Fraunhofer IME

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APPLIED ECOLOGY

FRAUNHOFER INSTITUTE FOR MOLECULAR BIOLOGY AND APPLIED ECOLOGY IME

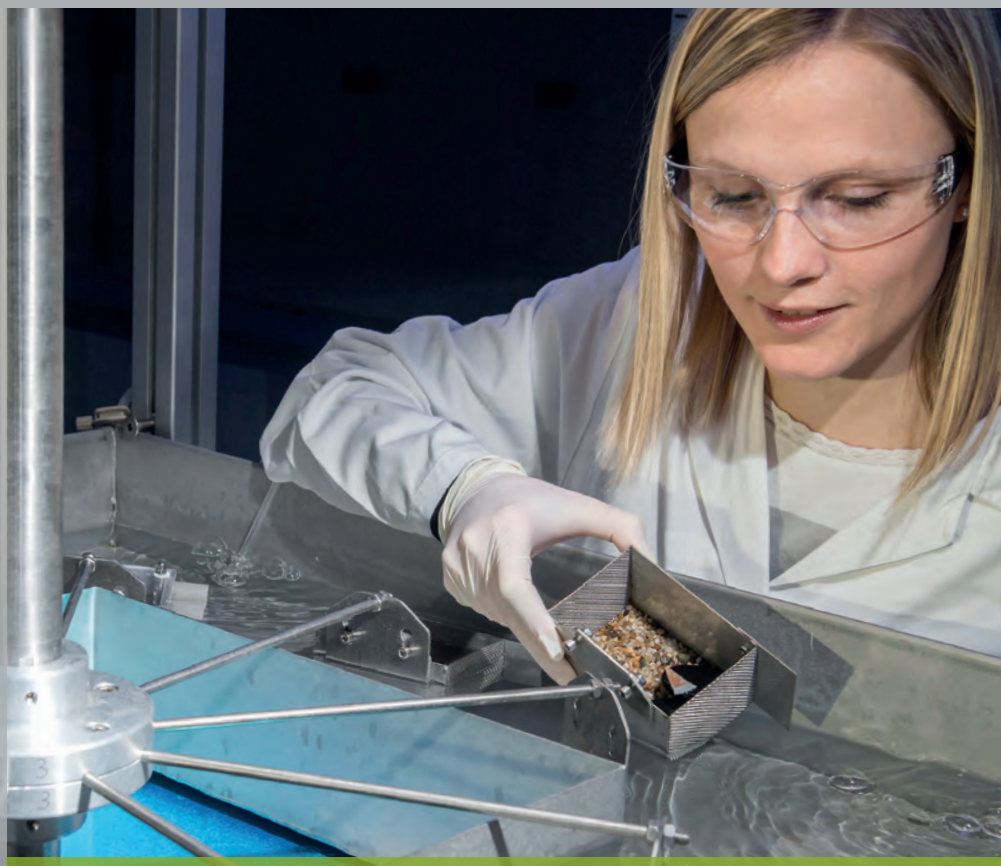
WELCOME

Analyzing the environmental risk of chemical substances and assessing the quality of environmental media – these are key tasks of the Applied Ecology Division at Fraunhofer IME. In this issue we present a novel test system for sensitive lotic invertebrates and a new method to prove the occurrence of Anticoagulant Rodenticides in German inland waters using a multi-method developed for the German Environmental Specimen Bank. Taking wastewater treatment as an example we explore whether the chemical composition of nanomaterials can give a hint on their ecotoxicity. We also introduce Matthias Teigeler, head of our worldwide recognized fish laboratory.

Yours sincerely,

Prof. Dr. Christoph Schäfers

Title picture: Test system to determine chronic effects on insect larvae.
Photo: Fraunhofer IME



In this issue you can read:

SMALL RUNNING WATER IDENTIFIES EFFECTS OF PLANT PROTECTION PRODUCTS

New test system to detect chronic effects of pesticides on organisms living in running waters

As a result of pesticide entry into surface waters aquatic organisms are exposed to a number of active substances. Organisms living in running waters are regarded to be particularly sensitive, but are hardly considered in ecotoxicological test procedures. We have now developed a test system suitable to investigate chronic effects on typical lotic insect larvae.

Species Sensitivity Distributions (SSDs) are increasingly applied in ecological risk assessment of chemicals. SSDs compile toxicity data of a chemical substance for several species. Most SSDs for plant protection products are currently based on data from acute toxicity tests, whereas the data base available for chronic tests is often insufficient. ▶

Broadening the spectrum of chronic tests with organisms living in running waters

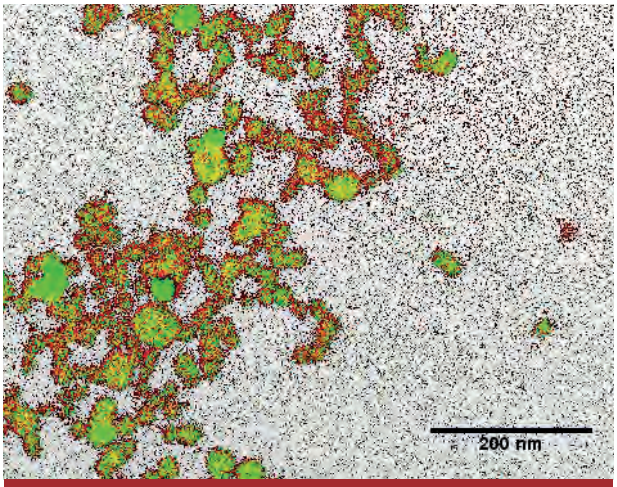
Some insect larvae present in native waters such as mayflies, stoneflies or caddisflies are considered especially sensitive towards plant protection products. Chronic testing with these organisms is difficult since this requires test systems that take into account their behaviour. The test system developed in Fraunhofer IME is suitable to mimic the natural habitat conditions of lotic insect larvae. Maria Brüggemann, research assistant in the Ecotoxicology department: "We have adapted flow, temperature, oxygen level, light intensity and food supply to the natural conditions of small natural creeks."

Contrary to common indoor stream systems moving the waterbody itself, individual vessels are circulated through the water to obtain the target flow. The space-saving design allows the assessment of single insects using vessels presenting each an individual unit for one test organism. The test design consists of up to six treatment levels with ten pseudoreplicates. As endpoints growth, emergence and mortality of the individual test organisms are determined over a 21 day exposure period. The applicability of the test system has been successfully tested in a pilot study for the stonefly species *Protonemura spp.* and the mayfly *Epeorus spp.* Various exposure scenarios such as static and semi-static, peak exposure or flow-through exposure can be simulated. ■

GOOD FOR SOCKS – BAD FOR THE ENVIRONMENT: ARE SULFIDIZED SILVER NANOMATERIALS BIOAVAILABLE?

Simulation experiments in the laboratory and in the field give an insight

Bioavailability is an important criterion when assessing the environmental risk of silver nanomaterials (AgNM) released into the environment via sewage sludge applied as fertiliser on agricultural soils. Fraunhofer IME performed experiments with model wastewater treatment plants (WWTP) using an AgNM, and simulated subsequent agricultural use. The results indicate a potential long-term effect of AgNM on the soil microflora.



TEM image of sulfidized Ag NP (NM300K). Green represents silver, red represents sulfur. Photo: Leibniz Institute of Polymer Research Dresden

AgNM used as antibacterial substances can reach agriculturally used soils by sewage sludge application. In his thesis, Marco Kraas, doctoral student of the Ecotoxicology department, investigated the influence of sewage sludge treatment on the bioavailability of AgNM. Particular attention was paid to the sulfidation of AgNM and the consequences on their ecotoxicity. For this purpose experiments with model WWTPs were performed with a spherical AgNM and various Ag reference materials. After subsequent sewage sludge preparation such as anaerobic digestion or liming as well as direct spreading, the agricultural application was simulated in laboratory and field experiments.

Sulfidation does not necessarily result in a complete detoxification of the AgNM

Energy-dispersive X-ray spectroscopy analysis coupled with a transmission electron microscope revealed that the particles were completely sulfidized after wastewater treatment. In all setups of the long-term studies covering 140 to 196 d the nitrification process was substantially inhibited. Liming resulted in reduced inhibition due to an increase of soil-pH. Marco Kraas: "The influence of liming has to be considered as a temporary effect since the AgNM

remain in principle bioavailable." Ag_2SNM produced in the laboratory caused strong effects as well. Kraas: "Our investigations show that sulfidation does not necessarily result in a complete detoxification of the AgNM. To detect adverse effects resulting from the application of contaminated sewage sludge, studies with an extended duration need to be performed taking into account the slowly progressing toxicity."

The laboratory results were confirmed by a field lysimeter study running over a period of more than two years showing inhibition on the nitrification and respiration activities in soils. The magnitude of effects were less pronounced than in the laboratory studies, but constant over the whole test period. ■

ENVIRONMENTAL MONITORING OF RODENTICIDES

Rat poisons found in German inland waterbodies

So far few data are available on the impact of rat poisons on aquatic ecosystems. Fraunhofer IME has developed a method to determine Anticoagulant Rodenticides authorized in Germany in different matrices.

To control rats and mice for infection and material protection usually Anticoagulant Rodenticides (AR) are applied. Most of these biocidal products contain active ingredients which are persistent, bioaccumulative and toxic (PBTs). So far, research on the exposure of the environment and accumulation of AR in biota have been focused on terrestrial food webs, whereas few data are available on their impact on aquatic systems and water organisms. To fill this gap, Fraunhofer IME, together with the German Environment Agency (UBA), analyzed liver samples of bream and suspended particulate matter from the German Environmental Specimen Bank (ESB) for their AR contents. Dr. Matthias Kotthoff, head of laboratory in the Environmental and Food Analysis department: "We have developed and validated a multi-method allowing us to determine trace amounts of Anticoagulant Rodenticides authorized in Germany in fish liver and suspended particulate matter."

First evidence of Anticoagulant Rodenticides in fish

Bream liver samples from different streams including Rhine, Elbe and Danube archived in 2011 and 2015 were investigated. Five ARs were found at levels above limits of quantification. For 2015, brodifacoum was detected in 88% of the samples with a maximum concentration of 12.5 µg/kg fresh weight. Furthermore, difenacoum, bromadiolone, difethialone and flocoumafen were detected in some samples. Different results were found for the suspended particulate matter samples: Here only bromadiolone could be detected in 56% of the samples at levels up to 9.24 µg/kg. Kotthoff: "To our knowledge, this is the first evidence of AR in fish samples."

Breams – Pollutant monitoring with fish samples from the German Environmental Specimen Bank. © German Federal Environment Agency

Spatial exposure analysis of 17 fish samples taken in 2011 and 2015 indicates two hot spots showing high AR levels and a comparatively broad occurrence in the upper Elbe region and the Saar conurbation. A temporal trend analysis of bream liver over a period of up to 23 years revealed a significantly increasing trend for the concentration of brodifacoum in the Saar. The potential relevance of these results is now to be assessed by the responsible higher federal authorities. ■

"To identify environmental substances that affect hormonal systems we need better and more efficient methods.

After completing his training as a biological technical assistant Matthias Teigeler studied "Environmental Protection" at the University for Applied Sciences Bingen. His diploma thesis on "Vitellogenin as a biomarker for the environmental impact of estrogenic substances in waters" was the beginning of his research activities in aquatic ecotoxicology. Today his research work focuses on the improvement of methods to identify hormone-active substances. In this context, he develops concepts for studies on chronic fish toxicity for regulatory bodies and industrial clients. These procedures are applied in testing the environmental safety of pesticides, industrial chemicals and pharmaceuticals.

Matthias Teigeler…

… has been leading the department "Ecotoxicology" together with Dr. Elke Eilebrecht since April 2017. His major research objective: Identifying hazards of environmental pollutants for aquatic organisms.

The regulation of chemicals requires standardized test procedures to identify potential risks for the environment. New research results require modifications of substance evaluation and approval regulations, followed by a continuous adaptation of test procedures and technical equipment. The laboratory for fish toxicology established by Matthias Teigeler and his team meets these requirements: It is one of the very small number of laboratories worldwide conducting fish life cycle studies under a quality assurance system over many years. Teigeler: "Such studies are needed, for example, to demonstrate the effect of endocrine disrupters on aquatic organisms".

TRANSFERRING KNOWLEDGE IN THE FORM OF TEACHING ACTIVITIES AND MEMBERSHIPS IN SCIENTIFIC COMMITTEES…

… this is of particular concern to Matthias Teigeler. With lectureships at the University for Applied Sciences Bingen and the Technical University Braunschweig in the field of ecotoxicology he contributes considerably to Fraunhofer IME networking with German universities. His lectureships in the framework of a professional training of German DGPT to become an expert in toxicology, as well as animal welfare training in fish toxicology transfer expertise for occupational practice.

On the international level Matthias Teigeler is involved in the preparation of guidelines to investigate the chemical impact on fish as a member of the OECD Fish Drafting Group.

Read more about our research activities here: www.ime.fraunhofer.de

IMPRINT

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