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ENVIRONMENTAL Science & Technology

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METAL COMPLEXES
and **FREE RADICAL**
TOXINS *Produced by*
Pfiesteria piscicida

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News and Features

NEWS

1060 New *Pfiesteria* toxin identified

After nearly a decade of work, researchers have discovered a toxin that could be responsible for fish kills in the eastern U.S.

1061 Mercury control costs drop

Activated carbon injection for coal-fired power plants can cost up to 50% less than previously thought.

1061-1065 News Briefs

Plastics component linked to breast cancer • Megawatt mileage • Bugs are everywhere—even on dust in city air • Livestock and greenhouse gases • State of the Arctic

1062 Pesticides waft into pristine rainforests

New research shows that pesticides are transported to remote mountain areas in Costa Rica.

1064 Overlooked impacts of bioproducts

Bio-based fuel and plastics could reduce global warming, but they have other environmental impacts.

1065 Scientists protest U.S. EPA library closures

Critics argue that library closures will make it harder for agency scientists to protect public health.

1066 New managing editor rejoins *ES&T*

Britt Erickson heads up *ES&T* news and features.

VIEWPOINT

1067 Laboratory-to-Field Extrapolation in Aquatic Sciences

Davide A. L. Vignati, Benoît J. D. Ferrari, and Janusz Dominik



Just because something happens in the laboratory doesn't mean it will happen in the real world. Reconciling laboratory and field observations remains a major challenge for both fundamental and applied research in aquatic sciences. Vignati et al. describe some well-known laboratory-versus-field gaps, examine the reasons for their existence and persistence, and propose a conceptual framework to improve the current situation.

describe some well-known laboratory-versus-field gaps, examine the reasons for their existence and persistence, and propose a conceptual framework to improve the current situation.

Cover: A major kill of juvenile menhaden, the fish most commonly affected by *Pfiesteria*, in North Carolina's Neuse River estuary was photographed by Rick Dove, www.doveimaging.com.

Online news: Read news first at <http://pubs.acs.org/estnews>.

Research

CRITICAL REVIEWS

1075

Biologically Mediated Transport of Contaminants to Aquatic Systems

Jules M. Blais, Robie W. Macdonald, Donald Mackay, Eva Webster, Colin Harvey, and John P. Smol

The concept of biovector transport is defined and developed with the use of examples from the literature and a model.

1085

Microevolution and Ecotoxicology of Metals in Invertebrates

A. John Morgan, Peter Kille, and Stephen R. Stürzenbaum

Ecotoxicological assessments using free-living invertebrate populations are complicated by microevolutionary adaptive responses that modulate the relationship between exposure and toxicological effect.

CHARACTERIZATION OF NATURAL AND AFFECTED ENVIRONMENTS

1097

Polychlorinated Biphenyl Release from Resuspended Hudson River Sediment

Abby R. Schneider, Elka T. Porter, and Joel E. Baker

PCBs, which rapidly desorb from resuspended Hudson River sediments, likely partition from a labile-sorbed pool in the river's sediments.

1104

XAFS Studies of Nickel and Sulfur Speciation in Residual Oil Fly-Ash Particulate Matters (ROFA PM)

Sidhartha Pattanaik, Frank E. Huggins, Gerald P. Huffman, William P. Linak, and C. Andrew Miller

Chemical speciation of nickel and sulfur in ROFA PM is studied with XAFS and aqueous leaching.

1111

Characterization of Natural Aquatic Colloids (<5 nm) by Flow-Field Flow Fractionation and Atomic Force Microscopy

M. Baalousha and J. R. Lead

Flow-field flow fractionation and atomic force microscopy have been coupled to quantify the structure of very fine (<5-nm) aquatic colloids.

1118

Accumulation of Current-Use Pesticides in Neotropical Montane Forests

Gillian L. Daly, Ying D. Lei, Camilla Teixeira, Derek C. G. Muir, Luisa E. Castillo, and Frank Wania

Supporting information is available free at <http://pubs.acs.org/est>.

This issue contains a news story about this research.

Atmospheric transport and temperature-dependent precipitation scavenging lead to greatly elevated levels of currently used pesticides in tropical mountain forests.

■ 1124

► **Organochlorine Pesticides in the Soils and Atmosphere of Costa Rica**

Gillian L. Daly, Ying D. Lei, Camilla Teixeira, Derek C. G. Muir, Luisa E. Castillo, Liisa M. M. Jantunen, and Frank Wania

A national-scale survey using passive air samplers and surface soils reveals generally low levels and a variety of distinct spatial distribution patterns of banned pesticides.

■ 1131

Temporal and Spatial Trends of Atmospheric Polychlorinated Biphenyl Concentrations near the Great Lakes

Ping Sun, Ilora Basu, Pierrette Blanchard, Kenneth A. Brice, and Ronald A. Hites

Atmospheric PCB concentrations are decreasing relatively rapidly near Lakes Michigan and Ontario and correlate with local population; these observations indicate controllable, urban PCB sources.

■ 1137

Aging Effects on the Availability of Herbicides to Runoff Transfer

Xavier Louchart and Marc Voltz

A field-derived desorption coefficient is proposed that characterizes the decreasing availability of herbicides to runoff transfer due to their aging in the soil surface layer.

■ 1145

European Emissions of HFC-365mfc, a Chlorine-Free Substitute for the Foam Blowing Agents HCFC-141b and CFC-11

Konrad Stemmler, Doris Folini, Sandy Ubl, Martin K. Vollmer, Stefan Reimann, Simon O'Doherty, Brian R. Grealley, Peter G. Simmonds, and Alistair J. Manning

Atmospheric monitoring of halogenated foam blowing agents (i.e., CFC-11, HCFC-141b, and HFC-365mfc) and their present emissions in Europe are discussed.

■ 1152

Air-Water Exchange of Polychlorinated Biphenyls in the Delaware River

Amy A. Rowe, Lisa A. Totten, Minge Xie, Thomas J. Fikslin, and Stephen J. Eisenreich

Volatilization of PCBs in the Delaware River is examined in the context of a new framework for understanding the uncertainty in the air-water fugacity calculations.

■ 1159

Characterizing the Emissions of Polybrominated Dibenzop-dioxins and Dibenzofurans from Municipal and Industrial Waste Incinerators

Lin-Chi Wang and Guo-Ping Chang-Chien

Characteristics of PBDD/Fs in the stack flue gases of municipal solid-waste incinerators and industrial-waste incinerators are presented.

■ 1166

► **Metal Complexes and Free Radical Toxins Produced by *Pfiesteria piscicida***

Peter D. R. Moeller, Kevin R. Beauchesne, Kevin M. Huncik, W. Clay Davis, Steven J. Christopher, Pamela Riggs-Gelasco, and Andrew K. Gelasco

Ligated metals derived from *Pfiesteria piscicida* produce free radicals responsible in part for the observed toxicity associated with this organism.

■ 1173

Seabird Guano Is an Efficient Conveyer of Persistent Organic Pollutants (POPs) to Arctic Lake Ecosystems

A. Evenset, J. Carroll, G. N. Christensen, R. Kallenborn, D. Gregor, and G. W. Gabrielsen

The importance of seabirds as transport vectors for POPs is established via mass-balance analysis, analyses of contaminant patterns in lake samples and guano, and stable isotope patterns in biota.

■ 1180

Quantitation of Gas-Phase Perfluoroalkyl Surfactants and Fluorotelomer Alcohols Released from Nonstick Cookware and Microwave Popcorn Bags

Ewan Sinclair, Seung Kyu Kim, Henry B. Akinleye, and Kurunthachalam Kannan

Nonstick cookware and popcorn bags off-gas certain perfluorochemicals, including perfluorooctanoic acid, when heated at normal cooking temperatures.

ENVIRONMENTAL PROCESSES

1186

Sorption/Desorption Reversibility of Phenanthrene in Soils and Carbonaceous Materials

Guohui Wang, Sybille Kleineidam, and Peter Grathwohl

Sorption/desorption of phenanthrene in two soil samples and carbonaceous materials yield coincident equilibrium isotherms and a lack of significant hysteresis.

1194

Relationship between Micellar and Hemi-Micellar Processes and the Bioavailability of Surfactant-Solubilized Hydrophobic Organic Compounds

Derick G. Brown

A mechanistic model of the surfactant-enhanced bioavailability of hydrophobic organic compounds is developed that is based on both micellar and hemi-micellar processes.

1200

Using Gas-Phase Molecular Descriptors to Predict Dechlorination Rates of Chloroalkanes by Zerovalent Iron

Sathaporn Onanong, Steve D. Comfort, Paul D. Burrow, and Patrick J. Shea

Chloroalkanes' reactivity with zerovalent iron can be predicted from four molecular descriptors (LUMO energies, vertical attachment energies, thermal attachment rate constants, and electron capture detector response).

■ 1206

Hydrosulfide Oxidation Pathways in Oxidic Solutions Containing Iron(III) Chelates

Simon Piché and Faiçal Larachi

Hydrosulfide oxidation with iron chelates is slowed down by the presence of dissolved oxygen, which disrupts accumulation of polysulfides by generating thiosulfate.

■ 1212

Evidence for a Pore-Filling Mechanism in the Adsorption of Aromatic Hydrocarbons to a Natural Wood Char

Thanh H. Nguyen, Hyun-Hee Cho, Dianne L. Poster, and William P. Ball

Isotherms obtained with a natural char and its residue after solvent extraction suggest sorption effects due to both authigenic organic content in the sorbent and the sorbate's condensed state.

■ 1218

Hydrologic Flow Controls on Biologic Iron(III) Reduction in Natural Sediments

Morgan L. Minyard and William D. Burgos

Biologic Fe(III) reduction, abiotic Fe(II) sorption, and cell synthesis are all coupled to the hydrologic flow rate in a complex manner.

■ 1225

In-Stream Biogeochemical Processes of a Temporary River

Ourania Tzoraki, Nikolaos P. Nikolaidis, Yorgos Amaxidis, and Nikolaos Th. Skoulidakis

In-stream processes play a significant role in altering the hydrology and biogeochemistry of the water of temporary rivers and their impacts to the coastal zone.

■ 1232

Binding of Iron(III) to Organic Soils: EXAFS Spectroscopy and Chemical Equilibrium Modeling

Jon Petter Gustafsson, Ingmar Persson, Dan Berggren Kleja, and Joris W. J. van Schaik

The complexation of iron(III) to organic matter in two soils involves the formation of hydrolyzed dimeric and trimeric iron(III).

■ 1238

Adsorption of Natural Organic Matter onto Carbonaceous Surfaces: Atomic Force Microscopy Study

Justin M. Gorham, Joshua D. Wnuk, M. Shin, and Howard Fairbrother

AFM is used to explore the influence of aqueous conditions (pH, ionic strength, and Ca^{2+} concentration) on the adlayers formed by NOM on carbonaceous surfaces.

1245

Slightly Weathered Exxon Valdez Oil Persists in Gulf of Alaska Beach Sediments after 16 Years

Jeffrey W. Short, Gail V. Irvine, Daniel H. Mann, Jacek M. Maselko, Jerome J. Pella, Mandy R. Lindeberg, James R. Payne, William B. Driskell, and Stanley D. Rice

Lingering Exxon Valdez oil sequestered within the intertidal zone is dissipating much more slowly than anticipated.

1251

Ionic Strength-Induced Formation of Smectite Quasicrystals Enhances Nitroaromatic Compound Sorption

Hui Li, Tanya R. Pereira, Brian J. Teppen, David A. Laird, Cliff T. Johnston, and Stephen A. Boyd

An increase of KCl concentration promotes formation of K-smectite quasicrystals; this increases the number of adsorption domains and facilitates the intercalation of 1,3-dinitrobenzene in clay interlayers.

■ 1257

Role of Organically Complexed Iron(II) Species in the Reductive Transformation of RDX in Anoxic Environments

Dongwook Kim and Timothy J. Strathmann

RDX and related *N*-heterocyclic nitramine contaminants are rapidly reduced by aqueous Fe(II) complexes with catechol and organothiol ligands.

1265

Transport and Deposition of Metabolically Active and Stationary Phase *Deinococcus radiodurans* in Unsaturated Porous Media

G. Gargiulo, S. A. Bradford, J. Šimůnek, P. Ustohal, H. Vereecken, and E. Klumpp

Studies are conducted to investigate how the physiological state of bacteria impacts their transport and deposition behavior in unsaturated porous media.

ENVIRONMENTAL MODELING

■ 1272

Alternative Approaches for Modeling Gas-Particle Partitioning of Semivolatile Organic Chemicals: Model Development and Comparison

Christian W. Götz, Martin Scheringer, Matthew MacLeod, Christine M. Roth, and Konrad Hungerbühler

Aerosol-air partitioning of SOCs is calculated with a K_{OA} -based model and a polyparameter LFER model; for polar compounds, the ppLFER model yields higher partition coefficients.

■ 1279

Colloid Retention in Porous Media: Mechanistic Confirmation of Wedging and Retention in Zones of Flow Stagnation

W. P. Johnson, Xiqing Li, and Gozde Yal

Trajectory simulations confirm wedging and retention in flow stagnation zones as important contributors to particle deposition in porous media in the presence of an energy barrier.

■ 1288

Nitrile, Aldehyde, and Halonitroalkane Formation during Chlorination/Chloramination of Primary Amines

Sung Hee Joo and William A. Mitch

Important trends in nitrile, aldehyde, and halonitroalkane formation from chlorination/chloramination of model primary amines are discussed.

ENVIRONMENTAL MEASUREMENTS METHODS

1297

Analysis of Volatile Organic Compounds in Mainstream Cigarette Smoke

Gregory M. Polzin, Rachel E. Kosa-Maines, David L. Ashley, and Clifford H. Watson

Volatiles were collected in polyvinylfluoride gas sampling bags and analyzed by automated gas chromatography/mass spectrometry.

■ 1303

Simultaneous Measurement of the Effective Density and Chemical Composition of Ambient Aerosol Particles

Matthew T. Spencer, Laura G. Shields, and Kimberly A. Prather

Results from measurements of the effective density and chemical composition of individual particles from Riverside, Calif., during the SOAR campaign are discussed.

■ 1310

Volatile Organic Compound Emissions from Dairy Cows and Their Waste as Measured by Proton-Transfer-Reaction Mass Spectrometry

Stephanie L. Shaw, Frank M. Mitloehner, Wendi Jackson, Edward J. DePeters, James G. Fadel, Peter H. Robinson, Rupert Holzinger, and Allen H. Goldstein

Compound-specific VOC emissions into an environmental chamber are quantified at various stages of the lactation cycle to refine dairy-cow emission inventories.

■ 1317

Polyethylene Devices: Passive Samplers for Measuring Dissolved Hydrophobic Organic Compounds in Aquatic Environments

Rachel G. Adams, Rainer Lohmann, Loretta A. Fernandez, John K. MacFarlane, and Philip M. Gschwend

■ Supporting information is available free at <http://pubs.acs.org/est>.
▶ This issue contains a news story about this research.

The use of passive samplers (polyethylene devices) for the measurement of hydrophobic organic contaminants is demonstrated using polyethylene-water partitioning coefficients and impregnated reference compounds.

■ 1324

Regional Calibration of Erosion Radiotracers (^{210}Pb and ^{137}Cs): Atmospheric Fluxes to Soils (Northern Spain)

Joan-Albert Sanchez-Cabeza, Marta Garcia-Talavera, Eduard Costa, Victor Peña, Jordi Garcia-Orellana, Pere Masqué, and Constantino Nalda

The atmospheric fluxes of radionuclides used to quantify erosion processes can be determined from basin- or region-wide calibration with mean annual rainfall.

■ 1331

Carbon and Nitrogen Isotope Variations in Tree-Rings as Records of Perturbations in Regional Carbon and Nitrogen Cycles

Andrew R. Bukata and T. Kurtis Kyser

Nitrogen and carbon isotopic compositions of tree rings record the regional and temporal trends of increasing anthropogenic nitrogen pollution across central and eastern Canada since 1945.

■ 1339

Quantifying the Dimensions of Nanoscale Organic Surface Layers in Natural Waters

C. T. Gibson, Ian J. Turner, Clive J. Roberts, and J. R. Lead

Atomic force microscopy is used to quantify absolute thicknesses of organic surface layers developed on solid surfaces, with implications for pollutant solid-surface partitioning.

REMEDICATION AND CONTROL TECHNOLOGIES

■ 1345

Stabilization/Solidification of Radioactive Molten Salt Waste via Gel-Route Pretreatment

Hwan-Seo Park, In-Tae Kim, Hwan-Young Kim, Seung-Kon Ryu, and Joon-Hyung Kim

A novel gel-route pretreatment method to stabilize and solidify radioactive molten-salt waste is reported.

■ 1352

Origin of a Mixed Brominated Ethene Groundwater Plume: Contaminant Degradation Pathways and Reactions

Bradley M. Patterson, Elizabeth Cohen, Henning Prommer, David G. Thomas, Stuart Rhodes, and Allan J. McKinley

The origin and degradation pathway of a mixed brominated ethene groundwater plume are hypothesized on the basis of laboratory microcosm experiments, column sorption experiments, and site groundwater concentrations.

■ 1359

Proteins and Protein-Rich Biomass as Environmentally Friendly Adsorbents Selective for Precious Metal Ions

Tatsuo Maruyama, Hironari Matsushita, Yukiko Shimada, Ichiro Kamata, Misa Hanaki, Saori Sonokawa, Norihiro Kamiya, and Masahiro Goto

Proteins and protein-rich biomass function as environmentally friendly adsorbents selective for recycling precious-metal ions from industrial refining solution and wastes.

■ 1365

DOE/NETL's Phase II Mercury Control Technology Field Testing Program: Preliminary Economic Analysis of Activated Carbon Injection

Andrew P. Jones, Jeffrey W. Hoffmann, Dennis N. Smith, Thomas J. Feeley, III, and James T. Murphy

Preliminary costs are estimated for mercury control via conventional (untreated) activated carbon injection (ACI), brominated ACI, and conventional ACI coupled with sorbent enhancement additives.

1372

Preparation of Titanium Dioxide (TiO_2) from Sludge Produced by Titanium Tetrachloride (TiCl_4) Flocculation of Wastewater

H. K. Shon, S. Vigneswaran, In S. Kim, J. Cho, G. J. Kim, J. B. Kim, and J.-H. Kim

TiCl_4 is used instead of more commonly used salts of iron (FeCl_3) and aluminum [$\text{Al}_2(\text{SO}_4)_3$] as an alternative coagulant to remove dissolved organic matter, which is not removed in conventional sewage treatment plants.

1378

Bioremediation of 2,4,6-Trinitrotoluene under Field Conditions

Pieter van Dillewijn, Antonio Caballero, José A. Paz, M. Mar González-Pérez, José M. Oliva, and Juan L. Ramos

The effectiveness of several remediation techniques for the removal of TNT is assessed, and phytoremediation is shown to be more efficient than bacterial remediation.

■ 1384

Biologically Enhanced Mass Transfer of Tetrachloroethene from DNAPL in Source Zones: Experimental Evaluation and Influence of Pool Morphology

Kent C. Glover, Junko Munakata-Marr, and Tissa H. Illangasekare

Detailed flow-cell experiments provide insight into processes that enhance PCE dissolution and degradation during bioremediation of DNAPL source zones at high saturation.

1390

Biochemical Interpretation of Quantitative Structure-Activity Relationships (QSAR) for Biodegradation of N-Heterocycles: A Complementary Approach to Predict Biodegradability

Bodo Philipp, Malte Hoff, Florence Germa, Bernhard Schink, Dieter Beimborn, and Volker Mersch-Sundermann

QSAR models for biodegradation of N-heterocycles are interpreted from a biochemical viewpoint to create concrete rules for prediction of biodegradability.

■ 1399

Novel NO Trapping Catalysts Derived from Co-Mg/X-Al (X = Fe, Mn, Zr, La) Hydrotalcite-like Compounds

Jun Jie Yu, Yan Xin Tao, Chang Chun Liu, Zheng Ping Hao, and Zhi Ping Xu

NO adsorption/desorption on five multication well-mixed oxides that are derived from corresponding layered double hydroxides are reported.

1405

Using Bromine Gas To Enhance Mercury Removal from Flue Gas of Coal-Fired Power Plants

Shou-Heng Liu, Nai-Qiang Yan, Zhao-Rong Liu, Zan Qu, H. Paul Wang, Shih-Ger Chang, and Charles Miller

The use of bromine gas to enhance mercury removal from the flue gas of coal-fired plants is discussed.

1413

Operation of a Two-Stage Fermentation Process Producing Hydrogen and Methane from Organic Waste

Yoshiyuki Ueno, Hisatomo Fukui, and Masafumi Goto

Pilot-scale experimental operation of a two-stage biogas production process is conducted, and the process performance is evaluated from energy recovery and retention time.

■ 1420

Steam Reactivation of Spent CaO-Based Sorbent for Multiple CO₂ Capture Cycles

Vasilije Manovic and Edward J. Anthony

Steam reactivation is used to improve the reversibility of sorbents in multiple CaO–CO₂ capture cycles.

1426

Removal of Copper in an Integrated Sulfate Reducing Bioreactor–Crystallization Reactor System

Reyes Sierra-Alvarez, Jeremy Hollingsworth, and Michael S. Zhou

An innovative wastewater treatment system consisting of a crystallization reactor/sulfate-reducing bioreactor enables removal and recovery of copper and simultaneous biodegradation of organic constituents.

■ 1432

Reactive Transport Modeling of Trichloroethene Treatment with Declining Reactivity of Iron

Sung-Wook Jeon, K. Ulrich Mayer, Robert W. Gillham, and David W. Blowes

The evolving reactivity of iron resulting from secondary mineral precipitation is included in a reactive transport model for trichloroethene treatment.

SUSTAINABILITY ENGINEERING AND GREEN CHEMISTRY

1439

Electrically Regenerated Ion Exchange for Removal and Recovery of Cr(VI) from Wastewater

Yunqing Xing, Xueming Chen, and Dahui Wang

The performance of electrically regenerated ion exchange for removal and recovery of Cr(VI) from wastewater is reported.

■ 1444

Diversifying Biological Fuel Cell Designs by Use of Nanoporous Filters

Justin C. Biffinger, Ricky Ray, Brenda Little, and Bradley R. Ringeisen

Nanoporous membranes are adequate replacements for expensive proton-exchange membranes in a traditional microbial-fuel-cell flow reactor and novel passive diffusion devices.

■ 1450

Chlortetracycline Detoxification in Maize via Induction of Glutathione S-Transferases after Antibiotic Exposure

Michael H. Farkas, James O. Berry, and Diana S. Aga

Evidence of enzyme-catalyzed glutathione conjugation to chlortetracycline is provided for the first time in maize grown in soil treated with antibiotics.

■ 1457

▶ Life Cycle of the Corn–Soybean Agroecosystem for Biobased Production

Amy E. Landis, Shelia A. Miller, and Thomas L. Theis

A life-cycle inventory is reported that includes C; N; P; major pesticides; energy; and air pollutants resulting from agricul-

tural processes, including fertilizer and energy production, and on-farm chemical and equipment use.

■ 1465

Simple Indicator To Identify the Environmental Soundness of Growth of Consumption and Technology: “Eco-velocity of Consumption”

Keisuke Nansai, Shigemi Kagawa, Sangwon Suh, Rokuta Inaba, and Yuichi Moriguchi

A new environmental indicator for consumption is invented to identify the soundness of the relationship between consumption growth and technological advancement.

ECOTOXICOLOGY AND HUMAN ENVIRONMENTAL HEALTH

■ 1473

Quantitative Bioimaging Analysis of Gonads in *olvas-GFP/ST-II YI Medaka (Transgenic *Oryzias latipes*) Exposed to Ethinylestradiol*

Takeishi Hano, Yuji Oshima, Masato Kinoshita, Minoru Tanaka, Noriko Mishima, Tetsuji Ohyama, Takashi Yanagawa, Yuko Wakamatsu, Kenjiro Ozato, and Tsuneo Honjo

In a living model, gonadal impairment caused by endocrine-disrupting chemicals is reported, and chronological changes from atrophy to restitution of the testis in vivo after depuration are followed.

■ 1480

New Ecotoxicological Model To Simulate Survival of Aquatic Invertebrates after Exposure to Fluctuating and Sequential Pulses of Pesticides

Roman Ashauer, Alistair B. A. Boxall, and Colin D. Brown

A new, process-based model, the Threshold Damage Model, links exposure with effects; this model is compared with two simpler models based on time-weighted averages.

■ 1487

Dioxin-Like and Transthyretin-Binding Compounds in Indoor Dusts Collected from Japan: Average Daily Dose and Possible Implications for Children

Go Suzuki, Hidetaka Takigami, Kazutoshi Nose, Shin Takahashi, Misuzu Asari, and Shin-ichi Sakai

Dioxin-like and TTR-binding activities in indoor dusts are investigated with in vitro bioassays, and human exposure to house dust containing these active compounds is assessed.

1494

Arsenic Accumulation in Bark Beetles and Forest Birds Occupying Mountain Pine Beetle Infested Stands Treated with Monosodium Methanearsonate

Christy A. Morrissey, Courtney A. Albert, Patti L. Dods, William R. Cullen, Vivian W.-M. Lai, and John E. Elliott

A study of the arsenic-based pesticide MSMA, used to suppress bark beetle outbreaks, reveals toxicological concerns for woodpeckers and other forest birds.

■ Supporting information is available free at <http://pubs.acs.org/est>.
▶ This issue contains a news story about this research.