519 under the control of LacZ promoter. The plasmid was mobilized into the nitrogen-fixing bacterium, Azospirillum brasilense strain SP51eFL1, through biparental mating. The conjugation frequency was in the range of $35\text{-}40 \times 10^{-6}$. The transconjugants grew in nitrogen-free media and fixed gaseous nitrogen in vitro. However, their growth and nitrogen-fixing ability were slightly less than those of the wild-type. Expression of the protein was demonstrated through western blotting of the total cell protein, which detected a 35 kDa band that was immuno-reactive to a barley chitinase antibody. The cell lysates also hydrolyzed various chitin substrates, which resulted in release of free sugars demonstrating the chitinase activity of transconjugants. The expressed protein also had antifungal activity as demonstrated by inhibition of growth of the plant pathogenic fungus, *Rhizoctonia solani*.

Zhang X, Zhao H, Zhang J, Li Z. (State Key Laboratory of Biochemical Engineering, Institute of Chemical Metallurgy, Chinese Academy of Sciences, P.O. Box 353, Beijing 100080. zhangxyy@yahoo.com), Growth of Azotobacter vinelandii in a solid-state fermentation of technical lignin. Bioresour Technol., 95(1) (2005): 31-33.

Azotobacter vinelandii was cultured on technical lignin, derived from Kraft pulping processes, for biofertilizer production in solid-state fermentation. The effects of the ratio of technical lignin to corn straw, initial water content, and material bed depth on the microorganisms were studied in detail. At 30 degrees C, technical lignin to corn straw at the ratio of 1:0.75, the bed depth of 5 cm, and 67% moisture content, *A. vinelandii* was grown and reached 4.2×10^{10} cfu g⁻¹ dry rot after 36 h.

Biocomposting

Arancon NQ, Galvis PA, Edwards CA. (Soil Ecology Laboratory, The Ohio State University, 400 Aronoff Laboratory, 318 W. 12th Avenue, Columbus, OH 43210, USA. arancon.1@osu.edu), Suppression of insect pest populations and damage to plants by vermicomposts. Bioresour Technol. 96(10) (2005): 1137-42.

The effects of commercial vermicomposts, produced from food waste, on infestations and damage by aphids, mealy bugs and cabbage white caterpillars were studied in the greenhouse. Vermicomposts were used at substitution rates into a soil-less plant growth medium, MetroMix 360 (MM360), at rates of 100% MM360 and 0% vermicompost, 80% MM360 and 20% vermicompost, and 60% MM360 and 40% vermicompost to grow peppers (*Capsicum annum* L.), tomatoes (*Lycopersicon esculentum* Mill.) and cabbages (*Brassica oleracea* L.), in pots. Groups of 10 pots containing young plants were distributed randomly in nylon mesh cages (40 cm x 40 cm x 40 cm). Groups of 10 pepper seedlings in a single cage were infested with either 100 aphids (*Myzus persicae* Sulz.) or 50 mealy bugs (*Pseudococcus* spp.) per cage. Similar groups of tomato seedlings were infested with 50 mealy bugs per cage. Groups of four cabbage seedlings in pots in cages were infested with 16 cabbage white caterpillars (*Pieris brassicae* L.). Populations of aphids and mealy bugs were counted after 20 days and the shoot dry weights of peppers, tomatoes and cabbages were measured at harvest. Numbers of cabbage white caterpillars and loss in shoot weights were measured after 15 days. The substitution rates of 20% and 40% vermicomposts suppressed populations of both aphids and mealy bugs on peppers, and mealy bugs on tomatoes, significantly. Substitutions with vermicomposts into MM360 decreased losses of dry weights of peppers, in response to both aphid and mealy bug infestations, decreased losses in shoot dry weights of tomatoes after mealy bug infestations significantly. There were significantly decreased losses in leaf areas of cabbage seedlings in response to the cabbage white caterpillar infestations.

Garg VK, Kaushik P. (Department of Environmental Science and Engineering, Guru Jambheshwar University, Hisar 125001, India. vinodkgarg@yahoo.com), Vermistabilization of textile mill sludge spiked with poultry droppings by an epigeic earthworm *Eisenia foetida*. Bioresour Technol. 96(9) (2005): 1063-71.

Investigations were made to explore the potential of an epigeic earthworm *Eisenia foetida* to transform textile mill sludge spiked with poultry droppings in to value added product, i.e., vermicompost. The growth and reproduction of *E. foetida* was monitored in a range of different feed mixtures for 77 days in the laboratory under controlled experimental conditions. The

maximum growth was recorded in 100% cow dung (CD). Replacement of poultry droppings by cow dung in feed mixtures and vice versa had little or no effect on worm growth rate and reproduction potential. Worms grew and reproduced favourably in 70% poultry droppings (PD)+30% solid textile mill sludge (STMS) and 60% PD+40% STMS feed mixtures. Greater percentage of STMS in the feed mixture significantly affected the biomass gain and cocoon production. Net weight gain by earthworms in 100% CD was 2.9-18.2 fold higher than different STMS containing feed mixtures. The mean number of cocoon production was between 23.4+/-4.65 (in 100% CD) and 3.6+/-1.04 (in 50% PD+50% STMS) cocoons earthworm(-1) for different feed mixtures tested. Vermicomposting resulted in significant reduction in C:N ratio and increase in nitrogen and phosphorus contents. Total potassium, total calcium and heavy metals (Fe, Zn, Pb and Cd) contents were lower in the final product than initial feed mixtures. Our trials demonstrated vermicomposting as an alternate technology for the recycling and environmentally safe disposal/management of textile mill sludge using an epigeic earthworm *E. foetida* if mixed with poultry droppings.

Kalam A, Tah J, Mukherjee AK. (Department of Botany, Burdwan University, Burdwan-713 104, India.), Pesticide effects on microbial population and soil enzyme activities during vermicomposting of agricultural waste. J Environ Biol. 25(2) (2004): 201-8.

The effects of different pesticides (propiconazole, profenofos, pretilachlor) on vermicomposting were evaluated for the adverse effects on soil enzyme activities (dehydrogenase, phosphatase, urease) and total microbial counts (TMC). There were remarkable increase in enzyme activities and TMC in presence of earthworm compared to control (earthworm absent). In comparison to control, the activities of phosphatase, dehydrogenase and urease in presence of vermicompost increased upto 30, 128 and 31.3% respectively; whereas increase of TMC was 71.9%. But, in presence of each of the pesticide, said activities decreased. Maximum inhibition of soil phosphatase activity (46.6%) was observed in presence of propiconazole (100 mg kg(-1)) after 120 days. Profenofos affected the soil dehydrogenase activity in the tune of 47% at 1000 mg kg(-1) concentration after 80 days and thereafter, the extent of toxicity decreased little. Soil urease activity was affected markedly in presence of profenofos and was 62% at 1000 mg kg(-1) level after 80 days. TMC also declined in presence of profenofos and pretilachlor. Increase in TMC was about 71.9% compared to control and the inhibition was more or less 60% when profenofos (1000 mg kg(-1)) was present even after 120 days of treatment.

Kaushik P, Garg VK. (Department of Environmental Science and Engineering, Guru Jambheshwar University, Hisar 125001, India.), Dynamics of biological and chemical parameters during vermicomposting of solid textile mill sludge mixed with cow dung and agricultural residues. Bioresour Technol. 94(2) (2004): 203-209.

In India, thousands of tons of textile mill sludge are produced every year. We studied the ability of epigeic earthworm *Eisenia foetida* to transform textile mill sludge mixed with cow dung and/or agricultural residues into value added product, i.e., vermicompost. The growth, maturation, mortality, cocoon production, hatching success and the number of hatchlings were monitored in a range of different feed mixtures for 11 weeks in the laboratory under controlled environmental conditions. The maximum growth and reproduction was obtained in 100% cow dung, but worms grew and reproduced favorably in 80% cow dung + 20% solid textile mill

sludge and 70% cow dung + 30% solid textile mill sludge also. Addition of agricultural residues had adverse effects on growth and reproduction of worms. Vermicomposting resulted in significant reduction in C:N ratio and increase in TKN, TP, TK and TCa after 77 days of worm activity in all the feeds. Vermicomposting can be an alternate technology for the management of textile mill sludge if mixed with cow dung in appropriate quantities. Copyright 2003 Elsevier Ltd.

Arancon NQ, Edwards CA, Atiyeh R, Metzger JD. (Soil Ecology Laboratory, The Ohio State University, 400 Aronoff Laboratory, 318 W 12th Avenue, Columbus, OH 43210, USA. arancon.1@osu.edu), Effects of vermicomposts produced from food waste on the growth and yields of greenhouse peppers. Bioresour Technol. 93(2) (2004): 139-44.

Vermicomposts, produced commercially from food wastes, were substituted at a range of different concentrations into a soil-less commercial bedding plant container medium, Metro-Mix 360 (MM360), to evaluate their effects on the growth and yields of peppers in the greenhouse. Six-week-old peppers (*Capsicum annum* L. var. California) were transplanted into 100%, 80%, 60%, 40%, 20% or 10% MM360 substituted with 0%, 10%, 20%, 40%, 60%, 80% and 100% vermicompost. All plants were watered three times weekly with 200 ppm Peter's Nutrient Solution from the time of transplanting up to 107 days. Peppers grown in potting mixtures containing 40% food waste vermicomposts and 60% MM360 yielded 45% more fruit weights and had 17% greater mean number of fruits than those grown in MM360 only. The mean heights, numbers of buds and numbers of flowers of peppers grown in potting mixtures containing 10-80% vermicompost although greater did not differ significantly from those of peppers grown in MM360. There were no positive correlations between the increases in pepper yields, and the amounts of mineral-N and microbial biomass-N in the potting mixtures, or the concentrations of nitrogen in the shoot tissues of peppers. Factors such as: an improvement of the physical structure of the potting medium, increases in populations of beneficial microorganisms and the potential availability of plant growth-influencing-substances produced by microorganisms in vermicomposts, could have contributed to the increased pepper yields obtained. Copyright 2003 Elsevier Ltd.

Ghosh C. (Centre for Environmental Management and Degraded Ecosystem, School of Environmental Studies, University of Delhi, New Delhi 110 007, India) Integrated vermipisciculture--an alternative option for recycling of solid municipal waste in rural India. Bioresour Technol. 93(1) (2004): 71-5.

Vermicomposts as a biofertilizer can be a great option for pond manuring as they never cause any long term harm to the soil like chemical fertilizer. In this study vegetable and horticulture waste was used as an important media for vermiculture. Three separate cemented tanks (6 m(3) each) were used in the system as control tank, vermicompost fertilized tank and inorganic fertilizer manured tank. Monoculture of fish was carried out with cat fish, *Clarias batrachus*. The produced earthworms were used as fish feed. Regular monitoring of water parameter was conducted in three different ponds. Specifically, the algal biomass variation was quite helpful in analyzing the behavior of the ponds. NPK value of soil samples were analyzed intermittently to know the eutrophication level. Despite the hot summer temperature in northern part of India,

which is not ideal for fish growth, we have recorded an encouraging growth performance in organic manured pond along with inorganic fertilizer treated and control pond. Among eutrophicated pond, the fish biomass from vermicompost fed pond showed an increasing trend compared to inorganic fertilizer treated pond. Water retention capacity of vermicompost pond soil was better in comparison to other ponds. Result shows that the low cost model by integrating two production system vermiculture and pisciculture could be a commercially and environmentally viable option.

Biopesticide

Ros M, Hernandez MT, Garcia C, Bernal A, Pascual JA. (Department of Soil Water Conservation and Organic Waste Management, Centro de Edafologia y Biologia Aplicada del segura (CEBAS-CSIC), 30100 Espinardo, Murcia, Spain.) Biopesticide effect of green compost against fusarium wilt on melon plants. J Appl Microbiol. 98(4) (2005):845-54

AIMS: The biopesticide effect of four green composts against fusarium wilt in melon plants and the effect of soil quality in soils amended with composts were assayed. METHODS AND RESULTS: The composts consisted of pruning wastes, with or without addition of coffee wastes (3/1 and 4/1, dry wt/dry wt) or urea (1000/1, dry wt/dry wt). In vitro experiments suggested the biopesticide effect of the composts against *Fusarium oxysporum*, while only the compost of pine bark and urea (1000/1dry wt/dry wt) had an abiotic effect. Melon plant growth with composts and *F. oxysporum* was one to four times greater than in the non-amended soil, although there was no significant decrease in the level of the *F. oxysporum* in the soil. The addition of composts to the soil also improved its biological quality, as assessed by microbiological and biochemical parameters: ATP and hydrolases involved in the P (phosphatase), C (beta-glucosidase) and N (urease) cycles. CONCLUSIONS: Green composts had greater beneficial characteristics, improved plant growth and controlled fusarium wilt in melon plants. These composts improve the soil quality of semi-arid agricultural soils. SIGNIFICANCE AND IMPACT OF THE STUDY: Biotic and abiotic factors from composts have been tested as responsible of their biopesticide activity against fusarium wilt.

Dey S, Sinha B, Kalita J. (Electron Microscopy Division, Sophisticated Analytical Instrument Facility, North Eastern Hill University, Laitumkhrach, Shillong-793003, Meghalaya, India. sudipdeysic@yahoo.com). Effect of Eupatorium adenophorum Spreng leaf extracts on the mustard aphid, *Lipaphis erysimi* Kalt: a scanning electron microscope study. Microsc Res Tech. 66(1) (2005): 31-6.

Scanning electron microscopic study revealed some remarkable adverse effects of *Eupatorium adenophorum* Spreng leaf extract on cuticular and antennal sensilla of the mustard aphid, *Lipaphis erysimi* Kalt. The study appears to be the first of its kind in providing evidence on toxic property of the plant on certain agricultural pests, although the indigenous tribes of the region know the insecticidal property of the plant for a long time. The study further provides indications regarding the neurotoxic nature of the leaf extract since it has caused abnormalities in the sensory structures. The presence of prominent swellings in some sensilla and shrinkage in others

suggests that the leaf extract affects different systems through different mechanisms. The possible use of the plant as a potential biopesticide against certain insect pests is discussed. Copyright 2005 Wiley-Liss, Inc.

Yeza A, Tyagi RD, Valero JR, Surampalli RY, Smith J. (INRS Eau, Terre et Environnement (INRS-ETE), 2800 Rue Einstein, CP 7500, Sainte-Foy, QC, G1V4C7, Canada). Scale-up of biopesticide production processes using wastewater sludge as a raw material. J Ind Microbiol Biotechnol. 31(12) (2004): 545-52.

Studies were conducted on the production of *Bacillus thuringiensis* (Bt)-based biopesticides to ascertain the performance of the process in shake flasks, and in two geometrically similar fermentors (15 and 150 l) utilizing wastewater sludge as a raw material. The results showed that it was possible to achieve better oxygen transfer in the larger capacity fermentor. Viable cell counts increased by 38-55% in the bioreactor compared to shake flasks. As for spore counts, an increase of 25% was observed when changing from shake flask to fermentor experiments. Spore counts were unchanged in bench (15 l) and pilot scale (5.3-5.5 e(+08) cfu/ml; 150 l). An improvement of 30% in the entomotoxicity potential was obtained at pilot scale. Protease activity increased by two to four times at bench and pilot scale, respectively, compared to the maximum activity obtained in shake flasks. The maximum protease activity (4.1 IU/ml) was obtained in pilot scale due to better oxygen transfer. The Bt fermentation process using sludge as raw material was successfully scaled up and resulted in high productivity for toxin protein yield and a high protease activity.

Koul O, Singh G, Singh R, Daniewski WM, Berlozecki S.. (Insect Biopesticide Research Centre, 30 Parkash Nagar, Jalandhar 144 003, India. koul@jla.vsnl.net.in). Bioefficacy and mode-of-action of some limonoids of salannin group from *Azadirachta indica* A. Juss and their role in a multicomponent system against lepidopteran larvae. J Biosci., 29(4) (2004): 409-16.

Biological activities of the salannin type of limonoids isolated from *Azadirachta indica* A. Juss were assessed using the gram pod borer *Helicoverpa armigera* (Hubner) and the tobacco armyworm *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae). Inhibition of larval growth was concomitant with reduced feeding by neonate and third instar larvae. All three compounds exhibited strong antifeedant activity in a choice leaf disc bioassay with 2.0, 2.3 and 2.8 microg/cm(2) of 3-O-acetyl salannol, salannol and salannin, respectively deterring feeding by 50% in *S. litura* larvae. In nutritional assays, all three compounds reduced growth and consumption when fed to larvae without any effect on efficiency of conversion of ingested food (ECI), suggesting antifeedant activity alone. No toxicity was observed nor was there any significant affect on nutritional indices following topical application, further suggesting specific action as feeding deterrents. When relative growth rates were plotted against relative consumption rates, growth efficiency of the *H. armigera* fed diet containing 3-O-acetyl salannol, salannol or salannin did not differ from that of starved control larvae (used as calibration curve), further confirming the specific antifeedant action of salannin type of limonoids. Where the three compounds were co-administered, no enhancement in activity was observed. Non-azadirachtin limonoids having structural similarities and explicitly similar modes of action, like feeding deterrence in the present case, have no potentiating effect in any combination.

Jones T, Scott-Dupree C, Harris R, Shipp L, Harris B. (Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1.). The efficacy of spinosad against the western flower thrips, *Frankliniella occidentalis*, and its impact on associated biological control agents on greenhouse cucumbers in southern Ontario. *Pest Manag Sci.*, 61(2) (2005): 179-85.

Insecticides are the most commonly used tactic to control western flower thrips (WFT), *Frankliniella occidentalis* Pergande (Thysanoptera: Thripidae), on greenhouse cucumber. However, WFT has developed resistance to several of the insecticides presently in use. In addition, some of these insecticides adversely affect greenhouse biological control agents used to control WFT, resulting in subsequent pest resurgence. Therefore, there is a need to identify novel insecticides with unique modes of action for use in integrated pest management (IPM) programs to effectively control WFT with minimal impact on associated biological control agents. In laboratory bioassays conducted in 2001, immature and adult WFT and three associated greenhouse biological control agents: *Amblyseius cucumeris* Oudemans (Acarina: Phytoseiidae), *Orius insidiosus* Say (Hemiptera: Anthocoridae) and *Encarsia formosa* Gahan (Hymenoptera: Aphelinidae) were exposed to direct, direct/residual, and residual contact applications of the novel biopesticide, spinosad (Conserve 120 SC), and the industry standard for whitefly control, endosulfan (Thiodan 50 WP). In all three types of assay, spinosad was effective against immature and adult WFT life stages. It showed low toxicity to *A. cucumeris*, moderate toxicity to *O. insidiosus* and high toxicity to *E. formosa*. Greenhouse studies involving exposure of immature and adult WFT and adult biological control agents to cucumber leaves sprayed previously with spinosad supported the laboratory data. Spinosad showed low toxicity to *A. cucumeris* exposed to leaves 1 day after treatment (DAT), moderate toxicity to *O. insidiosus* 1 and 8 DAT, and high toxicity to *E. formosa* up to 28 DAT. These data, along with spinosad's unique mode of action, suggest it would be a valuable reduced-risk control agent for greenhouse cucumber IPM programs. Copyright (c) 2005 Society of Chemical Industry.

Biodegradation

Laternus F, Fahimi I, Gryndler M, Hartmann A, Heal MR, Matucha M, Scholer HF, Schroll R, Svensson T. (The Swedish Institute for Climate Science and Policy Research, ITUF, Linköpings universitet, 601 74 Norrköping, Sweden. frank.laternus@ituf.liu.se). Natural formation and degradation of chloroacetic acids and volatile organochlorines in forest soil--challenges to understanding. *Environ Sci Pollut Res Int.*, 12(4) (2005): 233-44.

The anthropogenic environmental emissions of chloroacetic acids and volatile organochlorines have been under scrutiny in recent years because the two compound groups are suspected to contribute to forest dieback and stratospheric ozone destruction, respectively. The two organochlorine groups are linked because the atmospheric photochemical oxidation of some volatile organochlorine compounds is one source of phytotoxic chloroacetic acids in the environment. Moreover, both groups are produced in higher amounts by natural chlorination of organic matter, e.g. by soil microorganisms, marine macroalgae and salt lake bacteria, and show

similar metabolism pathways. Elucidating the origin and fate of these organohalogens is necessary to implement actions to counteract environmental problems caused by these compounds.

Ito Y, Hasuda H, Morimatsu M, Takagi N, Hirai Y. (Kanagawa Academy of Science and Technology, KSP East 309, 3-2-1 Sakado, Takatsu-ku, Kawasaki, 213-0012, Japan. y-ito@ksp.or.jp). A microfabrication method of a biodegradable polymer chip for a controlled release system. J Biomater Sci Polym Ed., 16(8) (2005): 949-55.

A simple microfabrication method for a controlled-release drug-delivery system has been designed using biodegradable polymeric microchips. Microholes were made in a poly(L-lactic acid) plate and dyes were cast in each well. After drying, the wells were sealed with polymers having different biodegradation rates using a mold that had hollows corresponding to the wells. The polymers were prepared by mixing polylactides with the co-polymers. The sealing was confirmed by ultrasonication. The plate was incubated in phosphate-buffered saline and the dye released from the plate as the degradation proceeded was detected spectrophotometrically. The higher the degradation rate of the polymer sealing, the faster the sealed dye was released. This biodegradable biochip is useful for the design of controlled-release drug-delivery systems.

Xia WX, Zheng XL, Li JC, Song ZW, Zhou L, Sun HF. (Department of Environmental Engineering, Ocean University of China, Qingdao 266003, China. xiawx2001@yahoo.com.cn). Degradation of crude oil by indigenous microorganisms supplemented with nutrients. J Environ Sci (China), 17(4) (2005): 659-61.

Different kinds of mineral nutrients($\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$ and $\text{PO}_4\text{-P}$) were applied in the simulated oil-polluted seawater for enhancing oil biodegradation in the N/P ratio 10:1 and 20:1. Although indigenous microorganisms have the ability to degrade oil, adding nutrients accelerated biodegradation rates significantly. For the group amended with $\text{NO}_3\text{-N}$ and $\text{PO}_4\text{-P}$ in the ratio 10:1, the reaction rate coefficient was 4 times higher than the natural biodegradation. Chemical and microbiological analysis showed that the optimal N/P ratio in the system is 10:1, and microorganisms tend to utilize nitrate rather than ammonium as N source.

Wang J, Yan B, Zhou JT, Bao YM, Lu H, Yuan XD. (School of Environmental and Biological Science and Technology, Dalian University of Technology, Dalian 116023, China. wangjing1967@sohu.com). Biodegradation of azo dyes by genetically engineered azoreductase. J Environ Sci (China), 17(4) (2005): 545-50.

A azoreductase gene with 537 bp was obtained by PCR amplification from *Rhodobacter sphaeroides* AS1.1737. The enzyme, with a molecular weight of 18.7 kD, was efficiently expressed in *Escherichia coli* and its biodegradation characteristics for azo dyes were investigated. Furthermore, the reaction kinetics and mechanism of azo dyes catalyzed by the genetically engineered azoreductase were studied in detail. The presence of a hydrazo-intermediate was identified, which provided a convincing evidence for the assumption that azo dyes were degraded via an incomplete reduction stage.

Xiang-Rong Xu^a, Hua-Bin Li^a and Ji-Dong Gu^b. (^aLaboratory of Environmental Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong, People's Republic of China, ^b The Swire Institute of Marine Science, The University of Hong Kong, Shek O, Cape d'Aguilar, Hong Kong, People's Republic of China). **Biodegradation of an endocrine-disrupting chemical di-*n*-butyl phthalate ester by *Pseudomonas fluorescens* B-1. *International Biodeterioration & Biodegradation*, 55(1) (2005): 9-15.**

Di-*n*-butyl phthalate ester (DBP) is known as an endocrine-disrupting chemical. A pure culture capable of using DBP as the sole source of carbon and energy from mangrove sediment was identified as *Pseudomonas fluorescens* B-1. Microbial degradation of DBP was studied in batch experiments for several environmental factors. The effect of initial DBP concentrations on the degradation was investigated between 2.5 and 10.0 mg l⁻¹, and the results showed that the biodegradation process conformed to the first-order kinetic model. The pH value of the culture medium also played an important role in the biodegradation of DBP, the optimum pH being 7.0. The effects of temperature and oxygen availability on the kinetics of DBP biodegradation were also determined. Degradation of DBP by *P. fluorescens* B-1 was quantified by reversed-phase high-performance liquid chromatography after solid-phase extraction. Two metabolites of DBP degradation were identified as mono-butyl phthalate and phthalic acid by gas chromatography-mass spectrometry. The results suggest that DBP can be degraded by indigenous microorganisms from the mangrove environment.

Kargi Fikret and Eker Serkan. (Department of Environmental Engineering, Tinaztepe Campus, Dokuz Eylul University, Buca, Izmir, Turkey). Kinetics of 2,4-dichlorophenol degradation by *Pseudomonas putida* CP1 in batch culture. *International Biodeterioration & Biodegradation*, 55(1) (2005): 25-28.

Biological degradation of 2,4-dichlorophenol (DCP) by *Pseudomonas putida* CP1 was investigated in batch shake flask-cultures. Experiments were carried out at initial DCP concentrations between 50 and 750mg l⁻¹ and the rate and extent of DCP degradation were quantified. With increasing initial DCP concentrations in shake-flask cultures, percentage removal of DCP decreased and residual DCP concentrations increased proportionally. The rate of DCP degradation increased with increasing initial DCP concentration up to 577mg DCP l⁻¹. Further increases in DCP concentration caused decreases in the rate of degradation because of substrate inhibition. A kinetic model based on substrate inhibition was proposed. Rate and inhibition constants were determined using the experimental data.

Abdullah Istek, Huseyin Sivrikaya, Hudaverdi Eroglu, Sezgin K.Gulsoy. (Bartın Faculty of Forestry, Zonguldak Karaelmas University, 74100 Bartın, Turkey). Biodegradation of *Abies bornmuelleriana* (Mattf.) and *Fagus orientalis* (L.) by the white rot fungus *Phanerochaete chrysosporium*. *International Biodeterioration & Biodegradation*, 55 (2005): 63 – 67.

The effects of *Phanerochaete chrysosporium* a white rot fungus, on the chemical composition of *Abies bornmulleriana* and *Fagus orientalis* wood chips were investigated. After the chips were

inoculated with the fungus, 20, 40 and 60-day samples were analyzed in order to determine the influence of fungal treatment on the chemical components of the cell walls, and the .bre properties of both species were measured. As a result of *P. chrysosporium* growth, both types of wood had slight relative increases in percentage cellulose. Percentage holocellulose showed statistically significant decreases and solubility values increased considerably. The lignin ratio for *F. orientalis* decreased significantly in relation to zero-time control samples.

Raeid M.M. Abed, and Jurgen Koster (Max-Planck Institute for Marine Microbiology, Celsiusstrasse 1, D-28359 Bremen, Germany, Institute for Chemistry and Biology of the Marine Environment (ICBM), Carl von Ossietzky University of Oldenburg, P.O. Box 2503, D-26111 Oldenburg, Germany). The direct role of aerobic heterotrophic bacteria associated with cyanobacteria in the degradation of oil compounds. *International Biodeterioration & Biodegradation*, 55(1) (2005): 29 –37.

This study aimed at evaluating the role of cyanobacteria and their associated aerobic heterotrophic bacteria in biodegradation of petroleum compounds. We investigated the potential of ten non-axenic typical mat-forming cyanobacterial strains to degrade phenanthrene, pristane, noctadecane, and dibenzothiophene. Five strains (*Aphanothece halophyletica* *Dactylococcopsis salina* *Halothece* strain EPUS, *Oscillatoria* strain OSC, and *Synechocystis* strain UNIGA) were able to degrade n alkanes. In case of the other .ve strains (*Microcoleus chthonoplastes* *Oscillatoria* sp. MPI 95 OS 01, *Halothece* strain EPUG, *Halomiconema exentricum* and *Phormidium* strain UNITF) alkanes were not significantly affected. Moderate changes in the concentration of the aromatic compounds were observed for three isolates only. In follow-up experiments with *Oscillatoria* strain OSC, we demonstrated that the cyanobacteria-associated aerobic heterotrophic bacteria were responsible for the observed biodegradation. The cyanobacteria themselves apparently do not degrade petroleum compounds, but more likely play a significant, indirect role in biodegradation by supporting the growth and activity of the actual degraders.

V.L. Gemini^a, A. Gallego^a, V.M. de Oliveira^b, C.E. Gomez^c, G.P. Manfio^b and S.E.Korol^a . (^aCátedra de Higiene y Sanidad, Facultad de Farmacia y Bioquímica, Universidad de Buenos Aires. Junín 956 4°Piso, (1113), Buenos Aires, Argentina, ^bDivisao de Recursos Microbianos, Centro Pluridisciplinar de Pesquisas Químicas, Biológicas e Agrícolas (CPQBA), Universidade Estadual de Campinas (UNICAMP), Caixa Postal 6109 13081-970 Campinas, SP, Brasil, ^cInstituto Nacional del Agua, C.C. No 7, (1802), Aeropuerto Internacional de Ezeiza, Buenos Aires, Argentina). *Biodegradation and detoxification of p-nitrophenol by Rhodococcus wratislaviensis. International Biodeterioration & Biodegradation*, 55(2) (2005): 103-108.

An indigenous bacterial strain capable of utilizing *p-nitrophenol* (PNP) as the sole carbon, nitrogen and energy source was isolated from a river sediment in Buenos Aires (Argentina). The 16S rDNA sequence showed a close relationship to *Rhodococcus wratislaviensis*. This indigenous bacterial strain degrades 0.36 and 0.72 mM PNP in 34 and 56 h, respectively, and releases the nitro group from the compound as nitrite. Aerobic biodegradation assays were performed using a 2-L microfermentor at 28°C with agitation (200 rpm). Biodegradation was evaluated by spectrophotometry, gas chromatography and microbial growth. As the nitrite

released during PNP degradation is also an environmental toxic agent it was removed by adding a denitrification step in an anoxic process. Detoxification was evaluated by using a *Daphnia magna* toxicity test. Toxicity was not detected after the combination of both, an aerobic biodegradation test and denitrification in an anoxic process.

Jiayi Li^a, Ji-Dong Gu^{a, b, c} and Li Pan^b . (^aSurface Marine Biology and Environmental Microbiology Group, Key Laboratory of Tropical Marine Environment Dynamics (LED), South China Sea Institute of Oceanography, Chinese Academy of Sciences, 164 West Xingang Road, Guangzhou 510301, PR China, ^bLaboratory of Environmental Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, 3S-11 Kadoorie BSB, Pokfulam Road, Hong Kong, ^cThe Swire Institute of Marine Science, The University of Hong Kong, Cape d'Aguilar, Shek O, Hong Kong). Transformation of dimethyl phthalate, dimethyl isophthalate and dimethyl terephthalate by *Rhodococcus rubber* Sa and modeling the processes using the modified Gompertz model. *International Biodeterioration & Biodegradation*, 55(3) (2005): 223-232.

Phthalate ester isomers, including dimethyl phthalate (DMP), dimethyl isophthalate (DMI) and dimethyl terephthalate (DMT), were found to be transformed by *Rhodococcus rubber* Sa isolated from a mangrove sediment using DMT as a carbon source initially. At a concentration of 80 mg l⁻¹, transformation of DMP, DMI and DMT was achieved in 9, 1 and 5 days, respectively. During the hydrolytical transformation of DMP, DMI and DMT, their corresponding intermediates were identified as mono-methyl phthalate (MMP), mono-methyl isophthalate (MMI) and mono-methyl terephthalate (MMT), suggesting that transformation of all three isomers followed an identical biochemical pathway of de-esterification. However, none of the produced monoesters was further transformed by *R. rubber* Sa and they accumulated in the culture media during incubation. It seems that further transformation of monoesters require a set of hydrolytic enzymes different from those involved in the first transformation reaction. Kinetics of DMT, DMI and DMP transformation was well described by the modified Gompertz model independent of the individual substrate condition or a mixture of the three isomers. Both DMI and DMT were easier transformed substrates than DMP, resulting in higher maximum transformation rate (R_m) and shorter lag time phase (λ) derived from the modified Gompertz model. The modified Gompertz model based on one-substrate system can be used in fitting transformation kinetics of mixture substrate system. Our data suggest that degradation of phthalate diesters involves different enzymes in the hydrolysis of the two identical ester groups.

R. Boopathy. (Department of Biological Sciences, Nicholls State University, P.O. Box 2021, Thibodaux, LA 70310, USA). Bioremediation of tetryl-contaminated soil using sequencing batch soil slurry reactor. *International Biodeterioration & Biodegradation*, 55(4) (2005): 293-297.

A laboratory study was conducted to determine whether tetryl (2,4,6-trinitrophenylmethylamine) contaminated soil could be bioremediated using a sequencing batch soil slurry reactor (SBR) operated under anoxic-aerobic sequence. The results indicated that tetryl was co-metabolically converted to aniline under anoxic conditions with molasses as the growth substrate. The gas chromatographic/mass spectrometric analysis of the soil slurry

showed various metabolites, identified as trinitrobenzeneamine, dinitrobenzenediamine, nitroaniline and aniline. Aniline was not metabolized further under anoxic conditions. When the soil slurry reactor was operated under aerobic conditions, the aniline concentration was reduced to below the detection limit (0.05 ppm). This metabolic conversion of tetryl is probably of value in the treatment of tetryl-contaminated soil and ground water, such as those found at the Joliet army ammunition plant site in Illinois and the Iowa army ammunition plant site in Burlington, Iowa.

Esmail S. AL-Saleh and Christian Obuekwe. (Microbiology Program, Department of Biological Sciences, P.O. Box 5969, Safat 13060, Faculty of Science, Kuwait University, State of Kuwait). Inhibition of hydrocarbon bioremediation by lead in a crude oil-contaminated soil. *International Biodeterioration & Biodegradation*, 56(1) (2005): 1-7.

Analyses of soil samples revealed that the level of lead (total or bioavailable) was three-fold greater in crude oil contaminated than in uncontaminated Kuwaiti soils. Investigation of the possible inhibitory effect of lead on hydrocarbon degradation by the soil microbiota showed that the number of hydrocarbon-degrading bacteria decreased with increased levels of lead nitrate added to soil samples, whether oil polluted or not. At 1.0 mg lead nitrate g⁻¹ dry soil, the number of degraders of hexadecane, naphthalene and crude oil declined by 14%, 23% and 53%, respectively. In a similar manner, the degradation and mineralization of different hydrocarbons decreased with increased lead content in cultures, although the decreases were not significantly different ($P>0.05$). The dehydrogenase activities of soil samples containing hydrocarbons as substrates also declined with an increase in the lead content of soil samples.

Silvia F. Pesce and Daniel A. Wunderlin. (Departamento Bioquímica Clínica, Facultad de Ciencias Químicas, Universidad Nacional de Córdoba, Pabellón Argentina, Ciudad Universitaria, Córdoba 5000, Argentina). Biodegradation of lindane by a native bacterial consortium isolated from contaminated river sediment. *International Biodeterioration & Biodegradation*, 54(4) (2004): 255-260.

The aerobic biodegradation of lindane (γ -hexachlorocyclohexane) by a consortium of acclimated bacteria from sediment at a polluted site on the Suquia River, Cordoba, Argentina, is reported. The bacteria were acclimated for 30 days under aerobic conditions, using a minimal culture medium containing lindane (0.034 mM) as sole carbon source. Growth of the bacterial consortium decreased at a lindane concentration of 1.03 mM and was totally inhibited at 2.41 mM. The consortium showed initial lindane degradation rates of 4.92×10^{-3} , 11.0×10^{-3} and 34.8×10^{-3} mM h⁻¹ when exposed to lindane concentrations of 0.069, 0.137 and 0.412 mM, respectively. Chloride concentration increased during aerobic biodegradation, indicating lindane mineralization. A metabolite identified as γ -2,3,4,5,6-pentachlorocyclohexene appeared during the first 24 h of biodegradation. Four different bacteria, identified as *Sphingobacterium spiritivorum*, *Ochrobactrum anthropi*, *Bosea thiooxidans* and *Sphingomonas paucimobilis*, were isolated. Pure strains of *B. thiooxidans* and *S. paucimobilis* degraded lindane after 3 days of aerobic incubation. This is the first report of lindane biodegradation by *B. thiooxidans*.

Noemi Mendez-Sanchez, Teresa J. Cutright and Pizhong Qiao (Department of Civil Engineering, The University of Akron, Akron, OH 44325-3905, USA). Accelerated weathering and biodegradation of E-glass polyester composites International Biodeterioration & Biodegradation, 54(4) (2004): 289-296.

Successful material performance of composites depends on the environmental conditions to which they are exposed. Biological factors in aquatic environments may accelerate material deterioration. Simultaneously, leached constituents can adversely affect the surrounding ecosystem. An accelerated weathering was used to demonstrate the ease of coupon biodeterioration. In 3 months, 21 mg l⁻¹ of organics were leached, aquatic bacteria numbers increased by 43%, and biofilm growth was accelerated. Degradability of leached compounds was tested in experiments with water collected from the accelerated weathered coupons and a synthetic leachate. The first experiment verified isophthalaldehyde as a polyester biodegradation byproduct. Although the rate of biodegradation was twice that of the abiotic system, microbial numbers had reduced from 5.0×10⁷ to 5.4×10⁴ CFU l⁻¹. Synthetic resin experiments showed that the bacteria were able to use the resin as a carbon source. However, compound toxicity prevented exponential growth of the bacteria.

Lotta Levén and Anna Schnürer. (Department of Microbiology, Swedish University of Agricultural Sciences, Box 7025, SE-750 07 Uppsala, Sweden). Effects of temperature on biological degradation of phenols, benzoates and phthalates under methanogenic conditions. International Biodeterioration & Biodegradation, 55(2) (2005): 153-160.

The effect of temperature on the efficiency of degradation of the aromatic compounds benzoic acid, 2,3,5-trichlorobenzoic acid, phthalic acid, methyl- and ethylphthalate, resorcinol, phenol, pentachlorophenol, 4-nitrophenol, 4-ethylphenol and *o*-, *m*- and *p*-cresol by a mesophilic or a thermophilic anaerobic community was examined. Anaerobic batch systems were incubated at different temperatures and inoculated with microbial communities from either of two biogas reactors fed with the same substrate, but run at 37 °C or 55°C. Benzoic acid, phthalic acid, methylphthalate, phenol, *m*- and *p*-cresol were mineralised by the mesophilic cultures incubated at 37°C. Apart from benzoic acid, no aromatic compounds were mineralised by the thermophilic community incubated at 55°C, suggesting that channelling reactions to the central intermediate benzoyl-CoA were inoperative in this microbial community. The restricted degradation of phenols observed at 99°C was confirmed by chemical analyses of the anaerobic digestion residue, which contained a higher level of phenols (322µg g⁻¹ total solids) in the system that was run at 55°C than that run at 37°C (65µg g⁻¹). However, a decrease from 99°C to 55°C triggered the degradation of phenol by the thermophilic batch system, most likely due to an activation of enzymes involved in the phenol degradation.

M. Memić^a, M. Vrtačnik^b, V. Vatrenjak-Velagić^a and K.S. Wissiak Grm^b. (^aUniversity of Sarajevo, Zmaja od Bosne 33–35, 71000 Sarajevo, Bosnia and Herzegovina, ^bFaculty of Natural Sciences and Engineering, Department of Chemical Education and Informatics, University of Ljubljana, Vegova 4, 1000 Ljubljana, Slovenia). Comparative biodegradation studies of pre-emergence broadleaf and grass herbicides in aqueous medium. International Biodeterioration & Biodegradation, 55(2) (2005): 109-113.

The biodegradation of the herbicides hexazinone, metribuzin, metobromuron and propachlor was evaluated in liquid cultures of an adapted and a non-adapted mixed microbial culture obtained from a wastewater treatment plant. All herbicides were poorly degraded after 50 days (<50%). The adaptation of microbial culture prior to the biodegradation test shortened only the lag-time in degradation of hexazinone. The level of biodegradation correlated with the log K_{ow} values of the molecules tested ($R^2=0.970$). Metobromuron at 100 mg L^{-1} inhibited the metabolism of aniline by the mixed culture.

Facundo J. Marquez-Rocha^a, Jorge Olmos-Soto, Ma Concepcion Rosano-Hernandez, Manuel Muriel-Garcia. (Departamento de Biotecnología Marina, Centro de Investigación Científica y de Educación Superior de Ensenada PO BOX 434844, San Diego, CA 92143-4844, USA, ^bZona Marina/Tecnología Ambiental, Instituto Mexicano del Petróleo, CD. Carmen Camp, México). **Determination of the hydrocarbon-degrading metabolic capabilities of tropical bacterial isolates. International Biodeterioration & Biodegradation, 55 (2005): 17- 23.**

Of more than 20 bacteria isolated from a tropical soil using minimal medium supplemented with hydrocarbons, 11 grew well on diesel as sole carbon source, and another 11 grew in the presence of polynuclear aromatic hydrocarbons (PAHs). Ten isolates were identified phenotypically as *Pseudomonas* sp. and eight as *Bacillus* sp. Gene sequences representing the catabolic genes (alkM, todM, ndoM and xylM and 16S rRNA gene sequences characteristic for *Pseudomonas* and *Bacillus* were amplified by PCR, using DNA recovered from the supernatant of hydrocarbon-contaminated soil suspensions. Based on their rapid growth characteristics in the presence of hydrocarbons and the formation of PCR products for the catabolic genes alkM and ndoM six isolates were selected for biodegradation assays. After 30 days a mixed culture of two isolates achieved close to 70% hydrocarbon removal and apparent mineralization of 16% of the hydrocarbons present in the soil. Biodegradation rates varied from 275 to 387 mg hydrocarbon kg⁻¹ day⁻¹. Several bacterial isolates obtained in this study have catabolic capabilities for the biodegradation of alkanes and aromatic hydrocarbons including PAHs.

Fikret Kargi and Serkan Eker. (Department of Environmental Engineering, Tinaztepe Campus, Dokuz Eylul University, Buca, Izmir, Turkey). **Kinetics of 2,4-dichlorophenol degradation by *Pseudomonas putida* CP1 in batch culture. International Biodeterioration & Biodegradation, 55 (2005): 25-28.**

Biological degradation of 2,4-dichlorophenol (DCP) by *Pseudomonas putida* CP1 was investigated in batch shake flask cultures. Experiments were carried out at initial DCP concentrations between 50 and 750 mg l⁻¹ and the rate and extent of DCP degradation were quantified. With increasing initial DCP concentrations in shake flask cultures, percentage removal of DCP decreased and residual DCP concentrations increased proportionally. The rate of DCP degradation increased with increasing initial DCP concentration up to 577 mg DCPI l⁻¹. Further increases in DCP concentration caused decreases in the rate of degradation because of substrate inhibition. A kinetic model based on substrate inhibition was proposed. Rate and inhibition constants were determined using the experimental data.

Zhen-Hu Hu, Han-Qing Yu and Ren-Fa Zhu. (Laboratory of Environmental Biotechnology, School of Chemistry, Department of Applied Chemistry, The University of Science and Technology of China, Hefei, Anhui 230026, China). Influence of particle size and pH on anaerobic degradation of cellulose by ruminal microbes. *International Biodeterioration & Biodegradation*, 55(3) (2005): 233-238.

Batch experiments were performed to investigate the influence of cellulose particle size and pH on the anaerobic degradation of crystalline cellulose by ruminal microbes. At a particle size of 50 μm there was a higher hydrolysis and acidogenesis rate, and a reduced degradation time, than for 100- μm particles. Reduction in cellulose particle size resulted in decreased methane production, but an increase of soluble products. Cellulose degradation increased with pH from pH 6.0 to 7.5, whereas at pH \leq 5.5 there was no degradation. The inhibitory effect of low pH (\leq 5.5) on ruminal microbes was not completely remedied even when the pH of the medium was adjusted to a neutral range. In an anaerobic cellulosic waste degrading system inoculated with ruminal microbes the fermentation system should therefore be maintained above pH 6.0. In all cases, volatile fatty acids were the major water-soluble products of cellulose degradation; acetate and propionate accounted for more than 90% of the volatile fatty acid total.

Monika Walter^a, Kirsty Boyd-Wilson^a, Lawrence Boul^{b, 1}, Chris Ford^c, Derek McFadden^{d, 2}, Bob Chong^c and James Pinfold^e. (^aHortResearch, Environment and Risk Management Group, Gerald Street, PO Box 51, Lincoln, New Zealand, ^bCanesis, Private Bag 4749, Christchurch, New Zealand, ^cMassey University, Biotechnology Group, Private Bag 11 222, Palmerston North, New Zealand, ^dURS New Zealand Ltd., 287 Durham St., Christchurch, New Zealand, ^eHortResearch, BioEngineering Group, Private Bag 3123, Hamilton, New Zealand). Field-scale bioremediation of pentachlorophenol by *Trametes versicolor*. *International Biodeterioration & Biodegradation*, 56(1) (2005): 51-57.

Engineered soil cells were designed to develop proof-of-concept biopiles for white-rot bioremediation of aged PCP-contaminated soil from a former timber treatment site. Soil cells were constructed to allow for forced aeration, irrigation, leachate collection and monitoring of temperature and soil humidity. In experiments setup in January 2000 and monitored at regular intervals for 2.5 years, parameters studied were the effect of a New Zealand white-rot fungus *Trametes versicolor* isolate on PCP degradation, the effect of fungal inoculum concentration on PCP degradation and reproducibility of the experiments. PCP degradation and fungal survival were monitored at regular intervals for 2.5 years. There was no effect of inoculum concentration, and treatment effects were reproducible. PCP residues declined from 800–1000 mg kg^{-1} to 4 (0–9.4 mg kg^{-1}) according to first-order kinetics. Irrigation was neither required during the 2.5 years of the study, nor did leachate form. The soil cells did not exceed average daily temperatures of 35 °C. The results support the conclusion that the isolate of the *T. versicolor* can biodegrade PCP from aged soils in a field situation.

Shih-Chin Chen¹, Kuo-Hsu Li² and Hung-Yuan Fang² (¹Graduate School of Engineering Science and Technology (Doctoral Program), National Yunlin University of Science and Technology, Touliu, Yunlin, 640, Taiwan; ²Graduate Institute of Safety, Health and Environmental Engineering, National Yunlin University of Science and Technology,

Touliu, Yunlin, 640, Taiwan) Growth kinetics of EDTA biodegradation by *Burkholderia cepacia*, World Journal of Microbiology and Biotechnology , Volume 21(1) (2005): 11 – 16.

A pure culture of an EDTA-degrading strain was isolated from the Taiwan environment. It was identified as *Burkholderia cepacia*, an aerobic bacterium, elliptically shaped with a length of 5–15µm. The degradation assay showed that the degradation efficiency of Fe-EDTA by *B. cepacia* was approximately 91%. Evaluation of kinetic parameters showed that Fe-EDTA degradation followed substrate inhibition kinetics. This is evident from the decrease in specific growth rate with an increase in the initial substrate concentration greater than 500 mg/l. To estimate the kinetic parameters $-\mu_{\max}$, K_S and K_I , five substrate–inhibition models were used. From the results of non-linear regression, the value of μ_{\max} ranged from 0.150 to 0.206 d⁻¹, K_S from 74 to 87 mg/l, and K_I from 890 to 2289 mg/l. The five models were found to underestimate the maximum specific growth rate by 1.5–3.7. Therefore, predictions based on these models would result in lower predicted value than those from the experimental kinetic data.

Fátima Menezes Bento¹, Iwona Boguslava Beech², Christine Claire Gaylarde³, Gelsa Edith Englert⁴ and Iduvirges Lourdes Muller⁴ (¹Department of Soil, Faculty of Agronomy, UFRGS, 7712 Bento Gonçalves Avenue, CEP 91540-001, POA, RS, Brazil; ²Department of Soil, MIRCEN, UFRGS, 7712 Bento Gonçalves Avenue, CEP: 90001-970, POA, RS, Brazil; ³School of Pharmacy and Biomedical Sciences, Microbiology Research Laboratory, St Michael's Building, White Swan Road, Portsmouth, PO1 2DT, UK; ⁴Department of Metallurgy, Biocorrosion and Biofilms Lab, UFRGS, 99 Osvaldo Aranha Avenue s.615D, CEP: 90035-190, POA, RS, Brazil), Degradation and corrosive activities of fungi in a diesel–mild steel–aqueous system, World Journal of Microbiology and Biotechnology, Volume 21(2) (2005): 135 – 142.

The fungi *Aspergillus fumigatus*, *Hormoconis resiniae* and *Candida silvicola* were isolated from the fuel/water interfacial biomass in diesel storage tanks in Brazil. Their corrosive activities on mild steel ASTM A 283-93-C, used in storage tanks for urban diesel, were evaluated after various times of incubation at 30 °C in a modified Bushnell–Haas mineral medium (without chlorides) with diesel oil as sole source of carbon. Their ability to degrade diesel oil was evaluated after growth for 30 and 60 days. The fungus *Aspergillus fumigatus* and the consortium of all three organisms showed the highest production of biomass; *A. fumigatus* gave the greatest value for steel weight loss and produced the greatest reduction in pH of the aqueous phase. Solid phase microextraction (SPME) showed that the main acid present in the aqueous phase after 60 days incubation with *A. fumigatus* was propionic acid. Polarization curves indicated that microbial activity influenced the anodic process, probably by the production of corrosive metabolites, and that this was particularly important in the case of *A. fumigatus*. This fungus preferentially degraded aliphatic hydrocarbons of chain lengths C₁₁–C₁₃ in the diesel, producing 47.7, 37.5 and 51% reductions in C₁₁, C₁₂ and C₁₃, respectively. It produced more degradation than the consortium after 60 days incubation. It is likely that the presence of other species in the consortium inhibited the growth of *A. fumigatus*, thus resulting in a lower rate of diesel fuel degradation.

Kátia Maria Gomes Machado^{1,4}, Dácio Roberto Matheus², Regina Teresa Rosim Monteiro³ and Vera Lúcia Ramos Bononi² (¹Universidade Católica de Santos, Santos, and Fundação Centro Tecnológico de Minas Gerais, Belo Horizonte, Brazil; ²Instituto de Botânica, Secretaria do Meio Ambiente do Estado de São Paulo, Brazil; ³Centro de Energia Nuclear na Agricultura, Universidade de São Paulo, São Paulo, Brazil; ⁴UniSantos, Av. Conselheiro Nébias 300, Santos, São Paulo, CEP11015-002, Brazil), **Biodegradation of pentachlorophenol by tropical basidiomycetes in soils contaminated with industrial residues, World Journal of Microbiology and Biotechnology, Volume 21(3) (2005): 297 – 301.**

The ability of tropical Brazilian basidiomycetes to degrade pentachlorophenol (PCP) in soils from areas contaminated with organochlorine industrial residues was studied. Thirty-six basidiomycetes isolated from different tropical ecosystems were tested for tolerance to high PCP concentrations in soil. *Peniophoracinerea* and *Psilocybecastanella*, two strains of *Trametes villosa*, *Agrocybe perfecta*, *Trichaptum bisogenum* and *Lentinus villosus* were able to colonize soil columns containing up to 4600 mg pentachlorophenol kg⁻¹ soil. The first four species were inoculated into soil containing 1278 mg pentachlorophenol kg⁻¹ soil supplemented with gypsum and sugar cane bagasse. *P. cinerea*, *P. castanella*, *T. villosa* CCB176 and CCB213 and *Agrocybe perfecta* reduced the PCP present in the contaminated soil by 78, 64, 58, 36 and 43%, respectively, after 90 days of incubation. All fungi mineralized [¹⁴C] pentachlorophenol, mainly *P. cinerea* and *T. villosa* with the production of 7.11 and 8.15% ¹⁴CO₂, respectively, during 120 days of incubation. All fungi produced chloride ions during growth on soil containing PCP, indicating dehalogenation of the molecule. Conversion of PCP to pentachloroanisole was observed only after 90 days of incubation in soils inoculated with *A. perfecta*, *P. cinerea* and one of *T. villosa* strain. The present study shows the potential of Brazilian fungi for the biodegradation of toxic and persistent pollutants and it is the first to report fungal growth and PCP depletion in soils with high pentachlorophenol concentrations.

Víctor M. Luque-Almagro,¹ María-J. Huertas,¹ Manuel Martínez-Luque,¹ Conrado Moreno-Vivián,¹ M. Dolores Roldán,¹ L. Jesús García-Gil,² Francisco Castillo,¹ and Rafael Blasco^{3*} (Departamento de Bioquímica y Biología Molecular, Universidad de Córdoba, Campus de Rabanales, Cordova,¹ Institute of Aquatic Ecology, Universidad de Girona, Campus de Montilivi, Girona,² Departamento de Bioquímica y Biología Molecular y Genética, Facultad de Veterinaria, Universidad de Extremadura, Cáceres, Spain³), **Bacterial Degradation of Cyanide and Its Metal Complexes under Alkaline Conditions, Applied and Environmental Microbiology, 71(2) (2005): 940-947.**

A bacterial strain able to use cyanide as the sole nitrogen source under alkaline conditions has been isolated. The bacterium was classified as *Pseudomonas pseudoalcaligenes* by comparison of its 16S RNA gene sequence to those of existing strains and deposited in the Colección Española de Cultivos Tipo (Spanish Type Culture Collection) as strain CECT5344. Cyanide consumption is an assimilative process, since (i) bacterial growth was concomitant and proportional to cyanide degradation and (ii) the bacterium stoichiometrically converted cyanide into ammonium in the presence of L-methionine-D,L-sulfoximine, a glutamine synthetase inhibitor. The bacterium was able to grow in alkaline media, up to an initial pH of 11.5, and tolerated free cyanide in concentrations of up to 30 mM, which makes it a good candidate for the

biological treatment of cyanide-contaminated residues. Both acetate and D,L-malate were suitable carbon sources for cyanotrophic growth, but no growth was detected in media with cyanide as the sole carbon source. In addition to cyanide, *P. pseudoalcaligenes* CECT5344 used other nitrogen sources, namely ammonium, nitrate, cyanate, cyanoacetamide, nitroferrocyanide (nitroprusside), and a variety of cyanide-metal complexes. Cyanide and ammonium were assimilated simultaneously, whereas cyanide strongly inhibited nitrate and nitrite assimilation. Cyanase activity was induced during growth with cyanide or cyanate, but not with ammonium or nitrate as the nitrogen source. This result suggests that cyanate could be an intermediate in the cyanide degradation pathway, but alternative routes cannot be excluded.

Hiroyuki Futamata,^{1*} Yayoi Nagano,¹ Kazuya Watanabe,² and Akira Hiraishi¹
(**Department of Ecological Engineering, Toyohashi University of Technology, Toyohashi,¹**
Laboratory of Applied Microbiology, Marine Biotechnology Institute, Kamaishi, Japan²),
Unique Kinetic Properties of Phenol-Degrading *Variovorax* Strains Responsible for
Efficient Trichloroethylene Degradation in a Chemostat Enrichment Culture, Applied and
Environmental Microbiology, 71(2) (2005): 904-911.

A chemostat enrichment of soil bacteria growing on phenol as the sole carbon source has been shown to exhibit quite high trichloroethylene (TCE)-degrading activities (H. Futamata, S. Harayama, and K. Watanabe, *Appl. Environ. Microbiol.* **67**:4671-4677, 2001). To identify the bacterial populations responsible for the high TCE-degrading activity, a multidisciplinary survey of the chemostat enrichment was conducted by employing molecular-ecological and culture-dependent approaches. Three chemostat enrichment cultures were newly developed under different phenol-loading conditions (0.25, 0.75, and 1.25 g liter⁻¹ day⁻¹) in this study, and the TCE-degrading activities of the enrichments were measured. Among them, the enrichment at 0.75 g liter⁻¹ day⁻¹ (enrichment 0.75) expressed the highest activity. Denaturing gradient gel electrophoresis of PCR-amplified 16S rRNA gene fragments detected a *Variovorax* ribotype as the strongest band in enrichment 0.75; however, it was not a major ribotype in the other samples. Bacteria were isolated from enrichment 0.75 by direct plating, and their 16S rRNA genes and genes encoding the largest subunit of phenol hydroxylase (LmPHs) were analyzed. Among the bacteria isolated, several strains were affiliated with the genus *Variovorax* and were shown to have high-affinity-type LmPHs. The LmPH of the *Variovorax* strains was also detected as the major genotype in enrichment 0.75. Kinetic analyses of phenol and TCE degradation revealed, however, that these strains exhibited quite low affinity for phenol compared to other phenol-degrading bacteria, while they showed quite high specific TCE-degrading activities and relatively high affinity for TCE. Owing to these unique kinetic traits, the *Variovorax* strains can obviate competitive inhibition of TCE degradation by the primary substrate of the catabolic enzyme (i.e., phenol), contributing to the high TCE-degrading activity of the chemostat enrichments. On the basis of physiological information, mechanisms accounting for the way the *Variovorax* population overgrew the chemostat enrichment are discussed.

Trine Løbner, Lars Toräng, Damien John Batstone, Jens Ejbye Schmidt, Irini Angelidaki*. (*Correspondence to Irini Angelidaki, E&R DTU, Bygningstorvet, bygning 115, DK-2800 Kgs. Lyngby, Denmark; telephone: 45-452-51-429; fax: 45-459-52-850, email: Irini Angelidaki (ria@er.dtu.dk)). **Effects of process stability on anaerobic biodegradation of LAS in UASB reactors. *Biotechnology and Bioengineering*, 89(7) (2005): 759 – 765.**

Anaerobic biodegradation of linear alkylbenzene sulfonates (LAS) was studied in upflow anaerobic sludge blanket (UASB) reactors operated under mesophilic (37°C) and thermophilic (55°C) conditions. LAS C₁₂ concentration in the influents was 10 mg·L⁻¹, and the hydraulic retention time in the reactors was 2 days. Adsorption of LAS C₁₂ was assessed in an autoclaved control reactor and ceased after 115 days. The reactors were operated for a minimum of 267 days; 40-80% removal of LAS C₁₂ was observed. A temperature reduction from 55°C to 32°C for 30 h resulted in process imbalance as indicated by increase of volatile fatty acids (VFA). The imbalance was much more intense in the LAS amended reactor compared with an unamended reactor. At the same time, the process imbalance resulted in discontinued LAS removal. This finding indicates that process stability is a key factor in anaerobic biological removal of LAS. After a recovery period, the removal of LAS resumed, providing evidence of biological anaerobic LAS degradation. The removal remained constant until termination of experiments in the reactor. Biodegradation of LAS in the mesophilic reactor was at the same level as in the thermophilic reactor under stable conditions.

Alessandro D'Annibale¹, Marika Ricci², Vanessa Leonardi^{1,2}, Daniele Quarantino¹, Enrico Mincione¹, Maurizio Petruccioli¹ (*¹Dipartimento di Agrobiologia e Agrochimica, Università degli Studi della Tuscia, Via S. C. De Lellis, 01100 Viterbo, Italy; telephone: 39 0761 357332; fax: 39 0761 357242, ²Interuniversity Consortium "The Chemistry for the Environment," Venezia, Italy, email: Maurizio Petruccioli (petrucci@unitus.it)). **Degradation of aromatic hydrocarbons by white-rot fungi in a historically contaminated soil. *Biotechnology and Bioengineering*, 90(6) (2005): 723 - 731**

Phanerochaete chrysosporium NRRL 6361 and *Pleurotus pulmonarius* CBS 664.97 were tested for their ability to grow under nonsterile conditions and to degrade various aromatic hydrocarbons in an aged contaminated soil that also contained high concentrations of heavy metals. After 24 days fungal incubation, carbon-CO₂ liberated, an indicator of microbial activity, reached a plateau. At the end of the incubation time (30 days), fungal colonization was clearly visible and was confirmed by ergosterol and cell organic carbon determinations. In spite of unfavorable pH (around 7.4) and the presence of heavy metals, both fungi produced Mn-peroxidase activity. In contrast, laccase and aryl-alcohol oxidase were detected only in the soil treated with *P. pulmonarius* CBS 664.97 and lignin-peroxidase in that with *P. chrysosporium* NRRL 6361. No lignin-modifying enzyme activities were present in non-inoculated soil incubated for 30 days (control microcosm). Regardless of the fungus employed, a total removal of naphthalene, tetrachlorobenzene, and dichloroaniline isomers, diphenylether and *N*-phenyl-1-naphthalenamine, was observed. Significant release of chloride ions was also observed in fungal-treated soil, in comparison with that recorded in the control microcosm. Both fungi led to a significant decrease in soil toxicity, as assessed using two different soil contact assays, including the *Lepidium sativum* L. germination test and the Collembola mortality test.

Biosensor

Zajoncova L, Kosina P, Vicar J, Ulrichova J, Pec P. (Department of Biochemistry, Faculty of Science, Palacky University, Slechtitelu 11, 783 71, Olomouc, Czech Republic. zajoncov@prfholt.upol.cz) Study of the inhibition of alpha-amylase by the benzo[c]phenanthridine alkaloids sanguinarine and chelerythrine. J Enzyme Inhib Med Chem. 20(3) (2005): 261-7.

Inhibition of porcine pancreas and human saliva alpha-amylase (EC 3.2.1.1) by sanguinarine and chelerythrine was studied. The inhibition of alpha-amylase was assayed using a biosensor method which utilises a flow system equipped with a peroxide electrode. 250 microM sanguinarine and 250 microM chelerythrine cause complete inhibition of 1.9 nkat alpha-amylase from porcine pancreas. The same concentration of sanguinarine and chelerythrine caused 23.9% and 7.5% inhibition, respectively, of 1.9 nkat alpha-amylase from human saliva. Mixed type and partially reversible inhibition was found for both alpha-amylases treated with either alkaloid.

Rothermel A, Kurz R, Ruffer M, Weigel W, Jahnke HG, Sedello A, Stepan H, Faber R, Schulze-Forster K, Robitzki A. (Center for Biotechnology and Biomedicine, Department of Molecular biological- biochemical Processing Technology, University of Leipzig, Germany.) Cells on a Chip - the Use of Electric Properties for Highly Sensitive Monitoring of Blood-Derived Factors Involved in Angiotensin II Type 1 Receptor Signalling. Cell Physiol Biochem., 16(1-3) (2005): 51-8.

Background: We developed a highly sensitive cardiomyocyte based screening system for the non-destructive electronic detection of chronotropic drugs and tissue-secreted factors involved in AT(1) receptor-mediated cardiovascular diseases. Methods: For this purpose we cultured spontaneously beating neonatal rat cardiomyocytes on microelectrode arrays (MEAs), and tested the optimised, stable culture parameters for a reproducible real-time recording of alterations in contraction frequency. After the evaluation of culture parameters, computer-based electronic measurement systems were used for counting of contractions by recording of the field potential of cardiomyocytes. Results: Using the biosensor, angiotensin II, the predominant ligand of the AT(1) receptor, was detected at very low concentrations of 10(-11) M via altered contractions of cardiomyocytes. Moreover, we demonstrated that cardiomyocyte coupled microarrays allow the detection of blood-derived low concentrated anti-AT(1) receptor autoimmune antibodies of pregnant women suffering from preeclampsia. Conclusion: This study demonstrates the first well-suited electrophysiological recording of cardiomyocytes on multielectrode arrays as a benefit for functional biomonitoring for the detection of AT(1) receptor/ligand interactions and other marker proteins in sera directed to cardiovascular diseases. Copyright (c) 2005 S. Karger AG, Basel.

Anjan Kumar Basu, Parimal Chattopadhyay, Utpal Roy Choudhury & Runu Chakraborty*. (Department of Food Technology and Bio Chemical Engineering, Jadavpur University, Kolkata 700 032, India). Development of an amperometric hypoxanthine biosensor for determination of hypoxanthine in fish and meat tissue. Indian Journal of Experimental Biology, 43 (2005): 646-653.

A hypoxanthine (Hx) biosensor based on immobilized xanthine oxidase (XO) as the bio-component was developed and studied for the rapid analysis of fish (sweet water and marine) and goat meat samples. The biosensor was standardized for the determination of Hx in the range of 0.05 to 2 mM. Crosslinking with glutaraldehyde in presence of BSA as a spacer molecule was used for the method of immobilization. One layer of gelatin (10%) was applied over the immobilized enzyme layer to reduce the leaching out of enzyme from the membrane (cellulose acetate) matrix. The optimum pH of the immobilized system was determined to be 8.5 at 25°C instead 7.0-7.2 for free enzyme system. K_m and C_{max} values were determined for the immobilized system. The developed sensor was applied to determine the amount of Hx present in fish and meat over a period of time. The stability of the enzyme immobilized membrane was also tested over a period of 30 days.

Tcherkasskaya O, Davidson EA, Schmerr MJ, Orser CS. (Department of Biochemistry and Molecular Biology, Georgetown University School of Medicine, Washington, DC 20057, USA. ovt@georgetown.edu) Conformational biosensor for diagnosis of prion diseases. Biotechnol Lett. 27(9) (2005): 671-5.

A fluorescence technology to monitor the proliferation of amyloidogenic neurological disorders is proposed. A crude brain homogenate (0.01%) from animals infected with a transmissible spongiform encephalopathy is employed as a catalytic medium initiating conformational changes in 520 nM polypeptide biosensors (Tris/trifluoroethanol 50% mixture at pH 7). The fluorescence methods utilize pyrene residues covalently attached to the peptide ends. The coil-to-beta-strand transitions in biosensor molecules cause elevation of a distinct fluorescence band of the pyrene aggregates (i.e. excimers). This approach enables the detection of infectious prion proteins at fmol, does not require antibody binding or protease treatment. Technology might be adopted for diagnosing a large variety of conformational disorders as well as for generic high-throughput screening of the amyloidogenic potential in plasma.

Popovtzer R, Neufeld T, Biran D, Ron EZ, Rishpon J, Shacham-Diamand Y. (Department of Electrical Engineering--Physical Electronics and TAU Research Institute for Nano Science and Nano-technologies, Tel-Aviv University. rachela@eng.tau.ac.il) Novel integrated electrochemical nano-biochip for toxicity detection in water. Nano Lett., 5(6) (2005): 1023-7.

An electrochemical nano-biochip for water toxicity detection is presented. We describe chip design, fabrication, and performance. Bacteria, which have been genetically engineered to respond to environmental stress, act as a sensor element and trigger a sequence of processes, which leads to generation of electrical current. This novel, portable and miniature device provides rapid and sensitive real-time electrochemical detection of acute toxicity in water. A clear signal is produced within less than 10 min of exposure to various concentrations of toxicants, or to stress conditions, with a direct correlation between the toxicant concentration and the induced current.

Zong W, Thirstrup C, Sorensen MH, Pedersen HC. (Vir Biosensor, Vir A/S, Kuldysen 10,

DK-2630 Taastrup, Denmark.) Optical biosensor with dispersion compensation. *Opt Lett.* 30(10) (2005): 1138-40.

Dispersion limits performance in many optical systems. In surface plasmon resonance (SPR) biosensors, the sensing area is an optical element in which the dispersion depends on the effective refractive index of the biochemical compounds to be measured. We report a method of compensating for wavelength dispersion in SPR biosensors employing two integrated diffractive optical coupling elements in a polymer substrate. The dispersion compensation is achieved over the whole dynamic measurement range and provides a biosensor more robust to wavelength fluctuations than prism-coupler SPR systems. The concept can readily be employed in other types of sensor measuring refractive-index changes.

May KM, Vogt A, Bachas LG, Anderson KW. (Department of Chemical and Materials Engineering, University of Kentucky, Lexington, KY 40506, USA.) Vascular endothelial growth factor as a biomarker for the early detection of cancer using a whole cell-based biosensor. *Anal Bioanal Chem.* 382(4) (2005): 1010-6.

Vascular endothelial growth factor (VEGF) is a cytokine and endothelial cell (EC) mitogen that has been studied for its role in angiogenesis of malignant tumors. Elevated quantities of VEGF in the serum and plasma of patients have been correlated with the presence of cancer and metastasis. Since VEGF induces hyperpermeability of EC monolayers, this protein can be detected in vitro with a whole cell-based biosensor. This biosensor consists of a confluent monolayer of human umbilical vein endothelial cells (HUVECs) attached to a cellulose triacetate (CTA) membrane of an ion-selective electrode (ISE). Previous studies regarding this biosensor have shown that when the biosensor was exposed to a model toxin, such as histamine, the response of the biosensor served as an indirect measurement of the presence of histamine. Similarly, the biosensor responds to the presence of VEGF, but is much more sensitive because VEGF is known to be 50,000-fold more potent than histamine when inducing EC hyperpermeability. The ISE response increased with increasing VEGF concentration. Since lower concentrations required more exposure time, the detection limit was established as a function of exposure time (2-10 h). The practical applicability of the biosensor was also established with cultured human melanoma cells WM793 (nonmetastatic) and 1205LU (metastatic). The resultant change in the potential values revealed significant production of VEGF from the 1205LU cells. A VEGF ELISA was performed to confirm the VEGF concentration in each sample. The biosensor closely predicted the concentrations determined through the ELISA. These results support the use of a cell-based ISE as a quick screening method for the presence of VEGF.

Guzman O, Abbott NL, de Pablo JJ. (Department of Chemical and Biological Engineering, University of Wisconsin, Madison, Wisconsin 53706-1691, USA. orlando@che.wisc.edu) Quenched disorder in a liquid-crystal biosensor: adsorbed nanoparticles at confining walls. *J Chem Phys.* 122(18) (2005): 184711.

We analyze the response of a nematic liquid-crystal film, confined between parallel walls, to the

presence of nanoscopic particles adsorbed at the walls. This is done for a variety of patterns of adsorption (random and periodic) and operational conditions of the system that can be controlled in experimental liquid-crystal-based devices. We compute simulated optical textures and the total optical output of the sensor between crossed polars, as well as the correlation function for the liquid-crystal tensor order parameter; we use these observables to discuss the gradual destruction of the original uniform orientation. For large concentrations of particles adsorbed in random patterns, the liquid crystal at the center of the sensor adopts a multidomain state, characterized by a small correlation length of the tensor order parameter, and also by a loss of optical anisotropy under observation through crossed polars. In contrast, for particles adsorbed in periodic patterns, the nematic at the center of the cell can remain in a monodomain orientation state, provided the patterns in opposite walls are synchronized.

Du H, Strohsahl CM, Camera J, Miller BL, Krauss TD. (Department of Chemistry, and The Center for Future Health, University of Rochester, Rochester, New York, USA.) Sensitivity and specificity of metal surface-immobilized "molecular beacon" biosensors. *J Am Chem Soc.* 127(21) (2005):7932-40.

The separate developments of microarray patterning of DNA oligonucleotides, and of DNA hairpins as sensitive probes for oligonucleotide identification in solution, have had a tremendous impact on basic biological research and clinical applications. We have combined these two approaches to develop arrayable and label-free biological sensors based on fluorescence unquenching of DNA hairpins immobilized on metal surfaces. The thermodynamic and kinetic response of these sensors, and the factors important in hybridization efficiency, were investigated. Hybridization efficiency was found to be sensitive to hairpin secondary structure, as well as to the surface distribution of DNA hairpins on the substrate. The identity of the bases used in the hairpin stem as well as the overall loop length significantly affected sensitivity and selectivity. Surface-immobilized hairpins discriminated between two sequences with a single base-pair mismatch with high sensitivity (over an order of magnitude difference in signal) under identical assay conditions (no change in stringency). This represents a significant improvement over other microarray-based techniques.

Hong SH, Hao Q, Maret W. (Center for Biochemical and Biophysical Sciences and Medicine, Department of Pathology, Harvard Medical School, One Kendall Square, Cambridge, MA 02139, USA.) Domain-specific fluorescence resonance energy transfer (FRET) sensors of metallothionein/ thionein. *Protein Eng Des Sel.* 18(6) (2005): 255-63.

Each of the two domains of mammalian metallothioneins contains a zinc-thiolate cluster. Employing site-directed mutagenesis and chemical modification, fluorescent probes were introduced into human metallothionein (isoform 2) with minimal perturbations of the structures of these clusters. The resulting FRET (fluorescence resonance energy transfer) sensors are specific for each domain. The design and construction of a sensor for the alpha-domain cluster is based on a FRET pair where a C-terminally added tryptophan serves as the donor for a fluorescence acceptor attached to a free cysteine in the linker region between the two domains. Molecular modeling studies and steady-state fluorescence polarization anisotropy measurements suggest unrestricted motion of the tryptophan donor, but limited motion of the AEDANS ([[(amino)ethyl]amino]naphthalene-1-sulfonic acid) acceptor, putting constraints on the use of the alpha-domain sensor with this FRET pair as a spectroscopic ruler. The fluorescent

metallothioneins allow distance measurements during binding and removal of metals in the individual domains. The overall dimensions of the apoprotein, thionein, for which no structural information is available, do not seem to be significantly different from those of the holoprotein. The single- and double-labeled fluorescent metallothioneins overcome a longstanding impediment in studies of the function of this protein, namely its lack of intrinsic probe characteristics.

Huang JD, Song Z, Li J, Wu BY, Yin HJ, Chen KJ, Chen Q. (College of Life Sciences, Nankai University, Tianjin, China.) Study on the therapeutic mechanism of the active principle of the Chinese drug *Paeoniae Radix 801* through affinity biosensors IAsys plus quartz crystal microbalance. *Chin J Integr Med.* 11(1) (2005): 37-40.

OBJECTIVE: To study the targeted point and mechanism of the function of the blood-activating and stasis-removing Chinese drugs, *Paeoniae Radix 801*(PR801) in its cardiovascular protective effects and its specific binding with endothelin 1 (ET-1) as well as the dynamics of the two's interactive function by means of using affinity biosensors: IAsys Plus and quartz crystal microbalance (IAQCM). **METHODS:** ET-1 was immobilized on the surfaces of IAQCM by using the new surface modification methods. The PR801 in the solution was detected by modified substrates and the specific binding between PR801 and ET-1 was studied. **RESULTS:** The curves went up or down after adding PR801. There is specific binding between PR801 and ET-1. The bound mass were 0.458 ng/mm² and 133.54 ng/cm², respectively. There exists relatively good stability with these two methods. **CONCLUSION:** The affinity biosensors: IAQCM can be used to study the interaction mechanism between PR801 and ET-1, providing a new way to study the interaction mechanism of TCM. PR801 can bind ET-1 specifically in the experiments. Therefore, ET-1 is another target that PR801 can bind specifically besides thromboxane A₂.

Ozturk G, Ertas FN, Akyilmaz E, Dinckaya E, Tural H. (Ege University Science Faculty, Chemistry Department, Bornova, Izmir, Turkey. niler@mail.ege.edu.tr) A novel amperometric biosensor based on artichoke (*Cynara scolymus L.*) tissue homogenate immobilized in gelatin for hydrogen peroxide detection. *Artif Cells Blood Substit Immobil Biotechnol.* 32(4) (2004):637-45.

A biosensor for specific determination of hydrogen peroxide was developed by using homogenized artichoke (*Cynara scolymus L.*) tissue in combination with a dissolved oxygen probe and applied in determination of hydrogen peroxide in milk samples. Artichoke tissue, which has catalase activity, was immobilized with gelatine by means of glutaraldehyde and fixed on a pretreated teflon membrane. The electrode response was maximum when 0.05 M phosphate buffer was used at pH 7.0 and at 30 degrees C. Upon addition of hydrogen peroxide, the electrode gives a linear response in a concentration range of 5.0-50 x 10⁻⁵ M with a response time of 3 min. The method was also applied to the determination of hydrogen peroxide in milk samples.

Ekgasit S, Thammachoen C, Yu F, Knoll W. (Sensor Research Unit, Department of Chemistry, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand. sanong.e@chula.ac.th) Influence of the metal film thickness on the sensitivity of surface plasmon resonance biosensors. *Appl Spectrosc.* 59(5) (2005): 661-7.

The influence of the metal film thickness (i.e., the chromium adhesion promoting film and the gold film) on the sensitivity of surface plasmon resonance (SPR) signals (i.e., resonance angle shift and reflectance change) towards the thickness variation of the nonabsorbing dielectric film is investigated. The sensitivity of reflectance change decreases when a thick chromium film or a thin gold film is employed. Its linear range becomes narrower as the thickness of the metal films increases. The sensitivity and linear range of the resonance angle shift are not affected by the thickness variation of the metal films. The phenomena were theoretically explained based on the attenuated total reflection (ATR) generated evanescent field at the prism/metal interface and the SPR-generated evanescent field at the metal/dielectric interface.

Nygren-Babol L, Sternesjo A, Jagerstad M, Bjorck L. (Department of Food Science, Swedish University of Agricultural Sciences, Uppsala.) Affinity and rate constants for interactions of bovine folate-binding protein and folate derivatives determined by optical biosensor technology. Effect of stereoselectivity. J Agric Food Chem. 53(13) (2005): 5473-8.

The interactions between bovine folate-binding protein (FBP) and different folate derivatives in pure diastereoisomeric forms were studied at pH 7.4 by a surface plasmon resonance technology (Biacore). The results show that folic acid had the most rapid association rate ($k(a) = 1.0 \times 10(6) \text{ M}(-)(1) \text{ s}(-)(1)$), whereas (6S)-5-HCO-5,6,7,8-tetrahydrofolic acid had the most rapid dissociation rate ($k(d) = 3.2 \times 10(-)(3) \text{ s}(-)(1)$). The equilibrium dissociation constant ($K(D)$), calculated from the quotient of $k(d)/k(a)$, showed that the two forms of folates not occurring in nature, that is, folic acid and (6R)-5-CH(3)-5,6,7,8-tetrahydrofolic acid, had the highest affinities for FBP, 20 and 160 pmol/L, respectively. The results thus show that there were great differences in the interactions between folate-binding protein and the major forms of folate derivatives. The nutritional implications of these differences are discussed.

Verma N, Singh M. (Biosensor Development Laboratory, Department of Biotechnology, Punjabi University, Patiala 147 002, Punjab, India. neelam_verma2@rediffmail.com) Biosensors for heavy metals. Biometals. 18(2) (2005): 121-9.

A biosensor is an analytical device that consists of an immobilized biocomponent in conjunction with a transducer, and represents a synergistic combination of biotechnology and microelectronics. This review summarizes the use of biosensors for detecting and quantifying heavy metal ions. Heavy metal contamination is of serious concern to human health since these substances are non-biodegradable and retained by the ecological system. Conventional analytical techniques for heavy metals (such as cold vapour atomic absorption spectrometry, and inductively coupled plasma mass spectrometry) are precise but suffer from the disadvantages of high cost, the need for trained personnel and the fact that they are mostly laboratory bound. Biosensors have the advantages of specificity, low cost, ease of use, portability and the ability to furnish continuous real time signals. The analysis of heavy metal ions can be carried out with biosensors by using both protein (enzyme, metal-binding protein and antibody)-based and whole-cell (natural and genetically engineered microorganism)-based approaches.

Chang IH, Tulock JJ, Liu J, Kim WS, Cannon DM Jr, Lu Y, Bohn PW, Sweedler JV, Cropek DM. (Department of Chemistry and the Beckman Institute for Advanced Science

and Technology, University of Illinois at Urbana-Champaign, 600 South Mathews Avenue, Urbana, Illinois 61801, USA.) Miniaturized lead sensor based on lead-specific DNAzyme in a nanocapillary interconnected microfluidic device. Environ Sci Technol. 39(10) (2005): 3756-61.

A miniaturized lead sensor has been developed by combining a lead-specific DNAzyme with a microfabricated device containing a network of microfluidic channels that are fluidically coupled via a nanocapillary array interconnect. A DNAzyme construct, selective for cleavage in the presence of Pb²⁺ and derivatized with fluorophore (quencher) at the 5' (3') end of the substrate and enzyme strands, respectively, forms a molecular beacon that is used as the recognition element. The nanocapillary array membrane interconnect is used to manipulate fluid flows and deliver the small-volume sample to the beacon in a spatially confined detection window where the DNAzyme is interrogated using laser-induced fluorescence detection. A transformed log plot of the fluorescent signal exhibits a linear response ($r^2 = 0.982$) over a Pb²⁺ concentration range of 0.1- 100 microM, and a detection limit of 11 nM. The sensor has been applied to the determination of Pb²⁺ in an electroplating sludge reference material, the result agreeing with the certified value within 4.9%. Quantitative measurement of Pb²⁺ in this complex sample demonstrates the selectivity of this sensor scheme and points favorably to the application of such technologies to analysis of environmental samples. The unique combination of a DNAzyme with a microfluidic-nanofluidic hybrid device makes it possible to change the DNAzyme to select for other compounds of interest, and to incorporate multiple sensing systems within a single device for greater flexibility. This work represents the initial steps toward creation of a robust field sensor for lead in groundwater or drinking water.

Bioengineering

Oguz Bayraktar¹ (Department of Chemical Engineering, Bioreaction Engineering Laboratory, Izmir Institute of Technology, Gülbahçe Köyü, 35437 Urla-Izmir, Turkey), Bioleaching of nickel from equilibrium fluid catalytic cracking catalysts, World Journal of Microbiology and Biotechnology , Volume 21(5) (2005): 661 – 665.

This study investigates the possibility of reusing metal-contaminated equilibrium fluid catalytic cracking (FCC) catalyst after bioleaching. Leaching with *Aspergillus niger* culture was found to be more effective in the mobilization of nickel from the catalyst particles compared to chemical leaching with citric acid. Bioleaching achieved 32% nickel removal whereas chemical leaching achieved only 21% nickel removal from catalyst particles. The enhanced nickel removal from the catalysts in the presence of *A. niger* culture was attributed to the biosorption ability of the fungal mycelium and to the higher local concentration of citric acid on the catalyst surface. It

was found that 9% of solubilized nickel in the liquid medium was biosorbed to fungal biomass. After nickel leaching with *A. niger* culture, the hydrogen-to-methane molar ratio and coke yield, which are the measures of dehydrogenation reactions catalysed by nickel during cracking reactions, decreased significantly.

V.Christian¹, R. Shrivastava¹, D. Shukla¹, H.A.Modi² & B.R.M.Vyas¹. (¹Department of Biosciences, Saurashtra University Rajkot 360 005, India, ²Sheth P.T.Arts and Science College, Godhra 389 001, India, E-mail: brmvyas@hotmail.com). Degradation of xenobiotic compounds by lignin-degrading white-rot fungi: Enzymology and mechanisms involved. Indian Journal of Experimental Biology, 43 (2005): 301-312.

White-rot fungi (WRF) are ubiquitous in nature with their natural ability to compete and survive. WRF are the only organisms known to have the ability to degrade and mineralize recalcitrant plant polymer lignin. Their potential to degrade second most abundant carbon reserve material lignin on the earth make them important link in global carbon cycle. WRF degrade lignin by its unique ligninolytic enzymatic machinery including lignin peroxidase, manganese peroxidase, laccase, cellobiose dehydrogenase, H₂O₂-generating enzymes, etc. The ligninolytic enzymes system is non-specific, extracellular and free radical based that allows them to degrade structurally diverse range of xenobiotic compounds. Lignin peroxidase and manganese peroxidase carry out direct and indirect oxidation as well as reduction of xenobiotic compounds. Indirect reactions involved redox mediators such as veratryl alcohol and Mn²⁺. Reduction reactions are carried out by carboxyl, superoxide and semiquinone radicals, etc. Methylation is used as detoxification mechanism by WRF. Highly oxidized chemicals are reduced by transmembrane redox potential. Degradation of number of environmental pollutants by ligninolytic system of white rot fungi is described in the present review.

Pollen Biotechnology

Chilcutt CF, Tabashnik BE. (Department of Entomology, Texas A&M University, 10345 Agnes Street, Corpus Christi, TX 78406, USA. c-chilcutt@tamu.edu), Contamination of refuges by *Bacillus thuringiensis* toxin genes from transgenic maize. Proc Natl Acad Sci U S A., 101(20) (2004): 7526-9.

Transgenic crops producing insecticidal toxins from *Bacillus thuringiensis* (Bt) are widely used to control pests, but their benefits will be lost if pests evolve resistance. The mandated high-dose/refuge strategy for delaying pest resistance requires planting refuges of toxin-free crops near Bt crops to promote survival of susceptible pests. We report that pollen-mediated gene flow up to 31 m from Bt maize caused low to moderate Bt toxin levels in kernels of non-Bt maize refuge plants. Immunoassays of non-Bt maize sampled from the field showed that the mean concentration of Bt toxin Cry1Ab in kernels and the percentage of kernels with Cry1Ab decreased with distance from Bt maize. The highest Bt toxin concentration in pooled kernels of non-Bt maize plants was 45% of the mean concentration in kernels from adjacent Bt maize plants. Most previous work on gene flow from transgenic crops has emphasized potential effects

of transgene movement on wild relatives of crops, landraces, and organic plantings, whereas implications for pest resistance have been largely ignored. Variable Bt toxin production in seeds of refuge plants undermines the high-dose/refuge strategy and could accelerate pest resistance to Bt crops. Thus, guidelines should be revised to reduce gene flow between Bt crops and refuge plants.

Martinez-Giron R, Ribas-Barcelo A, Garcia-Miralles MT, Lopez-Cabanilles D, Tamargo-Pelaez ML, Torre-Bayon C, Fernandez-Alvarez L. (Cytopathology, Instituto de Piedras Blancas (Asturias), Piedras Blancas, Spain. rafaelmgiron@terra.es), Airborne fungal spores, pollen grains, and vegetable cells in routine Papanicolaou smears. *Diagn Cytopathol.* 30(6) (2004): 381-5.

The objective was to demonstrate the presence of airborne fungal spores, pollen grains, and vegetable cells in smears and establish their significance. Microscopic examination was of smears stained by the Papanicolaou technique. We found several types of airborne spores (*Alternaria*, *Exserohilum*, *Aspergillus*, *Cladosporium*, *Epicoccum*, *Curvularia*, and *Ascosmycete*), pollen grains (*Lilium*, bullrush, *Pinus*, *Acacia*, hazelnut, and oak), and several types of vegetable cells. The existence of these structures may be due to intrinsic or to extrinsic contamination of the sample. Anemophilous fungi spores and pollen grains have been shown to possess great allergenic capacity. Pollen grains and vegetable cells may be mistaken for certain microorganisms or malignant cells. Copyright 2004 Wiley-Liss, Inc.

Wolt JD, Shyy YY, Christensen PJ, Dorman KS, Misra M. (Biosafety Institute for Genetically Modified Agricultural Products, Iowa State University, Ames, IA 50011, USA. jdwolt@iastate.edu) Quantitative exposure assessment for confinement of maize biogenic systems. *Environ Biosafety Res.*, 3(4) (2004): 183-96.

The development of transgenic crops as production platforms for biogenic agents will largely depend on the success of efforts to confine the genes and their expressed proteins in field environments. We have used quantitative exposure assessment to evaluate how management practices affect materials escape due to outcrossing by pollen flow or grain loss during harvest operations. Specifically, we study the use of maize to produce biogenic agents within field-confined systems. Decision trees representing simplified schemes of fully conforming (designed to comply with current regulatory standards for field confined trials), partially conforming, and non-conforming management practices were developed. Exemplifying assumptions and published data for conformance and material fate probabilities were used in Monte Carlo simulations to forecast materials escape by pollen outcrossing and harvest operations from a 1 ha source field. Deterministic analyses showed fully conforming confinement management restricted materials loss to low levels (for this example, outcrossing produced <1 in 10(6) kernels in receptor fields). The corresponding high-end (90th percentile) probabilistic result was 16- and 4333-fold higher (relative to deterministic outcrossing = 1) for outcrossing and harvest loss, respectively. For partially conforming practice, high-end outcrossing ranged from 100- to >15000-fold over the base result in receptor fields, and harvest loss was >10000-fold over the base result. For non-conforming practice, high-end outcrossing produced >15000-fold greater kernels in receptor fields and high-end harvest loss was at least 19000-fold greater. Deterministic

estimates of off-field loss by machine transfer are as much as 30000-fold higher for non-conforming operations relative to the base case of pollen outcrossing. Better knowledge of failure frequencies for confinement management practices, improved physical models of materials flows, refined analysis of confinement loss probabilities using quantitative tools, and decision analysis to improve and audit management system performance are all needed to extend understanding of confinement integrity beyond the exemplifying case used here.

Imin N, Kerim T, Rolfe BG, Weinman JJ. (Australian Research Council Centre of Excellence for Integrative Legume Research, Genomic Interactions Group, Research School of Biological Sciences, Australian National University, PO Box 475, Canberra City, ACT 2601, Australia. imin@rsbs.anu.edu.au), Effect of early cold stress on the maturation of rice anthers. *Proteomics*. 4(7) (2004):1873-82.

Male reproductive development in rice (*Oryza sativa* Linnaeus) is very sensitive to various forms of environmental stresses including low temperature. Here, we present our findings on the proteomic analysis of the later developmental consequences of low temperature treatment on rice anthers. Anther proteins at the trinucleate stage, with or without cold treatment for four days at 12 degrees C at the young microspore stage, were extracted, separated by two-dimensional gel electrophoresis (2-DE) and compared. More than 3000 rice anther proteins of cold-sensitive cultivar Doongara plants at the trinucleate stage were resolved on 2-DE gels over a pH range of 4-7 and detected by silver-staining. Seventy protein spots were differentially displayed after four days of cold treatment at the young microspore stage. Of these, 12 protein spots were newly-induced, 47 were up-regulated, and 11 were down-regulated by cold treatment at the early microspore stage. We identified 18 by matrix-assisted laser desorption/ionization mass spectrometry time of flight (MALDI-TOF) analysis. Of the identified proteins, seven were observed as breakdown (cleavage) products by a combination of 2-DE and MALDI-TOF analysis, thus demonstrating for the first time that cold temperature stress at the young microspore stage enhances and induces partial degradation of proteins in the rice anthers at the trinucleate stage.

Boral D, Chatterjee S, Bhattacharya K. (Department of Botany, Visva-Bharati University, Santiniketan-731235, West Bengal, India.), The occurrence and allergising potential of airborne pollen in West Bengal, India. *Ann Agric Environ Med.*, 11(1) (2004): 45-52.

A continuous 2-year volumetric aerobiological survey was conducted in Berhampore town, a centrally located and representative part of West Bengal, India. The aim of the study was to assess the allergising potential of airborne pollen grains of West Bengal. A total of 31 pollen types were identified of which Poaceae (grasses) pollen showed maximum frequency, followed by Cyperaceae, Cassia sp., Acacia auriculiformis, etc. The seasonal periodicities of the pollen types and their relationship to meteorological conditions were investigated. It was found that the pollen concentration is positively correlated with temperature and negatively correlated with rainfall and relative humidity. Clinical investigations by skin prick test were carried out to detect allergenicity of pollen types. Eighteen common airborne pollen types induced positive responses of which pollen extracts of *Saccharum officinarum* (grass), *Azadirachta indica*, *Cocos nucifera*,

Phoenix sylvestris, *Cyperus rotundus* and *Eucalyptus citriodora* showed strongest sensitising potential. This result is consistent with previous investigations in different parts of West Bengal.

Boyer JS, Westgate ME. (College of Marine Studies, University of Delaware, 700 Pilottown Road, Lewes, DE 19958, USA. boyer@cms.udel.edu), Grain yields with limited water. J Exp Bot., 55(407) (2004): 2385-94.

Plant reproduction is sensitive to water deficits, especially during the early phases when development may cease irreversibly even though the parent remains alive. Grain numbers decrease because of several developmental changes, especially ovary abortion in maize (*Zea mays* L.) or pollen sterility in small grains. In maize, the water deficits inhibit photosynthesis, and the decrease in photosynthate flux to the developing organs appears to trigger abortion. Abscisic acid also increases in the parent and may play a role, perhaps by inhibiting photosynthesis through stomatal closure. Recent work indicates that invertase activity is inhibited and starch is diminished in the ovaries or affected pollen. Also, sucrose fed to the stems rescues many of the ovaries otherwise destined to abort. The feeding restores some of the ovary starch and invertase activity. These studies implicate invertase as a limiting enzyme step for grain yields during a water deficit, and transcript profiling with microarrays has identified genes that are up- or down-regulated during water deficit-induced abortion in maize. However, profiling studies to date have not reported changes in invertase or starch synthesizing genes in water-deficient ovaries, perhaps because there were too few sampling times. The ovary rescue with sucrose feeding indicates either that the changes identified in the profiling are of no consequence for inhibiting ovary development or that gene expression reverts to control levels when the sugar stream recovers. Careful documentation of tissue- and developmentally specific gene expression are needed to resolve these issues and link metabolic changes to the decreased sugar flux affecting the reproductive organs.

Koonjul PK, Minhas JS, Nunes C, Sheoran IS, Saini HS. (Institut de Recherche en Biologie Vegetale, Universite de Montreal, 4101, rue Sherbrooke est, Montreal H1X 2B2, Canada.), Selective transcriptional down-regulation of anther invertases precedes the failure of pollen development in water-stressed wheat. J Exp Bot., 56(409) (2005): 179-90.

Water deficit during male meiosis in wheat (*Triticum aestivum* L.) causes pollen sterility. With a view to identifying the internal trigger for this failure, it was found that water stress specifically impairs the activities of vacuolar and cell-wall invertases in anthers prior to the arrest of pollen development. The enzymes are affected only when water deficit occurs around meiosis. Three invertase cDNAs, two encoding the cell-wall (Ivr1, Ivr3) and one the vacuolar (Ivr5) isoform, were isolated from an anther cDNA library. RNA gel-blot analysis using floral organs of well-watered plants revealed that these genes were expressed preferentially, though not exclusively, in anthers. Semi-quantitative RT-PCR demonstrated that transitory water deficit during meiosis selectively down-regulated the transcription of two of the three genes, one encoding the vacuolar (Ivr5) and the other a cell-wall (Ivr1) isoform, without affecting the Ivr3 message. Their expression did not recover upon resumption of watering. Another homologue of Ivr1 was also down-regulated, but only during the post-stress period. The stress effects on invertase transcripts were consistent with those on the developmental profiles of the corresponding enzyme activities.

In situ hybridization revealed that the stress-sensitive invertase genes, unlike an insensitive one, were expressed within the microspores. No evidence for an invertase inhibitor under stress was found. Together the results show that the decline in invertase activity is probably regulated primarily at the transcriptional level in a gene- and cell-specific manner.

Madeja J, Wypasek E, Plytycz B, Sarapata K, Harmata K. (Institute of Botany, Jagiellonian University, Krakow, Poland.), Quantification of airborne birch (*Betula* sp.) pollen grains and allergens in Krakow. Arch Immunol Ther Exp (Warsz). 53(2) (2005):169-74.

INTRODUCTION: Birch (*Betula* sp.) pollen grains are the main cause of seasonal allergies in northern and central Europe. The allergen particles released from the grains are often well distributed in the air. Due to their size, airborne protein particles can easily penetrate into the lower parts of the respiratory airways and may lead to symptoms of asthma. The purpose of this paper was to quantify both *Betula* sp. pollen grains and allergens in the air. **MATERIAL/METHODS:** Materials for the investigation were collected in the spring of 2003 with two Hirst-type pollen volumetric traps. Tapes from one trap served for routine birch pollen grain counts, while those from the second for the immunodetection of birch allergens. As birch pollen allergen concentration is seen as dark spots on X-ray films densitometric measurements of the spots were used to quantify birch-pollen antigen concentrations in the air. **RESULTS:** In most instances, birch pollen counts corresponded with birch pollen allergen levels. However, on several occasions outside the pollen season, only grains or only allergens were detected. Apart from sampling variability, this could be due to faulty/dead pollen grains or submicronic airborne allergen particles. **CONCLUSIONS:** Counting intact pollen grains and antibody-based detection of allergen molecules are efficient tools in controlled allergen avoidance.

Chakraborty P, Ghosh D, Chowdhury I, Roy I, Chatterjee S, Chanda S, Gupta-Bhattacharya S. (Department of Botany, Bose Institute, Calcutta, India.), Aerobiological and immunochemical studies on *Carica papaya* L. pollen: an aeroallergen from India. Allergy. 60(7) (2005): 920-6.

BACKGROUND: *Carica papaya* L. is a fruit yielding tree, widely grown or cultivated in the tropics and subtropics. Its pollen grain has been reported to be airborne and cause immunoglobulin E (IgE)-mediated hypersensitivity. **OBJECTIVE:** To conduct long-term aerobiological study on *Carica* pollen, along with aeroallergenic particles originating from it and to identify vis-a-vis characterize an important IgE-reactive component present in this pollen. **METHODS:** The seasonal and diurnal periodicities of airborne *C. papaya* pollen were recorded in a 5-year survey using a Burkard volumetric sampler. The allergenic potential was studied by skin prick tests, IgE-enzyme-linked immunosorbent assay (ELISA) and also by aeroallergen immunoblotting. The total pollen extract was fractionated by Sephacryl S-200 column, and out of the eluted five fractions, the maximum IgE-reactive fraction (as found in ELISA inhibition) was resolved into five major subfractions in reverse-phase high-performance liquid chromatography (RP-HPLC). The subfraction with optimum IgE reactivity was studied by activity gel, native and nonreducing sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE). The homogeneity of the isolated protein fraction was checked by crossed

immunoelectrophoresis with rabbit antisera and IgE reactivity was confirmed by ELISA inhibition and immunoblotting using individual patient sera. RESULTS: The Carica pollen occurred in the air round the year with peaks during January and September-October. Among a patient population of 1000, skin-test results showed 27.8% +1 level and 5.6% +2/+3 level reactions. In aeroallergen immunoblotting of exposed Burkard tape segments, the detected allergen spots showed a significant correlation with airborne pollen count recorded. The pollen extract elicited loss of IgE reactivity when treated with reducing agent-like beta-mercaptoethanol and heat, but showed six IgE-reactive components in nonreducing IgE-immunoblot. The fraction 1 eluted from Sephacryl S-200 column showed highest IgE reactivity and resolved into five major components in RP-HPLC. Out of these, the fraction showing optimum IgE reactivity in IgE-ELISA inhibition and immunoblotting with patient antisera, elicited esterase activity and found to be a homogenous protein of 100 kDa. CONCLUSION: Carica papaya tree contributes significantly to the aeropollen and aeroallergen load of the suburban outskirts of Calcutta metropolis, India. The pollen extract contains an important IgE-reactive protein component of 100 kDa molecular weight with esterase activity.

Wolt JD, Shyy YY, Christensen PJ, Dorman KS, Misra M. (Biosafety Institute for Genetically Modified Agricultural Products, Iowa State University, Ames, IA 50011, USA. jdwolt@iastate.edu) , Quantitative exposure assessment for confinement of maize biogenic systems. *Environ Biosafety Res.* 3(4) (2004): 183-96.

The development of transgenic crops as production platforms for biogenic agents will largely depend on the success of efforts to confine the genes and their expressed proteins in field environments. We have used quantitative exposure assessment to evaluate how management practices affect materials escape due to outcrossing by pollen flow or grain loss during harvest operations. Specifically, we study the use of maize to produce biogenic agents within field-confined systems. Decision trees representing simplified schemes of fully conforming (designed to comply with current regulatory standards for field confined trials), partially conforming, and non-conforming management practices were developed. Exemplifying assumptions and published data for conformance and material fate probabilities were used in Monte Carlo simulations to forecast materials escape by pollen outcrossing and harvest operations from a 1 ha source field. Deterministic analyses showed fully conforming confinement management restricted materials loss to low levels (for this example, outcrossing produced <1 in 10(6) kernels in receptor fields). The corresponding high-end (90th percentile) probabilistic result was 16- and 4333-fold higher (relative to deterministic outcrossing = 1) for outcrossing and harvest loss, respectively. For partially conforming practice, high-end outcrossing ranged from 100- to >15000-fold over the base result in receptor fields, and harvest loss was >10000-fold over the base result. For non-conforming practice, high-end outcrossing produced >15000-fold greater kernels in receptor fields and high-end harvest loss was at least 19000-fold greater. Deterministic estimates of off-field loss by machine transfer are as much as 30000-fold higher for non-conforming operations relative to the base case of pollen outcrossing. Better knowledge of failure frequencies for confinement management practices, improved physical models of materials flows, refined analysis of confinement loss probabilities using quantitative tools, and decision analysis to improve and audit management system performance are all needed to extend understanding of confinement integrity beyond the exemplifying case used here.

Biotechnology Policy Issue

Then SN. (Court of Appeal, Queensland. snthen@inet.net.au), Stem cell technologies: regulation, patents and problems. J Law Med. 12(2) (2004): 188-204.

Human embryonic stem cell research promises to deliver in the future a whole range of therapeutic treatments, but currently governments in different jurisdictions must try to regulate this burgeoning area. Part of the problem has been, and continues to be, polarised community opinion on the use of human embryonic stem cells for research. This article compares the approaches of the Australian, United Kingdom and United States governments in regulating human embryonic stem cell research. To date, these governments have approached the issue through implementing legislation or policy to control research. Similarly, the three jurisdictions have viewed the patentability of human embryonic stem cell technologies in their own ways with different policies being adopted by the three patent offices. This article examines these different approaches and discusses the inevitable concerns that have been raised due to the lack of a universal approach in relation to the regulation of research; the patenting of stem cell technologies; and the effects patents granted are having on further human embryonic stem cell research.

Smith AC, Mugabe J, Singer PA, Daar AS. (Joint Centre for Bioethics, University of Toronto, 88 College Street, Toronto, ON, M5G 1L4, Canada. peter.singer@utoronto.ca.) "Harnessing genomics to improve health in Africa" - an executive course to support genomics policy. Health Res Policy Syst., 3(1) (2005): p2.

BACKGROUND: Africa in the twenty-first century is faced with a heavy burden of disease, combined with ill-equipped medical systems and underdeveloped technological capacity. A major challenge for the international community is to bring scientific and technological advances like genomics to bear on the health priorities of poorer countries. The New Partnership for Africa's Development has identified science and technology as a key platform for Africa's renewal. Recognizing the timeliness of this issue, the African Centre for Technology Studies and the University of Toronto Joint Centre for Bioethics co-organized a course on Genomics and Public Health Policy in Nairobi, Kenya, the first of a series of similar courses to take place in the developing world. This article presents the findings and recommendations that emerged from this process, recommendations which suggest that a regional approach to developing sound science and technology policies is the key to harnessing genome-related biotechnology to improve health and contribute to human development in Africa. **METHODS:** The objectives of the course were to familiarize participants with the current status and implications of genomics for health in Africa; to provide frameworks for analyzing and debating the policy and ethical questions; and to begin developing a network across different sectors by sharing perspectives and building relationships. To achieve these goals the course brought together a diverse group of stakeholders from academic research centres, the media, non-governmental, voluntary and legal organizations to stimulate multi-sectoral debate around issues of policy. Topics included scientific advances in genomics innovation systems and business models, international regulatory frameworks, as well as ethical and legal issues. **RESULTS:** Seven main recommendations emerged: establish a network for sustained dialogue among participants; identify champions among politicians; use

the New Plan for African Development (NEPAD) as entry point onto political agenda; commission an African capacity survey in genomics-related R&D to determine areas of strength; undertake a detailed study of R&D models with demonstrated success in the developing world, i.e. China, India, Cuba, Brazil; establish seven regional research centres of excellence; and, create sustainable financing mechanisms. A concrete outcome of this intensive five-day course was the establishment of the African Genome Policy Forum, a multi-stakeholder forum to foster further discussion on policy. CONCLUSION: With African leaders engaged in the New Partnership for Africa's Development, science and technology is well poised to play a valuable role in Africa's renewal, by contributing to economic development and to improved health. Africa's first course on Genomics and Public Health Policy aspired to contribute to the effort to bring this issue to the forefront of the policy debate, focusing on genomics through the lens of public health. The process that has led to this course has served as a model for three subsequent courses (in India, Venezuela and Oman), and the establishment of similar regional networks on genomics and policy, which could form the basis for inter-regional dialogue in the future.

Agricultural Biotechnology

Barea JM, Pozo MJ, Azcon R, Azcon-Aguilar C. (Departamento de Microbiología del Suelo y Sistemas Simbióticos, Estación Experimental del Zaidín, CSIC, Profesor Albareda 1, E-18008 Granada, Spain.), Microbial co-operation in the rhizosphere. J Exp Bot. 56(417) (2005):1761-78.

Soil microbial populations are immersed in a framework of interactions known to affect plant fitness and soil quality. They are involved in fundamental activities that ensure the stability and productivity of both agricultural systems and natural ecosystems. Strategic and applied research has demonstrated that certain co-operative microbial activities can be exploited, as a low-input biotechnology, to help sustainable, environmentally-friendly, agro-technological practices. Much research is addressed at improving understanding of the diversity, dynamics, and significance of rhizosphere microbial populations and their co-operative activities. An analysis of the co-operative microbial activities known to affect plant development is the general aim of this review. In particular, this article summarizes and discusses significant aspects of this general topic, including (i) the analysis of the key activities carried out by the diverse trophic and functional groups of micro-organisms involved in co-operative rhizosphere interactions; (ii) a critical discussion of the direct microbe-microbe interactions which results in processes benefiting sustainable agro-ecosystem development; and (iii) beneficial microbial interactions involving arbuscular mycorrhiza, the omnipresent fungus-plant beneficial symbiosis. The trends of this thematic area will be outlined, from molecular biology and ecophysiological issues to the biotechnological developments for integrated management, to indicate where research is needed in the future.

Shareck J, Choi Y, Lee B, Miguez CB. (Department of Food Science and Agricultural Chemistry, McGill University, Ste-Anne-de-Bellevue, Quebec, Canada.), Cloning vectors based on cryptic plasmids isolated from lactic acid bacteria: their characteristics and potential applications in biotechnology. Crit Rev Biotechnol. 24(4) (2004): 155-208.

Lactic acid bacteria (LAB) are Gram positive bacteria, widely distributed in nature, and industrially important as they are used in a variety of industrial food fermentations. The use of genetic engineering techniques is an effective means of enhancing the industrial applicability of LAB. However, when using genetic engineering technology, safety becomes an essential factor for the application of improved LAB to the food industry. Cloning and expression systems should be derived preferably from LAB cryptic plasmids that generally encode genes for which functions can be proposed, but no phenotypes can be observed. However, some plasmid-encoded functions have been discovered in cryptic plasmids originating from *Lactobacillus*, *Streptococcus thermophilus*, and *Pediococcus* spp. and can be used as selective marker systems in vector construction. This article presents information concerning LAB cryptic plasmids, and their structures, functions, and applications. A total of 134 cryptic plasmids collated are discussed.

A. Alam, M.H.Shah (Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar Campus, Srinagar Kashmir – 191 121). Status of organic agriculture worldwide-an overview. National Seminar on Organic Products and their Future Prospects, SKUAST(K), Srinagar, (2003): 7 –18.

Organic agriculture is frequently understood as a system of food production and consumption proper to environmentally and health conscious people of the developed world. The main drive of main developing countries to produce organic food and fibers is to tap market opportunities in developed nations. Organic farming is practiced in approximately 100 countries of the world and the area under organic management is continually growing. Almost 23 million hectares are managed organically worldwide. Currently the major part of this area is located in Australia (10.65 million hectare); Argentina (3.2m. ha) and Italy (more than 1.2 m. ha). The percentages, however are highest in Europe. The total organic area is Asia in now 6,00,000 hectares.

Bioenergy

Schwartz GE, Swanick S, Sibert W, Lewis DA, Lewis SE, Nelson L, Jain S, Mallory L, Foust L, Moore K, Tussing D, Bell IR. (Center for Frontier Medicine in Biofield Science and Department of Medicine, University of Arizona, Tucson, 85719, USA. GSCHWART@U.ARIZONA.EDU), Biofield detection: role of bioenergy awareness training and individual differences in absorption. J Altern Complement Med., 10(1) (2004): 167-9.

OBJECTIVE: To measure health care providers' capacity to detect biofields before and after bioenergy awareness training in relation to individual differences in the personality trait of absorption. METHODS: Twenty-seven (27) physicians, psychologists, and nurses participated in a 5-day intensive bioenergy healing training course with Rev. Rosalyn Bruyere. The course was part of the Associate Fellows Program in the Program in Integrative Medicine at the University

of Arizona. Blindfolded participants received a 24-trial hand biofield detection test (HBDT) pretraining and post-training. The experimenter placed his or her dominant hand a few inches above the participant's left or right hand for 30-second trials. After each trial, the participant guessed which hand was being tested. Blocks contained two right- and two left-hand trials in different orders. Participants filled out Tellegen's Absorption Scale, a measure of the capacity to focus attention in tasks. **RESULTS:** Percent HBDT accuracy for the entire sample was 50.8% (standard deviation [SD] = 12.24) at pretraining (50% is chance); accuracy increased to 55.5% (SD = 12.38) at post-training ($t = p = 2.08$, $p < 0.05$). Pretraining absorption (mean = 23.9; SD = 5.52) was significantly correlated with degree of detection accuracy increase ($r = 0.42$, $n = 22$, $p < 0.05$). High absorption (mean = 28.2 $n = 11$) participants increased to 58.3% compared to 52.7% for low absorption (mean = 19.2 $n = 11$) participants. **CONCLUSION:** The findings support claims of energy healers that (1) training can improve bioenergy awareness, and (2) there are substantial individual differences in response to training.

Lal R. (Carbon Management and Sequestration Center, The Ohio State University, Columbus, OH 43210, United States. lal.1@osu.edu), World crop residues production and implications of its use as a biofuel. *Environ Int.*, 31(4) (2005): 575-84

Reducing and off-setting anthropogenic emissions of CO₂ and other greenhouse gases (GHGs) are important strategies of mitigating the greenhouse effect. Thus, the need for developing carbon (C) neutral and renewable sources of energy is more than ever before. Use of crop residue as a possible source of feedstock for bioenergy production must be critically and objectively assessed because of its positive impact on soil C sequestration, soil quality maintenance and ecosystem functions. The amount of crop residue produced in the US is estimated at 367x10⁶ Mg/year for 9 cereal crops, 450x10⁶ Mg/year for 14 cereals and legumes, and 488x10⁶ Mg/year for 21 crops. The amount of crop residue produced in the world is estimated at 2802x10⁶ Mg/year for cereal crops, 3107x10⁶ Mg/year for 17 cereals and legumes, and 3758x10⁶ Mg/year for 27 food crops. The fuel value of the total annual residue produced is estimated at 1.5x10¹⁵ kcal, about 1 billion barrels (bbl) of diesel equivalent, or about 8 quads for the US; and 11.3x10¹⁵ kcal, about 7.5 billion bbl of diesel or 60 quads for the world. However, even a partial removal (30-40%) of crop residue from land can exacerbate soil erosion hazard, deplete the SOC pool, accentuate emission of CO₂ and other GHGs from soil to the atmosphere, and exacerbate the risks of global climate change. Therefore, establishing bioenergy plantations of site-specific species with potential of producing 10-15 Mg biomass/year is an option that needs to be considered. This option will require 40-60 million hectares of land in the US and about 250 million hectares worldwide to establish bioenergy plantations.

Youn JH, Shin HS. (Department of Environmental Information and Engineering, Shinsung College, Chungnam, Korea. younjh@shinsung.ac.kr), Comparative performance between temperature-phased and conventional mesophilic two-phased processes in terms of anaerobically produced bioenergy from food waste. *Waste Manag Res.*, 23(1) (2005): 32-8.

Comparative evaluation of bioenergy production from food waste was carried out with both a temperature-phased and a conventional mesophilic two-phased process at different organic loading rates (OLRs). No methane was detected in the temperature-phased thermophilic-

acidogenic fermenter at all the OLRs tested. However, a significant amount of methane content was detected in the conventional two-phased mesophilic-acidogenic fermenter, with increments depending on the organic loading rate [from 17% at 3 g VS L⁻¹ day⁻¹ to 25% at 8 g VS L⁻¹ day⁻¹ (VS, volatile solid)]. Acetate and butyrate were the main volatile fatty acids (VFAs) in the temperature-phased thermophilic-acidogenic fermenter; conversely propionate was a major VFA in the conventional two-phased mesophilic-acidogenic fermenter. Through the chemical oxygen demand (COD) balance of both temperature-phased and conventional mesophilic two-phased processes, the fraction of the feed-COD converted to the hydrogen-COD in the thermophilic-acidogenic fermenter within the former process was estimated from 7.9 to 9.3%, with a peak at ORL of 6 g VS L⁻¹ day⁻¹, whereas it was quantified from 0.3 to 0.9% in the mesophilic-acidogenic fermenter within the latter one. Moreover, the fraction of the feed-COD converted to the methane-COD in the mesophilic-acidogenic fermenter within the conventional two-phased process ranged from 5.4 to 7.9%. On the other hand, conversion of the feed-COD to the methane-COD in the mesophilic-methanogenic fermenter of both temperature-phased and conventional mesophilic two-phased processes ranged from 66.2 to 72.3% and from 63.5 to 70.5%, respectively, with decrements related to the increase of organic loading rate.

Rao MS, Singh SP. (Biomass and Waste Management Laboratory, School of Energy and Environmental Studies, Faculty of Engineering Sciences, Devi Ahilya University, Khandwa Road Campus, Indore, MP PIN--452 017, India.) Bioenergy conversion studies of organic fraction of MSW: kinetic studies and gas yield--organic loading relationships for process optimisation. *Bioresour Technol.*, 95(2) (2004):173-85.

Batch digestion of municipal garbage was carried out for 100 days at room temperature (26±4 degrees C; average temperature 25 degrees C) and at ambient temperature (32±10 degrees C; average temperature 29 degrees C) conditions for total solids concentrations varying between 45 and 135 g/l. A first order model based on the availability of substrate as the limiting factor was used to perform the kinetic studies of batch anaerobic digestion system. Effect of organic solids concentration and digestion time on biogas yield was studied and mass and energy balance analysis was conducted for batch digestion. The net bioenergy yield from municipal garbage and corresponding bioprocess conversion efficiency over the length of the digestion time were observed to be 12,528 kJ/kg volatile solids and 84.51% respectively. The methane content of the biogas generated from the reactors was in the range of 62-72% with the overall average methane content of the biogas, computed over the total digestion period was 65 vol%.

Angenent LT, Karim K, Al-Dahhan MH, Wrenn BA, Domiguez-Espinosa R. (Department of Chemical Engineering, Washington University in St. Louis, One Brookings Drive, St. Louis, MO 63130, USA. angenent@seas.wustl.edu), Production of bioenergy and biochemicals from industrial and agricultural wastewater. *Trends Biotechnol.*, 22(9) (2004): 477-85.

The building of a sustainable society will require reduction of dependency on fossil fuels and lowering of the amount of pollution that is generated. Wastewater treatment is an area in which these two goals can be addressed simultaneously. As a result, there has been a paradigm shift recently, from disposing of waste to using it. There are several biological processing strategies

that produce bioenergy or biochemicals while treating industrial and agricultural wastewater, including methanogenic anaerobic digestion, biological hydrogen production, microbial fuel cells and fermentation for production of valuable products. However, there are also scientific and technical barriers to the implementation of these strategies.

McLaren JS. (StrathKirn Inc., 2214 Stoneridge Terr. Ct, Chesterfield, MO 63017, USA. mclaren@strathkirn.com), Crop biotechnology provides an opportunity to develop a sustainable future. Trends Biotechnol. 23(7) (2005):339-42.

The current reliance on petro-based fuels and chemicals is not sustainable. New technologies typically take approximately 25 years to penetrate the market; consequently, the development of viable alternatives is required in the near future. Plant-based systems capture solar energy and can be produced in a renewable manner. However, the harvestable parts are not well optimized for energy transfer and this has been a significant limitation to the development of economically viable and sustainable biomass energy systems. Biotechnology has provided a new toolset that can be used to design and optimize the capture of solar energy through crops. Further development of biotechnology and genomics tools will enable the development of crops with specific traits that are optimized for biofuels and bioenergy. The implementation of such a system will enable a sustainable platform for centuries to come and should be given a high priority in society.

Feng J, Himmel ME, Decker SR. (National Bioenergy Center, National Renewable Energy Laboratory, Golden, Colorado, CO 80401, USA, steve_decker@nrel.gov.) Electrochemical oxidation of water by a cellobiose dehydrogenase from *Phanerochaete chrysosporium*. Biotechnol Lett. 27(8) (2005): 555-60.

Cellobiose dehydrogenase (CDH) is a redox protein containing two electron transfer centers; a flavin coenzyme performing a two-electron transfer reaction and an iron-heme coenzyme facilitating single-electron transfer. Purified CDH from *Phanerochaete chrysosporium* was immobilized on a pyrolytic graphite electrode and electron transfer from cellobiose to the electrode was generated. With cellobiose present during cyclic voltammetry, this novel enzyme/electrode system exhibited sharp, stable oxidation peaks with slower, though equivalent, reduction peaks. During cyclic voltammetry without substrate, the enzyme was rapidly oxidized during the initial scan, with no corresponding enzyme reduction during the reducing half of the cycle. After resting for several hours in aqueous buffer, the full oxidation current appeared again. These results suggest that the CDH is reduced by water splitting, albeit at a slow rate.

Kiang JG, Ives JA, Jonas WB. (Department of Cellular Injury, Walter Reed Army Institute of Research, 503 Robert Grant Avenue, Room 1N07, Silver Spring, MD 20910-7500, USA. Juliann.Kiang@na.amedd.army.mil) External bioenergy-induced increases in intracellular free calcium concentrations are mediated by Na⁺/Ca²⁺ exchanger and L-type calcium channel. Mol Cell Biochem., 271(1-2) (2005): 51-9.

External bioenergy (EBE, energy emitted from a human body) has been shown to increase intracellular calcium concentration ($[Ca^{2+}]_i$, an important factor in signal transduction) and regulate the cellular response to heat stress in cultured human lymphoid Jurkat T cells. In this study, we wanted to elucidate the underlying mechanisms. A bioenergy specialist emitted bioenergy sequentially toward tubes of cultured Jurkat T cells for one 15-minute period in buffers containing different ion compositions or different concentrations of inhibitors. $[Ca^{2+}]_i$ was measured spectrofluorometrically using the fluorescent probe fura-2. The resting $[Ca^{2+}]_i$ in Jurkat T cells was 70 ± 3 nM ($n = 130$) in the normal buffer. Removal of external calcium decreased the resting $[Ca^{2+}]_i$ to 52 ± 2 nM ($n = 23$), indicating that Ca^{2+} entry from the external source is important for maintaining the basal level of $[Ca^{2+}]_i$. Treatment of Jurkat T cells with EBE for 15 min increased $[Ca^{2+}]_i$ by $30 \pm 5\%$ ($P < 0.05$, Student t-test). The distance between the bioenergy specialist and Jurkat T cells and repetitive treatments of EBE did not attenuate $[Ca^{2+}]_i$ responsiveness to EBE. Removal of external Ca^{2+} or Na^+ , but not Mg^{2+} , inhibited the EBE-induced increase in $[Ca^{2+}]_i$. Dichlorobenzamil, an inhibitor of Na^+/Ca^{2+} exchangers, also inhibited the EBE-induced increase in $[Ca^{2+}]_i$ in a concentration-dependent manner with an IC_{50} of 0.11 ± 0.02 nM. When external $[K^+]$ was increased from 4.5 mM to 25 mM, EBE decreased $[Ca^{2+}]_i$. The EBE-induced increase was also blocked by verapamil, an L-type voltage-gated Ca^{2+} channel blocker. These results suggest that the EBE-induced $[Ca^{2+}]_i$ increase may serve as an objective means for assessing and validating bioenergy effects and those specialists claiming bioenergy capability. The increase in $[Ca^{2+}]_i$ is mediated by activation of Na^+/Ca^{2+} exchangers and opening of L-type voltage-gated Ca^{2+} channels.

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