

## **Antibiotics and Antibiotic Resistance in the Environment: Ecological Fate and Effects, Resistance Development and Implications for Human Health**

Edward Topp, Jason Snape, Joakim D.G. Larsson, James M. Lazorchak

Wednesday May 25, 2:00 PM - 4:00 PM, Salle R0-B

This session will focus on the fate and ecotoxicological effects of antibiotics, antibiotic resistance (AR) development and transfer in the environment and implications for human health. Specifically, we use the term antibiotic to include pharmaceutical agents with antibacterial properties. The scope of the session also extends to other chemical agents that can co-select for antibiotic resistance (e.g. metals and biocides).

Topics will be grouped in the following four areas:

- 1) The ecological effects of human and veterinary antibiotics including impacts on natural microbial community structure and function, aquatic food chains and other organisms.
- 2) The role of antibiotic residues in the environment on the selection and persistence of antibiotic resistant microorganisms and/or AR genes.
- 3) The dissemination and routes of transmission of AR to humans and implications for human health risk assessment.
- 4) The fate of antibiotics and AR in wastewater treatment and the environment; including removal and risk management strategies.

We would anticipate abstracts that address aspects related to the following questions:

Do human and veterinary antibiotics at environmentally relevant concentrations cause effects on aquatic and terrestrial organisms or affect ecosystem services provided by microbial communities?

Are particular environments and/or mixtures of antibiotics, metals, and pollutants of special concern?

Do bacteria secrete antibiotics in situ and, if so, what are the ecological roles of such compounds and how may these roles be disturbed by subinhibitory levels of antibiotic pollutants?

Do human and veterinary antibiotics at environmentally relevant concentrations select for resistant microorganisms or mobile genetic elements carrying AR.

What are the pathways of transfer of antibiotic resistant microorganisms and/or AR genes to the human population? What are the environmental conditions that promote the transfer of AR? Are there threshold concentrations of antibiotic agents that promote AR transfer?

To what extent does the rate of resistance selection, gene acquisition and dissemination of resistant microorganisms increase with increased exposure to antibiotics (e.g., AR bacteria selected for in treated pigs). Do antibiotic residues in manure storage facilities help maintain antibiotic resistant populations)?

What is the frequency and rate of transfer of AR genes between environmental and pathogenic bacteria and can an appropriate risk assessment framework be developed?

Does waste water treatment enrich for AR and what wastewater treatment strategies and other management options could be used to reduce the resistance load in the environment?

When new antimicrobial drugs are brought to market should an environmental assessment be conducted to identify the pre-existing resistance reservoir?

Should pharmacovigilance studies to assess the proliferation of resistance in clinically important pathogens be extended to include environmental compartments?

## **Biological effects of emerging micro pollutants at realistic environmental concentrations**

Ismael Rodea-Palomares, Valentina Elisabetta Viviana Ferrero, Keila Martin Betancor

Tuesday May 24, 8:15 AM - 12:50 PM, Salle R0-A

What are the biological effects of emerging micro pollutants in realistic conditions? This is a question difficult to address experimentally due to the complexity layers imposed by realism. Realistic complexity can be understood from two sides: from the side of the exposure and the side of the biological receptor. Realism in exposure to emerging micro pollutants implies to deal with factors such as exposure to low doses, temporal aspects of exposure (toxicodynamics), combined exposure (mixtures of emerging micro pollutants as well as with other natural and anthropogenic pollutants). Complexity also includes the interactions of the effect of emerging micro pollutants with biotic and abiotic factors, such as natural or anthropogenic stressors, inter and intra specific competition, predation, etc. In the side of the receptor, complexity includes the propagation of effects along biological complexity scales and the relationships among biodiversity, ecosystem structure and ecosystem functioning. Relevant questions for ecotoxicology from the receptor side of complexity is whether biological effects and mechanisms of action of emerging micropollutans observed at low biological complexity (organismal or sub organismal level) are consistent and predictable at higher complexity scales.

The present session is devoted to the experimental study of the biological effects of emerging micro pollutants in realistic conditions. The key word of the session is realistic environmental concentrations. Presentations are welcomed addressing any single or combine piece of complexity relevant for realistic exposures to emerging micro pollutants: low, environmentally realistic doses, mixtures (of emerging micro pollutants, or any realistic mixtures of emerging micro pollutants and other natural or anthropogenic pollutants such as nanoparticles, heavy metals, pesticides or biocides). Similarly, welcome is any study dealing with the the interaction of emerging micro pollutants with any other natural or anthropogenic stressor such as toxins, viruses, parasites, alterations in the nutrient cycle, climate change, competition, predation, etc.). In addition, studies specifically addressing the effects of emerging micro pollutants at higher biological complexity scales are welcome (such as micro and mesocosms studies or landscape ecotoxicological studies). Similarly studies dealing with the cross validation of findings along biological complexity scales are welcomed.

## **Contaminants of Emerging Concern in the Environment and their Management**

Damia Barcelo, Robert Kase, James M. Lazorchak

Monday May 23, 8:15 AM - 4:00 PM, Salle R0-A

Various contaminants of emerging concern (CEC) including endocrine disrupting chemicals (EDCs), pharmaceuticals, antibiotic resistant bacteria and resistance genes in effluents, surface and ground waters, sediments, soil, and tissues are impacting wildlife and human health. Wastewater treatment plants (WWTPs), pharmaceutical manufacturing industries, hospitals and biosolids have been shown to be continuous sources of CEC and/or affecting and medicating aquatic life (feminization of male fish), including among others transformation products and metabolites (e.g. of surfactants, steroid hormones, plasticizers, and pharmaceuticals). Three steroidal estrogens, 17 $\alpha$ -ethinylestradiol (EE2), 17 $\beta$ -estradiol (E2) and estrone (E1) and several antibiotics are currently included in the so-called "watch list" of the Water Framework Directive (WFD) and are therefore recommended for monitoring.

This session focuses on: Do wastewater treatment designs (e.g. conventional vs. advanced, centralized vs. decentralized) or agricultural Best Management Practices (BMPs) remove such contaminants better than others? What is the mass loading of such contaminants in the environment and how do operational or application characteristics (including reuse practices) impact efficiency? What are the chemical and biological approaches that can be used to measure reduction or removal of adverse effects of EDCs, pharmaceuticals and antibiotics? Is pretreatment of concentrated waste streams (e.g. hospital wastes, landfill leachates) efficient and cost effective for reducing ecological effects, human health effects and loadings to the environment?

Platform presentations will include reports on the fate of CEC within wastewater treatment plants, on-site wastewater systems, biosolids management, landfill wastes, manufacturers waste, receiving waters, etc. We anticipate that the audience for this session will include those who are interested in sources of CEC including toxicologists, engineers and chemists from research, regulatory organizations, and facilities operation.

## Ecotoxicology and risk assessment of nanomaterials - Grouping and read-across

Juan Riego Sintes, Eric A. J. Bleeker

Tuesday May 24, 2:00 PM - 4:00 PM, Salle 300

Consumers demand safe products and nanosafety for the user and the environment is envisaged as a justification for further development of nanotechnologies. There are a number of intrinsic physicochemical properties of ENMs which affects the level of interaction between the nanomaterials and the cells/organisms: Colloidal stability (basically the extent of agglomeration/aggregation); size, surface charge, shape, redox/catalytic activity; aspect ratio, surface coatings/functionalization or dissolution of metallic ENMs. Besides the intrinsic characteristics of ENMs, important issues are uptake/internalization of ENMs by different cell systems/organisms, and if so, the intracellular fate and relationship with cell/organisms toxicity.

Nanoparticles and organic compounds, both emerging contaminants, are expected to occur together into the water compartments. Little is known on the interactions between chemicals and nanoparticles and on how these interactions may affect the biological organization of aquatic ecosystems. Recent data suggest that nanoparticles may act as carriers for organic pollutants, facilitating their uptake and modifying their toxicity. The toxicological assessment of ENP is expected to cover possible interactions with existing environmental contaminants, and their effect on bioavailability, bioconcentration and toxicity profiles.

The present session is a continuation of its first and second edition at 24th SETAC Annual meeting at Basel (2014) and 25th Annual meeting in Barcelona last year but it will have an important focus on nanosafety assessment. The present session matches perfectly with the General Theme of the meeting: "Environmental contaminants from land to sea: Continuities and interfaces in environmental toxicology and chemistry".

Presentations in this session are intended to show how ENMs interact with cells/organisms in any environmental compartment, with emphasis in co-exposure of ENMs and organic contaminants. The basic mechanisms of this action and how this interaction influences the biological activity of ENMs will be considered in view of the implications for nanosafety assessment.

As a summary, the session specially welcomes presentations dealing with:

1. New approaches to understand the interaction between physicochemical factors and nanomaterial's intrinsic properties with cells/organisms living in any environmental compartment which may be subjected to ENMs pollution such as aquatic environments, soils and sediments. Systematic studies with ENMs libraries are needed in an effort to group and categorize ENMs, which is a crucial step towards nanosafety assessment.
2. Effect of abiotic and biotic transformations of nanomaterials on their intrinsic toxicological properties. Formation of protein coronas in biological media.
3. Effect of co-exposure of ENMs with other classes of pollutants. ENMs may interact/complex with other co-occurring contaminants and be indirectly toxic by enhancing the absorption/bioaccumulation of other pollutants.
4. Mixture effects of nanoparticle combinations as this is the most plausible scenario in the environment.
5. Routes of exposure and internalization. If accumulation is an issue, the study of food chain transfer is of outmost interest.

## **Ecotoxicology and risk assessment of nanomaterials - Interactions at nano-bio interface**

Francisca Fernandez-Piñas, Roberto Rosal, GEORGIANA AMARIEI

Monday May 23, 2:00 PM - 4:00 PM / Tuesday May 24, 8:15 AM - 10:15 AM, Salle 300

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## **Flame Retardants: Alternatives, Environmental Fate and Toxicity**

Adrian Covaci, Perihan B. Kurt-Karakus

Monday May 23, 10:50 AM - 4:00 PM, Salle G+H

Flame retardants, which are designed to slow flames' duration and propagation, have been used in commercial products since the 19th century. Due to their efficacy, they have been used in consumer products such as furniture, electronics, upholstery, and vehicles. Their widespread use caused their ubiquitous presence in the environment, ultimately resulting in an increased exposure for people and wildlife.

This session will focus on alternative flame retardants (FRs), particularly halogenated (brominated and chlorinated FRs) and organophosphate FRs. This broad category of compounds includes new types of FRs that continue to be identified, by virtue of their persistence and high volume use in consumer products worldwide. Health concerns on polybrominated diphenyl ethers (PBDEs) resulted in the voluntary phase-out of Penta- and Octa-BDEs commercial mixtures in the US in 2004 and in legislative measures limiting the production and use of Deca-BDE in Europe in 2009. As a response, the market is continuously shifting towards unregulated or less regulated compounds. Examples of this trend are Dechlorane Plus, introduced as a replacement of Mirex, or decabromodiphenylethane (DBDPE), introduced as a replacement of Deca-BDE commercial product. Other FRs of interest are the components of Firemaster 550 (a mixture of triaryl phosphate esters, tetrabrominated diethylhexyl phthalate and tetrabrominated ethylhexyl benzoate), which is used as replacement for Penta-BDE mixture in polyurethane foams.

Despite that a large number of alternative FRs are high production volume chemicals, the knowledge about their environmental fate and exposure is limited, while their application range is not fully disclosed by the industry. Nevertheless, these compounds have potential for bioaccumulation and/or biomagnification and they show persistency in various environmental media. New studies over the last couple of years have demonstrated that several of these alternative FRs are detected in both terrestrial and aquatic food webs all over the world, including the polar areas. Recently, the identification of the widespread presence of alternative FRs in aquatic and terrestrial sediments, the atmosphere, wastewater sludge, and indoor environments, has raised concerns over the continued use and eventual disposal of consumer products containing FRs.

As the market shifts towards new and unregulated chemicals, it becomes more challenging to identify them in the environment, in particular in complex matrices (i.e. food, soil) where they might be initially present at trace levels. This session will present recent developments in the study of alternative FRs in the environment and will focus on environmental fate, transformation of alternative FRs in the environment, including metabolism, toxicity and human exposure to alternative FRs.

## **Mechanistic toxicology of engineered nanomaterials: state of the art and future perspectives**

Teresa F Fernandes, Stephen J. Klaine

Thursday May 26, 8:15 AM - 12:50 PM, Salle R2

The interest in the ecotoxicological effects of engineered nanomaterials (ENMs) in the scientific literature is rapidly growing along with the increasing number of applications of nanotechnology. This session focus on the state of the art of ENMs mechanistic ecotoxicology, considering effects and responses at different levels of biological organization, from genes to populations and including aspects of ENM toxicokinetics and toxicodynamics. This session will provide a summary of the state of the art on the occurrence of specific nanomaterial effects in biological systems; differentiate cells/tissue injuries due to nano and non-nano materials and between nanomaterials with similar chemistry but different physical properties. In summary, this session will aim to include recent results in this area in the illustration of mechanistic pathways. Specifically the session will focus on the following aspects: nanomaterial (pristine and aged) bioavailability, testing procedures and biomarkers, results from topdown molecular approaches such as transcriptomics, proteomics and metabolomics. Derivation of read-across, extrapolation and QNAR development will also be included. It is expected that scientists, regulators and other stakeholders will have the opportunity to discuss future perspectives and requirements from nanosafety.

## **Microplastics in the environment: Sources, Fate and Effects**

Catherine Mouneyrac, Fabienne Lagarde, Miguel Oliveira

Monday May 23, 8:15 AM - 4:00 PM / Tuesday May 24, 8:15 AM - 10:15 AM, Auditorium 800

According to the last ten years of research, it appears now clear that all oceanic and continental compartments, from pole to pole, are affected by the presence of microplastics (MPs). Their ubiquitous presence and persistency in the aquatic environments are of particular concern, since they constitute a potential threat to marine organisms and ecosystems. However, evaluating this threat and the impacts of MP on aquatic organisms is challenging: MPs form a very wide range of materials with different sizes, shapes, chemical natures and physico-chemical properties; their concentration is highly variable depending on location; and results are difficult to compare due to a lack of standardization in the sampling and quantification protocols.

To provide comprehensive data, interactions of MPs with the environment (water, sediment biota) have to be explored at a laboratory scale. The physico-chemical characteristics of MPs are key factors determining their behavior and bioavailability to organisms and the relationships between MPs characterization and their impact have to be considered in these experiments.

We expect in this session contributions presenting consistent data on MPs presence in all kind of environmental samples (sea and continental waters, atmosphere, sediments, organisms) with their methodologies of sampling and characterization. Data on MP sources, accumulation and transfer between the different environmental compartments will be very valuable and may contribute to a better understanding of the possible pathways of MP in the environment. All results providing knowledge on MPs interactions with microcosm and toxicity to aquatic life through lab exposure experiments are also expected.

## **Pushing nanoparticle studies to the limit - working at environmentally relevant concentrations and with complex matrices**

Samuel Robert Thompson, Lars Skjolding, Patrick Bauerlein, Ralf Kaegi

Wednesday May 25, 8:15 AM - 4:00 PM, Auditorium 800

Engineered nanoparticles are ubiquitous in environmental matrices. However their identification and quantification is still very challenging due to the complexity of environmental samples and the vast diversity of these particles. They differ in size and shape, and also their elemental composition is variable. Engineered nanoparticles include inorganic particles such as nano-TiO<sub>2</sub> and nano-Ag, carbon-based nanoparticles such as fullerenes and carbon nanotubes, and organic micro- and nano-plastics. The analysis of organic particles can pose a particular problem, as there are vast numbers of different structures possible. Fullerenes can carry various functionalities, carbon nanotubes can have varying numbers of layers of walls, and nanoplastics can contain many different polymers. Add to this the low concentrations that these particles exist at in the natural environment compared to the concentration limits of most conventional analysis equipment and it's clear that the situation isn't optimal.

Some of these engineered nanoparticles are already used in many consumer products including sunscreens, paints, mouth washes, textiles, food packaging materials, and food additives, and there are numerous well-documented pathways from these products into the aquatic environment. To develop an understanding of i) release patterns, ii) transformation in the environment, and iii) the environmental distribution of such pollutants; analytical tools that are capable of detecting, identifying, and quantifying these particles at environmentally relevant concentrations and in environmentally relevant concentrations are urgently needed.

Recently developed and/or substantially improved analytical techniques such as Orbitrap MS, flow cytometry, pyrolysis GC/MS, field flow fractionation (FFF), coupled mass spectrometry, dynamic and static light scattering, nanoparticle tracking analysis (NTA), as well as single-particle ICP-MS and analytical electron microscopy have opened a new research front in analytical chemistry. Using sophisticated analytical tools and combinations thereof, engineered nanoparticles in both their pristine and transformed state after being exposed to environmental conditions have been investigated in unprecedented detail. Due to the enormous recent progress in this field, particles can be accurately quantified at high concentrations and in simple matrices. The next challenge is to modify these techniques to enable them to work at low concentrations, in complex matrices, ultimately allowing detection and classification in the natural environment.

This session aims to integrate contributions focusing on the latest developments for engineered nanoparticle analysis including sample preparation techniques, to provoke a discussion about the most pressing research questions in that field. We invite researchers from academia, government, industry, and research institutes to share their latest findings and experiences on methods used for detection and characterisation of engineered nanoparticles at environmentally relevant concentrations and in complex matrices, including food, soil, surface- and wastewater.

## **State of the science on poly- and perfluoroalkyl substances (PFASs) in the environment and humans**

Zhanyun Wang, Lutz Ahrens, Olivier Chastel, Katrine Borga

Tuesday May 24, 8:15 AM - 12:50 PM, Salle G+H

Since 2001, long-chain poly- and perfluoroalkyl substances (PFASs), i.e. long-chain perfluoroalkyl carboxylic acids (PFCAs), perfluoroalkane sulfonic acids (PFASAs) and their precursors derived from perfluoroalkane sulfonyl fluorides (PASFs) and fluorotelomer raw materials, have attracted much attention as global contaminants of high concern due to high persistence, bioaccumulation potential and toxicity. Based on numerous studies, the environmental and human exposure to and potential impacts to these legacy PFASs are increasingly understood, leading to actions to restrict/eliminate the production and use of these substances and an ongoing industrial transition to alternative substances in many parts of the world. This transition away from long-chain PFASs is an important step toward solving the global environmental concerns related to PFASs, but further efforts are still needed due to the following: [i] Many long-chain PFASs are today still produced and used in countries with emerging economies (e.g. China, India). [ii] There are many known and unknown sites historically contaminated by long-chain PFASs worldwide that need to be cleaned up but there is a lack of suitable methods. [iii] We have a paucity of knowledge of many emerging and novel PFASs other than long-chain PFASs in the environment, wildlife and humans, including perfluoroalkyl phosphonic and phosphinic acids (PFPAAs and PFPIAs), shorter-chain homologues of long-chain PFASs, and perfluoroether carboxylic and sulfonic acids (PFECAs and PFESAs).

In this session we invite scientists from academia, business and government to share recent and ongoing progress in understanding PFASs. We particularly welcome contributions within the following areas: [i] how the geographical shift of production and use of long-chain PFASs to emerging economies has impacted the environmental and human exposure; [ii] how new analytical techniques (e.g. measuring the ratios of known PFASs to total organic fluorine and non-target analysis) help to improve understanding of PFAS sources, fate and exposure; [iii] progress on understanding emerging and novel PFASs in terms of their physicochemical properties such as partitioning behavior, degradability and degradation pathways, bioaccumulation behavior including tissue distribution and maternal transfer, toxic effects on wildlife and humans (including non-standard endpoints, low-dose effects and mixture toxicity), environmental fate and transport, occurrence and exposure routes, and associated risks; [iv] latest developments on technically and financially feasible methods to identify and remediate contaminated sites. Ultimately, the session aims to provide a roadmap for future research needed to fill the identified critical knowledge gaps.