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Microplastics In Europe's Freshwater Ecosystems:
from sources to solutions

LimnoPlast: Microplastics in Europe's Freshwater Ecosystems: from sources to solutions
(Coordinator: Universität Bayreuth | Contact: EU-LimnoPlast@uni-bayreuth.de | Homepage: www.limnoplast-itn.eu)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

UNESCO-EU-H2020 LIMNOPLAST CONFERENCE

DIVING INTO FRESHWATER MICROPLASTIC POLLUTION - CONNECTING WATER, ENVIRONMENTAL

06-08 March 2023

Venue: Unesco HQ building

Entrance: 125 Av. de Suffren, 75007 Paris, France

Background

(A brief description of the problem of microplastics in freshwater; why it is a concern; knowledge gaps; and the role of science in addressing it)

PROBLEM. Plastics (i.e., synthetic polymers) have become an indispensable part of our daily life. On the other hand, plastic litter is an unavoidable marker of the Anthropocene as plastic pollution has become a major global environmental and societal issue of this century in addition to climatic change, biodiversity loss and material crisis. Of particular concern is microplastic pollution in freshwater ecosystems and the ocean. Microplastics are tiny plastic particles or pieces that either are produced in microscopic sizes for personal and industrial applications (such as microbeads in personal-care products, or industrial pellets), or result from the breakdown and fragmentation of plastic items discarded in the environment.

Microplastics have been detected ubiquitously all over the planet from the atmosphere to freshwater ecosystems and the deep sea. Microplastic pollution is a potential emerging risk to ecosystems and society. Microplastics are small, mobile and persistent in the environment. Thus, these tiny plastic waste particles and fragments are bioavailable for a broad range of biota, transfer through food webs and may negatively affect ecosystems. These ecological and economical risks resonate in society, with a growing global concern about the environmental and health effects of microplastics.

There is political awareness and willingness to solve the global plastic pollution; for example, the adoption in March 2022 of the new UNEA Resolution "End Plastic Pollution: Towards a legally binding instrument". However, the political attention and most actions on combatting the plastic pollution mainly focus on the ocean, as is the focus of the new UNEA Resolution on marine plastic pollution. In contrast, emerging research demonstrates that most plastic litter is produced on land and alerts that freshwater ecosystems are heavily polluted by microplastics making them a major pathway of microplastic emissions to the ocean. Yet, there is limited scientific understanding and research on freshwater microplastic pollution, nor political commitments. Accordingly, this knowledge and awareness gap on freshwater microplastic pollution needs to be addressed urgently via research and communication.

The complexity and global scale of plastic pollution represent a daunting challenge. Plastic and microplastic pollution is a "wicked problem" that is highly interconnected to the economy, environment, and society through interdependent benefits and risks at multiple levels in various sectors. The existing knowledge on microplastics is compartmented, whereas a comprehensive understanding of the environmental, technological, economic and societal complexity of plastic and microplastic pollution is lacking. In addition, gaps in scientific understanding on freshwater microplastic pollution cause considerable uncertainty that prevents appropriate prioritisation and

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implementation of prevention and mitigation measures to combat the global plastic and microplastic pollution.

A NEW SCIENTIFIC APPROACH. Acknowledging that the plastic pollution is a "wicked problem", we need to develop a holistic, transdisciplinary and cross-sectoral approach that breaks down the traditional barriers between different scientific disciplines and economic sectors. For this purpose, the EU Horizon 2020 research cooperation Project "Microplastics in Europe's Freshwater Ecosystems: from Sources to Solutions" (LimnoPlast), with UNESCO as an official partner organization, created a research network that combines environmental, engineering/technical and social/behavioural sciences as key disciplines studying and transforming the "Plastic Age". This unique combination of expertise and competences will advance significantly our scientific understanding of the freshwater microplastic pollution, promote a step change in responses to the plastics challenge, and boost the development of innovative solutions.

LimnoPlast:

Microplastics In Europe's Freshwater Ecosystems: from sources to solutions

The LimnoPlast project devotes its research and training program to microplastics in Europe's freshwater ecosystems. LimnoPlast challenges traditional barriers between disciplines and sectors and combines environmental, technical and social sciences in order to tackle the microplastics problem from its sources to potential solutions in a holistic approach.

Objectives and expected outcome

(a short description of LimnoPlast project and its objectives; the objectives of the Conference itself)

The conference aims to put the urgency of the freshwater microplastic pollution challenge at the centre of the global agenda for sustainable development.

The conference has two-fold objectives.

1. Dissemination of knowledge and innovative solutions, generated by the LimnoPlast project

The conference will disseminate knowledge and innovative solutions, resulting from the LimnoPlast project's cutting-edge inter-disciplinary research to the global scientific community, decision-makers, stakeholders and the general public. In particular, Early-Stage Researchers (ESRs) (PhD candidates of the LimnoPlast project) will present their research findings and discuss their policy implications with stakeholders.

2. A global discussion platform on freshwater microplastic pollution

The final symposium will be a major platform to discuss the project's outcomes with stakeholders and provide decisive advice to policy makers. It is also a unique opportunity to confront views of stakeholders towards not only the freshwater MP issue but also micro- and macro-plastics in general. The event will be an excellent opportunity to integrate the political dimension of the issue by providing advice for policy makers and increase the awareness of societal actors.

The LimnoPlast project for the first time brings together environmental, engineering, and social sciences with the vision to transform a new understanding of freshwater microplastics to innovative solutions by:

- Training the next generation of scientists to tackle complex environmental issues holistically and contribute to Europe's innovation and Circular Economy capacity.

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- Providing the first comprehensive assessment of the sources and impacts of freshwater microplastics.

- Developing innovate technological solutions to the plastics issue, including novel processes to remove microplastics from wastewater as well as bio-degradable, environmentally sound polymers.

- Evaluating the social and ecological impacts of freshwater microplastics and recommend intervention options.

- Transforming the scientific knowledge generated by the LimnoPlast project into guidance on specific solutions.

- Transferring the outcomes of the LimnoPlast project to European and global decision makers, stakeholders and the public to enable and promote action on freshwater microplastics.

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ORGANIZER AND SPONSORS

Hosted by UNESCO

Co-organized by the H2020 Project 'LimnoPlast' and its Partners:

UNESCO Intergovernmental Hydrological Programme (IHP), École nationale des ponts et chaussées (ENPC) & Université Paris-Est Créteil Val-de-Marne (UPEC) – University of Bayreuth (UBT, Coordinator) – Syndicat interdépartemental pour l'assainissement de l'agglomération parisienne (SIAAP)

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ORGANIZATIONAL ISSUES

Venue Conference

Monday – 6th of March till Wednesday – 9th of March

UNESCO HQ building

Entrance: 125 Av. de Suffren, 75007 Paris, France

Venue Conference Dinner

Tuesday – 7th of March

at L'Académie du Climat

2 Pl. Baudoyer, 75004 Paris, France

Conference Artist - Mbongeni Buthelezi

Monday – 6th of March till Wednesday – 9th of March

at L'Académie du Climat

2 Pl. Baudoyer, 75004 Paris, France

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Password : uneswifi

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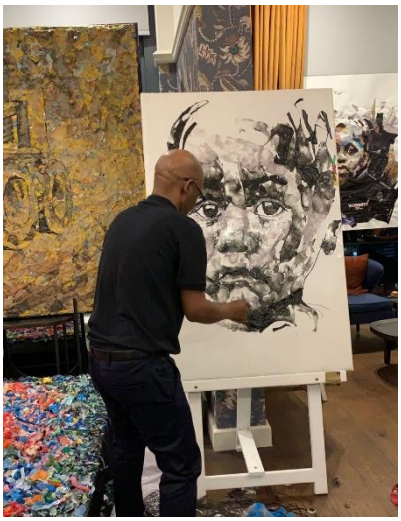
CONFERENCE ARTIST - MBONGENI BUTHELEZI:

at L'Académie du Climat

2 Pl. Baudoyer, 75004 Paris, France



Science Meets Art - Science of Microplastics and the Art of Plastics

As part of the LimnoPlast conference, the artist will be a guest at L'Academie du CLimat. Using novel techniques developed by himself, he processes plastic waste into expressive images and sculptures with colorful textured surfaces. Take the opportunity and get to know the artist and his works. Especially the conference dinner is a good opportunity to get in contact with him and to discuss with him the current problems around plastic.

Mbongeni Buthelezi was born in 1965 in Newcastle/South Africa and grew up in Johannesburg. After studying at the African Institute of Art in Cape Town, he completed a teacher training course at the Johannesburg Art Foundation. This was followed by studies at Witwatersrand University, from which he graduated with a degree in Fine Arts. Buthelezi works with a unique technique: he creates his works from plastic waste by using a heat gun to melt it onto a thick plastic sheet for roofing.

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Detailed Program

Registration and Welcome Coffee
6th March - 09:00 – 10:00

Opening Ceremony
6th March - 10:00 – 11:30
Keynote speaker: Bethanie Carney Almroth (University of Gothenburg – Sweden)

Name	Role	Institution	Country
Abou Amani	Director of Division of Water Sciences	UNESCO	France
Sam Azimi	Director of Research and Innovation Department	Service public de l'assainissement francilien (SIAAP)	France
Jerome Lesueur	Research Director	École des Ponts ParisTech (ENPC)	France
Christian Laforsch	Coordinator of the ITN H2020 Limnoplast Professor	University of Bayreuth	Germany

Speaker	Institution	Presentation title	Time
Bethanie Carney Almroth	University of Gothenburg (Sweden)	Outside the Safe Operating Space: Planetary Limits of Plastics and Chemicals	**11:00**

Thematic Session: Sources of MP in Freshwater Ecosystems

6th March - 11:30 – 12:30

Keynote speaker: Denise Mitrano (ETH Zürich – Switzerland)

The speakers of the session will present scientific approaches and research results characterizing the source dynamics and presence of microplastic particles in freshwater ecosystems.

Speaker	Institution	Presentation title	Time
Denise Mitrano	ETH Zürich (Switzerland)	Embracing ecosystem complexity to understand the full impacts of microplastics pollution	**11:30**
Feride Öykü Sefiloğlu	Vrije Universiteit Amsterdam (Netherlands)	Microplastics in drinking water: Monitoring microplastics from source to tap by pyrolysis GC-MS	**12:00**
Cleo Stratmann	École des Ponts ParisTech (France)	Riverine microplastics in the Seine catchment	**12:15**

Lunch Break - 12:30 – 14:00

Thematic Session: Sources of MP in Freshwater Ecosystems
6th March – 14:00 – 15:00

Speaker	Institution	Presentation title	Time
Marziye Molazadeh	Aalborg Universitet (Denmark)	Stormwater ponds, sinks, or sources of microplastics?	**14:00**
Sethunath Sethulekshmi	Indian Institute of Technology Bombay (India)	Sewage treatment plants as a source of microplastic pollution in water bodies	**14:15**
Friederike Stock	Federal Institute of Hydrology (Germany)	From the river to the sea: Microplastics in water and sediments of the Elbe and Thames rivers and the North Sea	**14:30**
Max Beaurepaire	École des Ponts ParisTech (France)	Local urban activity and atmospheric microplastics deposition	**14:45**

Coffee Break and Poster Session - 15:00 – 16:00

Youth Networking World Café
6th March - 16:00 – 17:00

Thematic Session: Impacts on Freshwater Biota and Public Health
7th March - 10:00 – 12:00

The speakers of this section will present how the microplastic particles presence in freshwater ecosystems is impacting public health and aquatic flora and fauna.

Speaker	Institution	Presentation title	Time
Romain Tramoy	École des Ponts ParisTech (France)	The Endless World: Plastic debris in the Seine estuary as a case study	**10:00**
Gary Hardiman	Queens University Belfast (Great Britain)	A systems level approach to studying the impacts of micro-nanoplastics (MNPs) on Freshwater Biota and Public Health	**10:15**
Gabriël Olthof	Norwegian University of Science and Technology (Norway)	Dose metric as one of the determining factors in comparing microplastic toxicity	**10:30**
Simona Mondellini	University of Bayreuth (Germany)	Beyond microplastics: Water soluble synthetic polymers exert sublethal adverse effects in the freshwater cladoceran Daphnia magna	**10:45**
Sarah Stevens	Norwegian University of Science andTechnology (Norway)	Endocrine disrupting chemicals in plastics – In vitro toxicity and chemical composition	**11:00**

Azora König Kardgar	University of Gothenburg (Sweden)	Chronic toxicity of microplastic in fish species	**11:15**
Anita Jemec Kokalj	University of Ljubljana (Slovenia)	Changes in immunity as an early response to microplastics exposure	**11:30**
Senavirathna Jayasanka	Saitama University (Japan)	Responses of freshwater macrophytes and cyanobacteria to microplastic exposure	**11:45**

Lunch Break - 12:00 – 14:00

Thematic Session: Social & Behavioral Science, Economics and Legal Perspectives

7th March - 14:00 – 17:00

Keynote speaker: Sabine Pahl (University of Vienna – Austria)

The speakers of this section will highlight the relevance of social and economic aspects to microplastic pollution. Further, they will discuss challenges and opportunities for behavioral transformation and legal opportunities to tackle the microplastic challenge.

Speaker	Institution	Presentation title	Time
Sabine Pahl	University of Vienna (Austria)	Microplastics and society: From risk perception to action	**14:00**
Carolin Völker & Johanna Kramm	ISOE – Institute for Social-Ecological Research (Germany)	On the creation of risk – discussions on microplastics in science, media and public	**14:30**
Aybüke Özdamar	Fraunhofer UMSICHT (Germany)	Understanding Effectiveness and Efficiency of Interventions to Reduce the Release of Microplastics into the Environment: Tire and Textile Case Studies	**14:45**
Coffee Break and Poster Session - 15:00 – 16:00			

Marcos Felipe Rodríguez	University of Bergen (Norway)	Mental models, worry and responsibility judgments about microplastics in the Norwegian public	**16:00**
Maja Grünzner	University of Vienna (Austria)	Behavioural Approaches to Microplastics Pollution: The Case of Fashion Consumption	**16:15**
Giorgia Carratta	HHL Leipzig Graduate School of Management (Germany)	(Micro)plastics Pollution in the International and EU Legal Landscape: Current Challenges and Intervention Recommendations	**16:30**
Karlijn von den Broek	Utrecht University (Netherlands)	Expert's mental models of microplastics pollution	**16:45**

Conference Dinner - 19:00 – 21:00

At Academy Du Climat

2 Pl. Baudoyer, 75004 Paris, France

Thematic Session: Innovative Technological Solutions to the MP Issue
8th March - 10:00 – 12:00
Keynote speaker: Lila Durix (Ville de Paris)

The speakers of this session will provide insights into analytical, technical, scientific and political solutions being investigated to reduce microplastic in the environment.

Speaker	Institution	Presentation title	Time
Lila Durix	Ville de Paris – Paris city hall (France)	Zero SUP by 2024 for Olympics and Paralympics games	**10:00**
MinhTrang Nguyen	Ecole des Ponts ParisTech (France)	Occurrence and fate of microplastics in Parisian combined sewer network	**10:30**
Vaibhav Budhiraja	National Institute of Chemistry (Slovenia)	Degradation of Microplastics in the Environment	**10:45**
Dipannita Ghosh	University of Bayreuth (Germany)	Degradation Control in Bio-based Polycarbonate	**11:00**
Emna Abdeljaoued	Evonik Technology & Infrastructure GmbH (Germany)	Electrostatic separation of Nanoplastics from wastewater	**11:15**

Christina Galafton	Fraunhofer Umsicht (Germany)	Plastic emission during strawberry cultivation in Germany	**11:30**
Linda Mederake	EcologicInstitute (Germany)	The challenge of reducing (micro)plastic emissions: Possible contribution of consumers and recommendations for effective policy interventions	**11:45**

Lunch Break - 12:00 – 14:00

Keynote Speech: Prof. Richard Thompson
8th March - 14:00 – 14:30

Speaker	Institution	Presentation title	Time
Richard Thompson	University of Plymouth (United Kingdom)	Plastic Litter: what progress are we making to solving this global environmental challenge?	**14:00**

High-level Panel: Science & Policy Dialogue on Microplastics (MP) Pollution
8th March - 14:30 – 15:30
Moderator: Aude Vidal (Le Monde Diplomatique)

Name	Role	Institution	Country
Moïra Tourneur	Advocacy Manager	Zero WasteFrance	France
Lucie Padovani	Advocacy and Water Waste Campaign Manager	Surfrider Foundation Europe	France
Xavier Leflaive	Principle Administrator	OECD	France
Richard Thompson	Professor	University of Plymouth	United Kingdom

Closing Ceremony
8th March - 15:30 – 16:15

Name	Institution	Presentation title	Time
Bruno Tassin	Ecole des Ponts ParisTech (France)	Summary on Sources of MP in Freshwater Ecosystems	**15:30**
Martin Wagner	Norges Teknisk-Naturvitenskapelige Universitet (Norway)	Summary on Impacts of MP on Freshwater Biota and Public Health	**15:35**
Gisela Böhm	Universiteteti Bergen (Norway)	Summary on Social & Behavioral Science, Economics and Legal Perspectives	**15:40**
Andrej Kržan	National Institute of Chemistry (Slovenia)	Summary on Innovative Technological Solutions to the MP Issue	**15:45**
Christian Laforsch	University of Bayreuth (Germany)	Final remarks and future perspectives of MP research	**15:50**
Sarantuyaa Zandaryaa	UNESCO (France)	Final remarks	**16:00**

End of conference

ABSTRACT BOOK

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

Opening Ceremony
6th March - 10:00 – 11:30
Keynote speaker: Bethanie Carney Almroth (University of Gothenburg – Sweden)

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Outside the Safe Operating Space: Planetary Limits of Plastics and Chemicals

Bethanie Carney Almroth

Medicinaregatan 18A, 413 90 Göteborg, University of Gothenburg, Sweden

Plastics are novel entities that have exceeded the planetary safe operating space due to extensive and resource-intensive production, uncontrolled environmental releases, and failure to control the chemicals within the materials. However, understanding plastics within the Planetary Boundaries framework requires multiple lines of evidence to capture the complex reality of these substances, attempts to quantify a singular boundary would be detrimental to the global governance of plastics. Instead, we understand available evidences and discusses how plastics pollution affects Earth-system processes along an impact pathway from production, to release, to environmental fate and impacts of plastics and their additives. We demonstrate causal links between plastics and other major environmental problems at the global scale, exacerbating the consequences of breaching other planetary boundaries, especially climate change and biodiversity loss. We propose ways to translate these assessments into control variables for the globally and biophysically defined planetary boundaries framework that can be utilized to tackle plastics pollution. Efforts should be oriented towards further developing and monitoring a set of control variables that describe the actual state of the system along the impact pathway. We call for experts and policymakers to take urgent action, considering plastics pollution not only as a waste management problem but as an integrative part of climate change, biodiversity and natural resource use policy.

Keywords: Plastic pollution, planetary boundaries, environmental problems, climate change, biodiversity loss

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Thematic Session: Sources of MP in Freshwater Ecosystems
6th March - 11:30 – 12:30
Keynote speaker: Denise Mitrano (ETH Zürich – Switzerland)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

Embracing ecosystem complexity to understand the full impacts of microplastics pollution

Denise M. Mitrano, Department of Environmental Systems Science, ETH Zurich, Universitatstrasse 16, 8092 Zurich, Switzerland

The natural environment is experiencing ever-increasing pressures from anthropogenic stressors, including the release of anthropogenic particles such as microplastics and nanoplastics (MnPs). Plastics pollution is frequently framed as an exercise in enumerating MnPs burdens through monitoring studies, assessing their transport between environmental compartments or as an (eco)toxicological and health issue. However, fewer studies aim to address the complexities of how the presence of MnPs impact natural systems and biogeochemical cycles in a more holistic way. In this context, I will present two scenarios where the presence of MnPs have indirect effects in aqueous and terrestrial environments. Freshwater snow (FWS), a mixture of algae and natural particles, is responsible for most of the flux of organic matter from the water surface to the sediments. Knowing how MnPs and FWS interact and influence their respective settling rates can support both MPs fate modelling efforts and assessing their ecological impacts with respect to FWS settling rates and nutrient cycling. Here we used a laser-illuminated plexiglass column equipped with a stereoscopic camera system to track the settling velocities of particles in three tests: 1) MPs of various size, density and morphology, 2) FWS flocks and 3) MPs-FWS heteroaggregates. For each experimental set, thousands of particles were tracked over a series of image sequences, providing robust data to assess particle settling velocities and improving subsequent statistical analysis between experimental replicates. Typical equations describing particle settling dynamics (e.g., Stokes law) were not able to accurately predict MPs velocities when the morphology deviated from perfectly spherical particles. Collectively, we provide further insights on the important interactions between MPs and FWS and how this changes their respective fate and transport dynamics using a new experimental setup. When MPs are incorporated into FWS, the faster settling velocities of these heteroaggregates may impact biogeochemical cycles by changing the flux of carbon, nitrogen, and phosphorus contained in FWS to the sediment, potentially having implications on productivity throughout the water column. In a second example, I will explore the responses of soil ecosystems to the presence of plastics. MPs can impact soil structure, nutrient cycling, and greenhouse gas (GHG) emissions. However, the mechanisms underpinning the direction and magnitude of MPs effects on these soil properties are uncertain, mainly due to the lack of knowledge of how the presence of MPs drives changes in soil structure and the subsequent linkages between soil structure and microbial activity. Here, the presence of MPs affected soil structure and changed pore connectivity, leading to higher or lower O_2 availability and consequently higher or lower soil respiration. The magnitude and direction of these effects were dependent on soil texture and MPs morphology. Framing the presence of MPs in soil in this way can serve as a baseline for understanding the important impacts of MPs have on soil functioning. Understanding the consequence of MnPs presence in natural systems will be more complete by increasing the scope of current experimental designs to advance plastics research and policy within the context of global environmental change.

Keywords: Microplastics, water, soil, ecosystem, biogeochemistry

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Microplastics in drinking water: Monitoring microplastics from source to tap by pyrolysis GC-MS

Feride Öykü Sefiloglu[1], Martin Brits[1], Lorenzo Scibetta[1], Martin van Velzen[1], Quinn Groenewoud[1], A. Dick Vethaak[1,2], Heather A. Leslie, and Marja Lamoree[1]

[1]Department of Environment and Health, Vrije Universiteit Amsterdam, De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands
[2]Deltares, Boussinesqweg 1, 2629 HV Delft, The Netherlands

E-mail contact: f.o.sefiloglu@vu.nl

There is widespread evidence that microplastics (MPs) occur in fresh surface water around the world. This raised the possibility of human exposure to MPs via drinking water derived from freshwater sources. In the present study, MP concentrations in the drinking water supply system of Amsterdam (the Netherlands) were assessed through samples collected from raw, treated, and tap water over a period of six months. The identification and quantification of plastic particles ≥700nm were achieved by using a selective and sensitive analysis using pyrolysis gas chromatography coupled with mass spectrometry (Pyr- GC-MS). As the water samples from the source contained the highest MP values up to 1 mg/L, low MP levels in treated water indicated a high removal efficiency of treatment processes (94-97%). Target polymers (PE, PP, PS, PET, PVC and PMMA) were found at least in one of the raw and treated water samples, while PE and PVC were frequently detected in tap water. Considering that drinking water is a pathway of MPs to humans, this study contributes to the knowledge of MP pollution in drinking water supply systems and provides important data for estimating human exposure to MPs.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

Riverine microplastics in the Seine catchment

Cleo Stratmann[1], Rachid Dris[1], Johnny Gasperi[2], Frans Buschman[3], Arjen Markus[3], Dick Vethaak[3,4], Sam Azimi[5], Vincent Rocher[5], Sabrina Guerin[5], Bruno Tassin[1]

[1]Leesu, Ecole des Ponts, Univ Paris Est Creteil, France
[2]Université Gustave Eiffel – Laboratoire eau environnement (LEE), France
[3]Deltares, Delft, The Netherlands
[4]VU University Amsterdam, Institute for Environmental Studies (IVM), Amsterdam, the Netherlands
[5]Syndicat Interdépartemental pour l'Assainissement de l'Agglomération Parisienne (SIAAP), Direction Innovation, France
E-mail contact: cleo.stratmann@enpc.fr

Riverine microplastics (MPs), synthetic polymer particles ≤5 mm, are a global environmental problem. Rivers receive MPs from different sources, transport MPs to the oceans, and can also act as sinks for accumulating MPs. The sources and fate of MPs in river catchments are not fully identified and understood. To advance the understanding of the fate of small (25-300 μm) MPs in urban agglomerations, a one-year monitoring in the Seine river (France) was carried out. We analyzed MP concentrations in the water upstream and downstream of the Greater Paris area in four sampling campaigns from July 2022 - July 2023. The monitoring covered seven sites along the Seine river and tributaries and different water flow conditions. Water samples up to one m^3 were taken with the help of a novel in-situ pump and cascade filtration system (UFO®, Aalborg University, DK). MPs were extracted with oxidation and density separation and further analyzed via μ-FT-IR spectrometry. Preliminary, we found concentrations of polypropylene (PP) and polyethylene (PE) were most abundant across all samples (~64 % and ~19 %, respectively). In total, we detected 16 different polymer types, including polystyrene (PS), polyvinyl chloride (PVC), polyester (including polyethylene therephtalate, PET), styrene butadiene rubber (SBR), polyamide (PA), and polyurethane (PU). The variety of polymer types is larger downstream (16 polymer types) compared to upstream (9 polymer types). Concentrations range from ~14 - 4668 # particles/m^3 and vary temporarily and spatially along the river catchment, which suggests potentially complex MP transport and fate dynamics. Very likely, parameters such as surface runoff, combined sewer system overflow (CSO), and hydrodynamics influence MP concentrations. To explain the observations and identify influences on the MP levels observed, we apply the field data to hydrodynamic modeling. We strongly recommend more frequent, intense, and continuous MP monitoring in river catchments to understand the local dynamics, identify sources and sinks (hotspots), and strategically develop mitigation measures.

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Thematic Session: Sources of MP in Freshwater Ecosystems
6th March – 14:00 – 15:00

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

Stormwater ponds, sinks, or sources of microplastics?

Marziye Molazadeh 1, , Fan Liu 1, , Jes Vollertsen 1,

1 Build Environment Aalborg university of Denmark - Danmark

Stormwater runoff can be quite polluted as it 'cleans' the city's surfaces of all sorts of dirt and debris. It collects soluble and particulate pollutants, including microplastics (MPs), and conveys them to downstream environments. Concern over the deterioration of downstream watercourses is severe and stormwater is hence commonly treated prior to discharge, for example in wet ponds. However, there is a lack of knowledge on how efficient such systems are towards MPs. To examine this, 13 sediment samples were taken from a stormwater pond in the city of Aarhus, Denmark and analyzed for MPs. The pond receives runoff from residential and commercial areas, and occasionally illicit discharges of wastewater. To further evaluate the retainment efficiency of the pond, a sediment sample was collected from the receiving water, a shallow lake, at the location where the pond discharges.

MPs were extracted in a treatment train applying pre-oxidation, Sodium Dodecyl Sulfate (SDS) treatment, enzymatic treatments, and density separation in a heavy liquid. Extracts were sieved through a 500 μm mesh. MPs below this size were identified and quantified by Fourier Transform Infrared microscopy (μFTIR with Focal Plane Array) at a spatial resolution of 5.5 μm. The obtained hyperspectral image underwent automatic analysis, allowing counting and sizing MPs as well as estimating the mass of each particle. MPs > 500 μm were sorted under a stereomicroscope and all potential candidates analysed for their chemical composition by ATR-FTIR.

The global average concentration across the pond was 11.8 mg kg-1 and 44,383 items kg-1 of dry sediments. The values for the lake sediments at the discharge point were 0.87 mg kg-1 and 7,625 item kg-1, respectively, showing a decrease by a factor of 14 when MPs were measured by mass and 6 when they were measured by numbers. Polypropylene (PP) was the most abundant MP type in both water systems. The average PP concentration in terms of mass and number in the pond were 10.14 mg kg-1 and 33,727 items kg-1, respectively. In the lake at the discharge point, the PP concentrations were 0.55 mg kg-1 and 3,500 item kg-1, respectively. The results illustrate that MPs, comprising both buoyant and nonbuoyant polymers, can be trapped in stormwater pond sediments, highlighting the potential of such facilities as the first barrier in preventing the discharge of MPs to downstream water environments and their role in plastic pollution management.

Keywords: microplastic, stormwater pond, source, sink

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Sewage treatment plant as a source of microplastic pollution in water bodies

Sethunath Sethulekshmi <ssethulekshmi@iitb.ac.in> , Shriwastav Amritanshu <amritan@iitb.ac.in>, Kalbar Pradip <kalbar@iitb.ac.in>

Shriwastav Lab Environmental Science and Engineering Department Indian Institute of Technology Bombay India

Sewage treatment plants (STPs) are identified as a potential source of MPs pollution in aquatic environment due to its inefficiency in the complete removal of MPs (Magni et al., 2019). However, recent literatures are focussed on the removal efficiencies of treatment units in STPs, neglecting the fate of MPs and its interactions in the STP. This study explored the possibility of generation of secondary MPs from the settled MPs in biological treatment units of STPs and subsequent MPs pollution in the STP effluent. The study also focussed on the possibility of leaching of harmful plastic additives into the effluent of STPs.

A mixture of known MPs in the size range 2.7±0.8 mm was spiked in the aerobic and anaerobic SBRs and the effect of microbial consortium on these MPs for a period of 120 days were studied. The fragmentation of MPs was studied along with leaching behaviour of additives into the STP effluent. The study revealed that there is a release of noteworthy fraction of secondary MPs from the existing MPs into the sludge and effluent of both aerobic and anaerobic SBRs. At the end of 120^{th} day, the presence of secondary MPs was maximum in the settled sludge, giving a maximum count of 1100±70 MPs/L and 650±140 MPs/L in aerobic and anaerobic sludge respectively. Most of the observed secondary MPs were of size fraction < 100 µm. LCMS results showed leaching of additives like cyclohexylamine, cyclotetradecane, octadecanol, pipericine etc. into the effluent of SBRs.

The observed formation of secondary MPs in STPs and its presence in the effluent samples possess the risk of discharge of these smaller fraction MPs and nano plastics into the aquatic bodies. This may further pose risks to the lives of aquatic organisms through food web transfer and biomagnification. Apart from that, the observed leaching of plastic additives from the settled MPs into the STP effluents may cause another emerging threat for aquatic environment. Thus, with the acquired evidences it can be concluded that, long term presence of MPs in the STPs are a source of MPs and chemical pollution in the aquatic systems.

Keywords: Secondary microplastics; Sewage treatment plants; source; leaching; additives.

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From the river to the sea: Microplastics in water and sediments of the Elbe and Thames rivers and the North Sea

Friederike Stock[1], Katsia Pabortsava[2], Richard Lampitt[2], Maria Luiza Pedrotti[3], Emma Labis[3], Aaron Beck[4], Eric Achterberg[4], Kathrin Voges[1], Christopher Feltham[2], Anna Lichtschlag[2], Matthew Trenwith[2], Alice Horton[4]

[1] Federal Institute of Hydrology, Koblenz, Germany

[2] National Oceanographic Center, Southampton, Great Britain

[3] Laboratoire d'Océanographie de Villefranche, Sorbonne University, France

[4] GEOMAR – Helmholtz Centre for Ocean Research, Kiel, Germany

Microplastics have been investigated for over 45 years especially in the marine environment, but only in the past years research has started to focus on freshwater environments. In the frame of the H2020 LABPLAS project, different compartments in the Elbe and Thames river basins and the North Sea were studied in order to better understand the sources, transport, distribution and impacts of plastic pollution and to detect the amount of plastics transport via the rivers into the sea.

In the frame of the project, a winter and a summer campaign were conducted 2022 and samples taken from 6 sites within each study area. Water samples were collected with a manta net in the middle of the river (>335 µm), plastics separated from zooplankton and measured with a hyperspectral system. Sediment samples were taken with a Van-Veen-grabber, wet-sieved into different compartments (10-100 µm, 100-1000 µm, >1000 µm), density-separated and the organic matter digested. The plastics from the sediments were characterized with a Laser Direct Infrared (LDIR), the plastics in. The preliminary results reveal that microplastics are present in all samples. The amount of particles varies significantly between the sampling sites showing the importance of industrial emissions and cities.

Keywords: microplastic, water, sediment, river, sea, LDIR

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Local urban activity, Covid lockdown, and atmospheric microplastic deposition

MAX BEAUREPAIRE, RACHID DRIS, JOHNNY GASPERI, BRUNO TASSIN

Since the earliest studies on the topic in 2015, The presence and behaviour of microplastics in the atmospheric compartment represent a subject of growing scientific interest. Over the last few years, a few dozen studies have been published on microplastics in the air and in atmospheric fallout. Several factors are suspected by authors to affect MP atmospheric deposition, human activity and precipitation being the leading ones.

In this work, unique microplastic atmospheric deposition data collected in an urban campus (site A) during the French national lockdown of spring 2020 are compared to deposition data of the same site in a period of normal activity as well as a site of intense agricultural activity. During each campaign, total atmospheric fallout was continuously sampled for 4 to 6 months using a passive sampling strategy. After collection, all samples underwent a density separation followed by a chemical treatment, before they were analysed using an automated µFTIR mapping analysis using a Nicolet iN10 by Thermo Scientific. MPs were identified down to a size of 25 µm, cutoff point determined by the µFTIR detectors.

Overall median deposition rates of 18.3 MP/m²/d were found when pooling all campaigns together. The lowest deposition rates were recorded during the national lockdown monitoring campaign in site A, with a median of 5.3 MP/m²/d compared to 26 MP/m²/d in the same site during normal periods of activity. The lockdown was also associated to a lower relative fraction of large microplastic fragments among the deposited particles. Lower median deposition rates were recorded in site B than in site A during periods of normal human activity. Based on the available meteorological data, no clear effect of rain events or accumulated rainfall on microplastic deposition was measured, suggesting the dominant effect observed here was the change in local human activity.

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Thematic Session: Impacts on Freshwater Biota and Public Health
7th March - 10:00 – 12:00

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

A systems level approach to studying the impacts of micro-nanoplastics (MNPs) on Freshwater Biota and Public Health

Prof Gary Hardiman; School of Biological Sciences & Institute for Global Food Security, Queens University Belfast, Belfast, Northern Ireland.

email: G.Hardiman@qub.ac.uk. @ghardiman https://hardimanlab.org/

One Health is a paradigm that recognizes that the health and well-being of humans, animals, and ecosystems are interconnected. The long-term durability and persistence of plastics in the environment has seen them accumulate in different ecosystems at increasing rates. This is particularly true in the aquatic environment, where plastic degradation may take decades. Micro (<5 mm; MP) and nano plastics (<0.1 mm; NP) are defined as persistent pollutants that remain intact within biological systems, with suggestive evidence of bioaccumulation through trophic levels. The negative effects of micro-nanoplastics (MNPs) are now widely recognized, on a range of biological levels of organization, from sub-cellular to organismal with profound consequences such as blockage of digestive tracts, false satiation, depletion of energy reserves, inflammatory responses, developmental defects, and behavioral change. Together with the leakage of chemical additives, many of which are endocrine disruptors (EDCs) the degradation of plastics poses risks to human and environmental health. Adverse outcomes from plastic exposure are shared cross-species, indicating common mechanisms of toxicity. Therefore, research to better understand the cellular and systemic toxicity caused by MNPs and the underlying biological mechanisms is urgently required. Our laboratory is studying the toxicological impacts of MNPs using a systems biology approach the objective of which is the study of biological systems, including genes, RNAs, proteins, metabolites and cells in a focused manner, and organs, organisms, and populations in a broader context.

Marine species with individuals ingesting naturally disparate levels of plastic present valuable opportunities for researchers in understanding the real-world impacts of plastic. Sampling from sentinels monitors dynamic exposures to the evolving plastics landscape, allowing transcriptomic and epigenetic adaptations to these exposures to be assessed. Advances in bioinformatics enable the elucidation of shared biological pathways from plastic toxicity in a systems-level context. Abundant seabirds such as the herring gull or the northern fulmar represent ideal marine plastic sentinels. *Pagurus bernhardus* the common marine hermit crab of Europe's Atlantic coasts is another excellent sentinel species with recent evidence suggesting that microplastic exposure disrupts behavior in a sex-dependent manner in this species.

Humans are primarily exposed to MNPs via food or derived from food packaging, although they can also be inhaled in a less well-defined manner. MNPs may accumulate and cause localized particle toxicity when inhaled or ingested by initiating or amplifying an immunological response. Localized leaching of component monomers, endogenous additives, and absorbed ambient contaminants also have the potential to cause chemical toxicity. Particles smaller than 20um may penetrate cell membranes and exert toxicological effects. Chronic MNP exposures are expected to be of greater concern because of cumulative and long-term effects. The toxic impacts of plastics include inflammation, oxidative stress, lysosomal dysfunction, mitochondrial dysfunction, autophagy, apoptosis, and genotoxicity. The available evidence suggests that the aggregation of micro-and nano plastics in living organisms could have negative long-term outcomes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

The Endless World: Plastic debris in the Seine estuary as a case study

Romain Tramoy, Johnny Gasperi, Rachid Dris, Bruno Tassin

École des Ponts ParisTech, Paris, France

Global plastic production is emblematic of the Anthropocene with an exponential and endless growth of 4% per year, reaching around 400 million metric tons in 2022. Plastics are everywhere, in every economic sector and under many chemical and physical configurations. They are widely used for 50 years, persistent in the environment and are not biodegradable, that is why they are found in soils, water, air and biota as macro- (> 5 mm), micro- (1 µm <> 5 mm), or even nanoplastics (< 1 µm). Consequently, the endless production growth yields an endless leakage into the environment. In contrast with other persistent chemical pollutants gathered within the term "novel entities", plastics – especially macroplastics – are visible. They thus focalize the public's attention thanks to impressive images and/or biased representations from polluted oceans and rivers. Rivers are major pathways of plastics from lands into the Ocean. However, there is still a huge lack of knowledge on how much and how riverine litter, including macroplastics, is transferred into the Ocean. Quantitative measurements of macroplastic emissions in rivers even suggest that a small fraction (0.001 to 3%) of the Mismanaged Plastic Waste generated within a river basin finally reaches the sea. Macroplastics may remain within the catchment and on coastlines because of complex transport dynamics that delay the transfer of plastic debris. In order to better understand those dynamics, we performed tracking of riverine litter over time. First, hundreds of date-prints items were collected on riverbanks in the Seine estuary. The distribution of their Use-By-Dates suggests that riverine litter may remain stored on riverbanks for decades. Second, we performed real time tracking of floating and sub-floating bottles using GPS-trackers in the estuary covering a wide range of hydrometeorological conditions and tidal cycles. Results show a succession of storage/remobilization episodes in combination with back and forth transport in the estuary related to tides. Plastic debris are thus submitted to an endless journey from rivers to the Ocean during which endless fragmentation occurs from macro- to micro- and perhaps nanoplastics well before they reach the Ocean. Due to this chaotic transport from land to sea, the residence time of these debris is much longer than the transit time of water. This offers the opportunity to collect them before they get fragmented and/or reach the Sea. To prevent endless cleaning of plastic debris, "a historic resolution was adopted to develop an international legally binding instrument on plastic pollution" in order to tackle plastic pollution at source. But time is running out because an endless world is not compatible with a finite world, where six on nine of the identified planet boundaries, including "novel entities", have already been exceeded.

Keywords: Fluxes, Macroplastics, Microplastics, Planet Boundaries, Transport

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Dose metric as one of the determining factors in comparing microplastic toxicity

Gabriël Olthof[1*], Erik Hvid Hundstad[2], Johannes Völker[2], Iurgi Imanol Salaverria-Zabalegui[2], Andy Booth[3], Martin Wagner[2]

*lead presenter

[1] gabriel.olthof@ntnu.no, Norwegian University of Science and Technology (NTNU), Norway

[2] Norwegian University of Science and Technology (NTNU), Norway

[3] SINTEF Ocean, Norway

One of the biggest challenges for microplastic toxicity studies is the diversity of microplastics. Different polymers, the vast number of associated chemicals, and variety in shape and sizes are some of the main challenges that these studies must deal with. To address part of this challenge, this study aims to comparatively assess the reproductive toxicity of microplastics of different polymers and shapes on the freshwater invertebrates *Daphnia magna*.

Daphnids were exposed for 21 days to polyamide (PA) and polyethylene terephthalate (PET) fibers and fragments. Polystyrene (PS) beads and wool fibers were used as reference material for other studies and as a natural reference, respectively. Animals were exposed to four concentrations ranging from 2 to 250 mg/L with 10 replicates for each treatment and 20 negative controls. A deviation from the standard OECD test setup was the use of plankton wheels to keep the different materials in suspension and maintain a consistent exposure concentration between treatments. The number of neonates produced during the experiment was recorded during every water exchange (thrice a week).

This research shows that the choice of dose metric (e.g., mass/volume or particles/volume) is one of the most important determining factors when comparing the toxicity of different microplastics. This means that any comparison of toxicity between different microplastic types should include a justification of the dose metric used, or the means to translate between different dose metrics. For future research, a focus on the mechanism behind microplastic toxicity should be a focus, as this will be essential to make this kind of comparisons.

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Beyond microplastics: Water soluble synthetic polymers exert sublethal adverse effects in the freshwater cladoceran Daphnia magna

Simona Mondellini[1,2] Matthias Schott[1,2], Martin G. J. Löder[1,2], Seema Agarwal[3], Andreas Greiner[3], Christian Laforsch[1,2,*]

[1] Department of Animal Ecology I, University of Bayreuth (UBT), Universitätsstraße 30 95447, Bayreuth (Germany)

[2] BayCEER, University of Bayreuth (UBT), Universitätsstraße 30 95447, Bayreuth (Germany)

[3] Department of Macromolecolar Chemistry II, Universitaetsstraße 30, 95447 Bayreuth, Germany

[*] Corresponding author

Plastic pollution is considered one of the causes of global change. However, water soluble synthetic polymers (WSSPs) have been neglected so far, although they are used in several industrial, dietary, domestic and biomedical products. Moreover, they are applied in wastewater treatment plants (WWTPs) as flocculants and coagulant agents. Hence, their presence in the aquatic environment as well as their uptake by aquatic organisms is probable, whereas no data are available regarding their potential adverse effects. Here we show in the freshwater key species *D. magna* exposed to five different WSSPs life history changes along with an altered level of reactive oxygen species, although acute mortality was not observed. Since daphnids act as keystone species in lake ecosystems by controlling phytoplankton biomass, even sublethal effects such as WSSPs induced changes in life history may result in cascading effects, from lower to higher trophic levels, which in turn could affect the whole food web.

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Endocrine disrupting chemicals in plastics – *In vitro* toxicity and chemical composition

Sarah Stevens[1], Zdenka Bartosova[1], Johannes Völker[1] and Martin Wagner[1]
[1]Norwegian University of Science and Technology (NTNU), Department of Biology, Trondheim
E-mail contact: sarah.steven@ntnu.no

Many of the adverse impacts of plastics are related to the leaching of hazardous chemicals. Plastics are chemically highly complex products. For instance, more than 10,000 substances are intentionally used in the production of plastics (e.g., plasticizers, antioxidants) and even more non-intentionally added substances (e.g., reaction byproducts, impurities) are associated with them. While there is abundant scientific evidence that some compounds used in plastics, such as bisphenols and phthalates, are endocrine disrupting chemicals (EDCs), little is known about the composition and toxicity of the complex mixtures of chemicals present in and leaching from everyday plastic products. Therefore, this study aims at characterizing the *in vitro* toxicity and the chemical composition of plastic food contact articles (FCA) as relevant sources of exposure to humans and the environment. Further, as bioplastics are promoted as a sustainable alternative, biobased and/or biodegradable preproduction pellets are compared to conventional polymers. The plastic samples were extracted with methanol and analyzed with reporter gene assays for a set of nuclear receptors relevant to human health, including pregnane X receptor (PXR), peroxisome proliferator receptor gamma (PPARγ), estrogen receptors alpha (ERα) and androgen receptor (AR). To better quantify chemicals and toxicity leaching under more realistic conditions, selected samples were also leached into food simulants (water and water-ethanol mixture) and analyzed with the same assays. To assess if the interference with hormonal receptors translates to effects on a cellular level, samples activating the PPARγ are being analyzed for their adipogenic activity in murine preadipocytes. In addition, all samples were analyzed using non-target high-resolution mass spectrometry to quantify the number of chemical features and tentatively identify the chemicals in the plastic products. Nuclear receptors were activated or inhibited by 92% (PXR) to 36% (AR) of the extracts. Many of the active FCA extracts also leached chemicals that interfered with these receptors, again with the PXR as the primary target. With some exceptions, the water leachates were less potent than the ethanol-water leachates and the methanolic extracts. Chemicals in the bio-based and conventional preproduction pellets interfered with the selected nuclear receptors to a lesser extent than the finished FCAs. In total, we detected >16,000 unique chemical features in the extracts, with the number of features per sample ranging from 37 to 10,000. Only 17% of the chemical features were tentatively identified using spectral libraries and *in silico* tools. To identify the active compounds in these complex mixtures, an effect-directed analysis will be performed. This research demonstrates that plastic FCAs and preproduction pellets contain and leach EDCs and highlights the importance of analyzing the final plastic products to cover the toxicity of unknown compounds and mixtures.

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Keywords: Endocrine disruption, plastic chemicals, non-target chemical analysis, food packaging

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Chronic toxicity of microplastic in fish species

Azora König Kardgar 1, *, @ , Joachim Sturve 1, @ , Bethanie Carney Almroth 1, @

University of Gothenburg (GU)

This project investigates the acute and chronic toxicity of conventional versus biobased and biodegradable microplastics in freshwater fish species using in vivo and in vitro test systems. Our studies differentiate between polymer microparticles and the chemicals inherent to these materials. We used the microplastic particles in different relevant size ranges and concentrations for the ingestion by fish, chemical extracts or water leachates of larger particles and non-polymer natural kaolin control particles.

The toxicity of poly(L-lactide) (PLA) microplastic particles was assessed in juvenile perch (*Perca fluviatilis*) in a 6-month chronic food-exposure study, using several endpoints, life cycle parameters (growth, weight gain), metabolism, general stress response and behavior (locomotion, schooling, and predator response).

The cytotoxicity of chemicals associated with biobased and biodegradable microplastic polymers (PLA, PBS, PBAT, PBSA, P3HB and PLimC) was tested using chemical extracts on rainbow trout (*Oncorhynchus mykiss*) gill and liver cell lines. Cytotoxicity was studied on cell viability and metabolic endpoints, such as lysosomal membrane stability, proliferation, and enzymatic activities.

Adult and juvenile Tilapia (*Oreochromis niloticus*) were exposed to a mixture of microplastics from four conventional polymers (PP, HDPE, PET, and Nylon-6). Adult Tilapia were exposed for 7 days while juveniles were exposed for a 30-day feeding. Biomarkers for fish health and intestinal integrity were studied in both experiments.

To investigate the potential toxicity of additives and pollutants adherent to microplastic, we designed studies with recycled polyethylene pellets on the development of zebrafish (*Danio rerio*) embryos. The fish embryos were exposed to different concentrations of water leachates from the recycled pellets. Gene expression, related to adipogenesis and thyroid disruption, and locomotion were studied after the exposure period.

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Keywords: fish, toxicology, biobased polymers, conventional polymers, chronic exposure

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Changes in immunity as an early response to microplastics exposure

Anita Jemec Kokalj[1], Andraž Dolar[1], Damjana Drobne[1]

[1]University of Ljubljana, Biotechnical faculty, Department of Biology, Ljubljana, Slovenia

E-mail contact: anita.jemec@bf.uni-lj.si

Over the years, numerous data had been gathered regarding the potential impacts of microplastics on aquatic and terrestrial crustaceans. It became clear that often adverse effects are observed only at very high exposure concentrations, while lower concentrations induce sublethal responses. We have focused to investigate how the organisms respond to microplastics exposure at the immune system level. Namely, immune response is not only induced when the organisms encounter the pathogen, but also when the change in its surrounding environment is perceived. For example, it is known that crustaceans induce an immune response as a result to changes in temperature, salinity, chemicals, etc. Having this in mind, we performed a series of experiments with different types of microplastics: tire wear particles, textile fibers, polypropylene microplastics from disposable medical masks, LDPE fragments from packaging, and LDPE fragments milled from non-degradable and biodegradable mulching films. The model organism was a terrestrial crustacean woodlouse *Porcellio scaber*, which is well known for its basic immune parameters. Most of our data show that these crustaceans respond to microplastics exposure by inducing an immune response already shortly after the exposure and then this alteration is gradually decreased to basal levels after longer exposure times. The second question was what this change in immune response means for the overall immunocompetence of organisms. For this purpose, we challenged the organisms by bacterial-like infection after the microplastics exposure and investigated how competent the organisms are to cope with this second stressor. Preliminary data show that the immunocompetence is not different between the unexposed and microplastics (tire particles) treated organisms, while this was evident for the positive control (pesticide). Although this conference is aimed at aquatic environment, we think that most of the findings with terrestrial crustaceans can be transferred to aquatic crustaceans as well. Most of all we would like to draw attention to the immunity as an interesting and relevant endpoint to investigate in the case of microplastics exposure.

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Responses of freshwater macrophytes and cyanobacteria to microplastic exposure

Senavirathna Mudalige Don Hiranya Jayasanka <jayasanka@mail.saitama-u.ac.jp> (1), Zhaozhi Liu <liu.z.840@ms.saitama-u.ac.jp> (1), Aihemaiti Bahaguri <bahaguli.a.212@ms.saitama-u.ac.jp> (1)

Saitama University (Japan)

Freshwater macrophytes and cyanobacterial responses to microplastic (MPs) exposure were tested in laboratory studies. Two macrophyte species (*Egeria densa* and *Myriophyllium roraima*) and cyanobacteria (*Microcystis aeruginosa*) were subjected to MP exposure under controlled laboratory conditions. The MPs (3 μm polystyrene microspheres) concentrations, 0.05 mg L-1, 0.25 mg L-1, 1.25 mg L-1, and 6 mg L-1 were tested. In three different experiments, macrophytes and cyanobacteria were exposed to MPs for seven days. Treatments were conducted under controlled light, temperature, and nutrient conditions in soilless cultures. The growth, pigmentation, oxidative stress, and antioxidant responses were quantified. Plants, shoots, roots, and cyanobacterial cells were microscopically observed for absorption and adsorption of MPs. Exposure to microplastics caused a change in the growth and physiochemical parameters of macrophytes and cyanobacteria. The elongation of *E. densa* was reduced at high MPs concentrations, while *M. roraima* showed a slight increment at high MPs concentrations. The growth rate (OD730) of *M. aeruginosa* was reduced with the increasing MPs concentration. The chlorophyll-a contents were unchanged in any of the species. The cellular H2O2 contents of all three species were increased and recorded highest at 1.25 mg L-1 or 6 mg L-1 MPs concentrations. Interestingly, GPX (an antioxidant) of all three species was recorded highest at 0.25 mg L-1 MPs concentration. Microscopic observations confirmed the adsorption of MP particles with the roots of both macrophyte species at each treatment, and the adsorption was proportional to the MPs concentration. The non-association of MPs with individual cells or cell colonies of *M. aeruginosa* was confirmed. Present research confirmed that the presence of MPs in the media could affect the growth and physiology of both macrophytes and cyanobacteria in a short period. We further investigated the influence of MPs on the allelopathic interaction between cyanobacteria-macrophytes by comparing the data of *M. aeruginosa- M. roraima* co-existence culture treated with MPs. It was found that at 1.25 – 6 mg L-1 exposure conditions, *M. aeruginosa* showed an elevation in H2O2 content, while the H2O2 content of *M. roraima* was elevated only at the highest MP concentration. Further research will be conducted on the effect of nano-plastics on macrophytes, cyanobacteria, and the interaction of macrophytes-cyanobacteria.

Keywords: Adsorption, Cyanobacteria, Freshwater macrophytes, Growth response, Stress response

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Thematic Session: Social & Behavioral Science, Economics and Legal Perspectives
7th March - 14:00 – 17:00
Keynote speaker: Sabine Pahl (University of Vienna – Austria)

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Microplastics and society: From risk perception to action

Sabine Pahl[a]

[a] *Environmental Psychology Group, University of Vienna, Austria*

sabine.pahl@univie.ac.at

Microplastic risk is assessed, and regulation is planned, based on an evidence base from the natural and technical sciences, e.g., ecotoxicology, marine biology, modelling and other disciplines and approaches. This evidence is communicated to society and policy makers via the media and other social channels, and science advice processes. Regulatory initiatives can be fuelled by societal demand, for example where citizen have high concern and demand change from policy makers. On the other hand, regulation may fail, or fail to reach its predicted effect, due to opposition by the public or other involved groups. This presentation will give an overview of social and behavioural sciences approaches to risk perception, risk communication and policy, focusing on key perspectives. I will review social data on perceptions of plastic impact on human health and environment and refer to key insights from an evidence review report on microplastics we wrote for the European Commission (SAPEA 2019), including its subsequent reception, posing the question of how much evidence is needed to justify action. I will also provide findings from recent work with the European Food Standards Authority on risk perception in the context of food and drink, data from the LimnoPlast and Plenty projects and from projects set in the Global South, specifically Indonesia and the Philippines. The presentation will end with discussing some gaps and challenges, in the context of current science-to-policy activities (e.g., GESAMP WG-40, the “plastics treaty”) and plastics as a system.

Keywords: perception, communication, behaviour, human health effects

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On the creation of risk – discussions on microplastics in science, media and public

Carolin Völker & Johanna Kramm

1 - ISOE – Institute for Social-Ecological Research, Frankfurt/Main, Germany, 2 - Goethe University Frankfurt/Main, Institute for Ecology, Evolution, and Diversity

Macro- and microplastics in the environment are examples of a complex problem, due not only to uncertainty regarding their negative effects, but also to competing views on how to combat the problem. Therefore, scientific evidence is not the only prerequisite for management and related policy-making; an agreement on how to understand, interpret and value the evidence by different interest groups is also necessary. While the scientific knowledge about the environmental risk of microplastics is still incomplete, the topic receives great public attention. So far, the public's awareness and risk perception regarding microplastics have been little researched.

For the presentation, we scrutinize how the media have covered scientific studies and in which way ignorance, risk and uncertainty are communicated to the public. We will present results from a media analysis and discuss them in relation to natural scientific data as well as risk perception of the resident population in Germany. We draw on the results from a representative survey where we investigated 1) the public's knowledge about microplastics, 2) the risk perception regarding microplastics and 3) the factors affecting risk perception of microplastics.

We are part of an interdisciplinary group researching plastics in the environment from a socialecological risk perspective ("PlastX"). Our team comprises researchers from ecotoxicology, chemistry, geography and sociology analyzing plastics from different environmental as well as societal perspectives.

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Understanding Effectiveness and Efficiency of Interventions to Reduce the Release of Microplastics into the Environment: Tire and Textile Case Studies

Authors: Aybüke Özdamar, Jürgen Bertling, Jan Blömer

Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT

Osterfelder Straße 3, 46047 Oberhausen / Germany

Although the full extent of their impact is not yet understood, the presence of microplastics in the environment has raised concerns. As a result, policy discussions have already started as precautionary measure both at EU level (such as ECHA's proposal on restriction of intentionally added microplastics) and at global level (such as UNEA 5, "End Plastic Pollution" resolution). However, the effectiveness and efficiency of mitigation measures remains unknown.

In this study, we considered the entire product life cycle to identify point of microplastics loss to identify intervention options. Conceptual models covering tire and synthetic textile garment life cycle, point of microplastics losses and their pathway to environmental compartments were prepared and presented to LimnoPlast Early-Stage Researchers (ESRs). The ESRs suggested around 10 policy, technical and behavioral interventions to reduce microplastics pollution. At the end, four measures for each product were selected to be presented to stakeholders from research, policy, non-governmental organizations (NGO) and industry. These selected measures were then critically evaluated based on their relevance, feasibility, effectiveness, efficiency, coherence, and environmental-social trade-offs.

We found that our methodology combining multi-criteria evaluation approach with life cycle perspective is beneficial to obtain detailed input from stakeholders and understand the various aspects for decision making. The results highlighted the complexity of the microplastics issue and shows that there is no perfect solution. We also observed that the significance of engaging all relevant stakeholder groups for better evaluation of each measure.

Keywords: mitigation measures, intervention evaluation, stakeholder engagement, plastic loss, life-cycle, tire, synthetic textile

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Mental models, worry and responsibility judgments about microplastics in the Norwegian public

Marcos Felipe Rodriguez[1], Gisela Böhm[1,2], Rouven Doran[1]

[1]Department of Psychosocial Science, University of Bergen, Bergen, Norway

[2]Department of Psychology, Inland Norway University of Applied Sciences, Lillehammer, Norway

This presentation attempts to briefly cover three studies that aimed to investigate different aspects of public perceptions about microplastics. The first study investigated laypeople's intuitive understanding of microplastics, asking an online sample (*N* = 2722) to state the first thing that came to mind when thinking about microplastics. The structure and content of the responses were analyzed focusing on beliefs about causes and impacts of microplastics, and the role of personal values influencing such perceptions was also assessed. Results indicate that the public seem to think of microplastics as something bad that might pollute the ocean and harm animal species. Endorsing self-transcendence and openness-to-change values was associated with thinking of ways to solve and of consequences of microplastics.

The second study investigated factors related to worry about microplastics, using an online survey (*N* = 699), for which they answered a battery of questions about their worry, personal values, and risk perceptions. Microplastics were judged to be moderately known, somewhat uncontrollable, very threatening to humankind, and even more so to plants and animals. Regression analyses predicted worry about microplastics from sociodemographic variables and personal values, and in an additional step, from different aspects of people's risk perceptions. Endorsing self-transcendence over self-enhancement values predicted greater worry. However, sociodemographics and personal values were not significantly associated when risk perception components were included in the regression model.

The third study employed the same sample as the second (N = 699). Respondents were first asked two open-ended questions about the main source and solution to the problem of microplastics, respectively. Further, they were asked to ascribe responsibility for causing and responsibility for solving the problem, competence, and motivation to tackle the problem to a list of six actors. Lastly, they rated a set of measures to address microplastics in regard to how effective they deemed them to be. A correspondence analysis revealed that responsibility for causing the problem was mostly associated with industry and individual consumers, responsibility for solving and competence were mostly associated with authorities, and ascribed motivation was associated with environmental groups. Different patterns of judgments on varied actors show to be positively associated with perceived effectiveness of distinct types of solutions.

Keywords: microplastics, mental models, worry, risk perception, personal values, responsibility

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Behavioural Approaches to Microplastics Pollution: The Case of Fashion Consumption

Maja Grünzner **1, *,** @ , Sabine Pahl **1,** @ , Mathew White **1,** @ , Kayleigh Wyles **2,** @ , Richard Thompson **2,** @

1 : University of Vienna (UniVie); 2: University of Plymouth (UoP)

Microplastics increasingly pollute European rivers. Therefore, it is evident that European citizens as well as experts researching plastics are worried about the potential impact of microplastics. Hence, effective actions to reduce it are needed. In a recent study, policy and behavioural measures as well as a reduction in plastic production and use were named as most impactful solutions by experts. Moreover, textiles were rated as one of the riskiest sources by the same sample. Therefore, we want to present an approach targeting microplastics pollution focusing on fashion consumption in young consumers, a behaviour causing fibrous microplastics emissions. First, we report results from semi-structured interviews with seventeen young consumers (19-33 years) in the UK, exploring their views on fashion and knowledge about fibrous microplastics. Results indicated that fashion purchase behaviour is often impulsive and that many barriers towards sustainable purchase practices exist. Additionally, studies in the US and a study in South Korea have shown that short reflections can decrease buying urge. Hence, we want to explore further if short reflections based on two deliberation tasks (neutral framing and environmental consideration framing) or a desire depletion task can decrease purchase desire and likelihood. To do so, we prime participants' purchase desire with a shopping scenario vignette. Participants who click on *"shop now"* will be randomly allocated to one of three short reflection tasks or to the control condition in a between-subject-design. The data will be collected in March and April 2023 via Prolific with young fashion consumers in the UK.

Keywords: psychology, social science, survey, interview, experiment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 860720

(Micro)plastics Pollution in the International and EU Legal Landscape: Current Challenges and Intervention Recommendations

Giorgia Carratta, Liv Jaeckel, Tobias Dauth
HHL Leipzig Graduate School of Management

Since the beginning of their mass production in the XXI century, plastic products have been an essential element of the contemporary human lifestyle. Synthetic polymer materials have become almost irreplaceable in several economic sectors thanks to their physical and chemical properties: packaging, automotive, building and construction, textile and many others. At the same time, the exponential accumulation of plastic debris in the environment is an urgent call for action today. The adverse effects on habitats, wildlife and human health require robust decision-making on a global scale. In this context, the occurrence and persistence of small-size particles in the environment, such as micro- and nano-plastics, have gained attention within the scientific community as an additional and severe threat. The more data collected on the magnitude of this phenomenon, the more necessary it appears to prevent and mitigate it.
Plastic pollution presents an unprecedented challenge to policymakers at every level of governance. There are countless factors contributing to the plastic problem and, therefore, countless actions to be taken to fight it. Although several instruments applicable to plastics governance are already in place at the international level, UN Member States have recently decided to begin a path toward adopting a new international plastics treaty (UNEA 5.2). At the EU level, establishing a Plastics Strategy as part of the EU Circular Economy Action Plan promises to change how plastic is designed, produced, used and treated after consumption. Under the Strategy, measures that have already been approved regulate critical issues such as the production and consumption of single-use plastic items, plastic bags, packaging and plastic waste management. Meanwhile, European authorities are also working to address other crucial issues (e.g., minimising microplastic pollution under REACH or providing clear rules on bio-based, biodegradable and compostable plastics).
Are these efforts sufficient? Is there anything to add to the solutions adopted so far by decision-makers? With my contribution to the LimnoPlast final conference, I will try to answer these questions, structuring my analysis around the main steps of the plastics life cycle (production, consumption, and waste management). Pointing out their weaknesses and opportunities, I will also mention the main legal instruments devoted to ecosystem protection, which potentially come into play whenever plastic pollution occurs.

Keywords: environment, international law, microplastics, plastic life cycle, plastic pollution

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Expert's mental models of microplastics pollution

Karlijn von den Broek

1 - Utrecht University, Utrecht, The Netherlands

This presentation is situated in psychological and social science research on microplastics pollution. The aim is to map experts' so-called mental models about this domain. Mental models are internal, subjective representations of some aspect of the external world. We illustrate and compare two approaches to mental model elicitation and representation: a decision analytic approach and a graphical drawing tool (the M-Tool) applied to the emergent global problem of microplastics accumulation in the environment. We draw on recent ecological risk assessments of microplastics pollution and the expertise on the Limnoplast project, this research makes methodological and practical contributions to the study of mental models of hazardous processes and to understanding heterogeneity and commonalities in diverse scientists' mental models of microplastics pollution. Findings highlight key knowns and unknowns about microplastics pollution, priority topics to address in risk communications about microplastics pollution, and opportunities for further research into the risks it poses, as well as strategies for mitigating those risks.

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Thematic Session: Innovative Technological Solutions to the MP Issue
8th March - 10:00 – 12:00
Keynote speaker: Lila Durix (Ville de Paris)

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Occurrence and fate of microplastics in Parisian combined sewer network

Minh Trang NGUYEN[1], Gabriel Olthof[2], Vaibhav Budhiraja[3], Ngoc Nam PHUONG[4], Rachid DRIS[1], Johnny GASPERI[4], Thomas GILLET[5], Mohamed SAAD[1], Sam AZIMI[6], Martin Wagner[2], Bruno TASSIN[1]

Affiliations:

[1] Leesu, Ecole des Ponts, Univ Paris Est Creteil, Marne-la-Vallee, France

[2] Department of Biology, Norwegian University of Science and Technology (NTNU), Norway

[3] Department of Polymer Chemistry and Technology, National Institute of Chemistry, Slovenia

[4]Université Gustave Eiffel – Laboratoire eau et environnement (LEE)- France

[5] Section de l'Assainissement de Paris, Subdivision Contrôle des Eaux, Paris

[6] Syndicat Interdépartemental pour l'Assainissement de l'Agglomération Parisienne (SIAAP), Direction du Développement et de la Prospective, France

MPs are present in sewage, reflecting the wide use of plastic and plastic-contained products in human modern daily life. Sewer management systems, which comprise a sewer network and wastewater treatment plants (WWTPs), need to tackle this pollutant. The present study aims to investigate MPs occurrence and fate in the sewer network – WWTP continuum, thereby gaining a better understanding of their pathways in urban waters before entering the environment.

A sewer network, responsible for conveying wastewater from household, commercial or industrial establishments to WWTPs, is a conglomeration of underground pipes, pumping stations and other accessories. In case of combined sewer, mixture of wastewater and stormwater is transported to WWTPs for purification. During the transport, particulate contaminants in wastewater can settle down inside the sewer network, leading to the formation of sewer deposits or sewer sediments. Sedimentation happens due to moderate flow rate of sewage during nights and dry weather periods, especially in case of Parisian combined sewer systems where sewer pipes are oversized. During wet weather periods, sediments can get resuspended with an increasing flow rate inside the sewer network. This releases contaminants trapped in sewer sediments into wastewater. Especially, in case of intense events, total water volume in the networks may exceed the capacity of WWTPs and be discharged directly to the environment. These discharges, named combined sewer overflows (CSOs), can add a considerable amount of contaminants into receiving water bodies without treatment. MPs are expected to behave similarly to other contaminants in sewage – trapped in sewer sediments and released into wastewater later. To examine this hypothesis, samples were collected from sand chambers inside Parisian combined sewer networks, providing a first idea about MP content inside sewer sediments. Moreover, samples from two major CSO outfalls were taken to assess the amount of MPs released into the environment during intense events. Also, a preliminary ecotoxicology study was carried out to investigate potential impacts of MPs discharged along with CSOs on aquatic organisms in the receiving water bodies.

WWTP is designed to remove organic matter and nutrient pollution in sewage before returning clean water to the environment. Despite showing up as an emerging contaminant in sewage, MPs can be removed efficiently from water phase in WWTPs. High removal efficiency up to 96-99 % was reported in literature, although discrepancies exist among published data. Indeed, MPs still remain in the system; they are transferred and concentrated in sewage sludge. MP content and fate in this matrix are however little-known. Here, four different types of sludge (e.g., raw sludge, dewatered sludge, digested sludge and treated sludge) and returned water were studied to elucidate the occurrence of MP throughout the sludge-line treatment in WWTP with different technologies involved. The results provide information for improving sludge treatment and assessing the potential to release MPs into the environment through sludge application in agriculture.

Keywords: sewer sediment, combined sewer network

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Degradation of Microplastics in the Environment

Vaibhav Budhiraja, Andrej Krzan*

National Institute of Chemistry, Department for Polymer Chemistry and Technology, Hajdrihova 19, 1000 Ljubljana, Slovenia

vaibhav.budhiraja@ki.si, andrej.krzan@ki.si

One route for plastics to enter the environment is through plastic litter that gradually degrades into (secondary) microplastics (MP). In the environment, polymers degrade chemically, mechanically and biologically in a series of reactions, ultimately leading to fragmentation. The degradation rate of plastic debris depends on polymer characteristics such as its chemical composition, morphology, form, additives etc. as well as its exposure to abiotic and biotic factors such as sunlight, humidity, mechanical stress and depositional environment e.g. soil, freshwater, seawater etc. Degradation is a long-term process resulting in the formation and continued transformation of MPs, which further break down into nanoplastics. The problem is made worse by the fact that different materials will degrade differently depending on their properties and exposed environment. In the present study, forty-four naturally degraded lobster trap tags made of polyethylene (PE) were collected from the marine environment and several naturally aged polypropylene (PP) items were studied with respect to their degradation in the environment. The manufacturing dates printed on lobster tags were used as a temporal indication of their presence in the environment as plastic litter. The oldest PE tag was manufactured in 1983, whereas some PP items were more than forty years old. The results revealed an extreme degradation of several PP items that has a very pronounced effect on fragmentation. The PE tags do not show a direct degradation correlation with their time of manufacture. The oldest PE tag made in 1983 remained robust, whereas a lobster tag manufactured in 2007 showed the highest degradation, as confirmed by ATR-FTIR. One interesting pattern observed was that the red-colored lobster tags were showing more degradation while the blue-colored tags were showing the least degradation, suggesting an important role of pigments and additives in degradation.

Keywords: degradation, microplastics, plastic litter, polyethylene, polypropylene, weathering.

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Degradation Control in Bio-based Polycarbonate

Dipannita Ghosh, Seema Agarwal*

Department of Macromolecular Chemistry II, University of Bayreuth, Universitätsstraße 30, 95447 Bayreuth, Germany

E-mail: dipannita.ghosh@uni-bayreuth.de

Poly (limonene carbonate) (PLimC) is a biobased polymer prepared by reaction of limonene oxide (LO) obtained from chemical modification of waste orange shell and carbon dioxide (CO_2). The utility of PLimC for real world application as environment friendly polymer can be enhanced by introducing biodegradation. In this present talk chemical approaches to make PLimC biodegradable will be discussed. One of the main approaches is introducing phase separated morphologies for faster degradation achieved by preparing graft polymer architecture. In-depth characterization like structural, molecular, and thermal of the graft copolymers were done by nuclear magnetic resonance spectroscopy (NMR), gel permeation chromatography (GPC), thermal gravimetry analysis (TGA), differential scanning calorimetry (DSC) and morphological study has been done by transmission electron microscopy (TEM). The prepared films were also characterized for their hydrophilicity by checking the contact angle. Degradation test for the polymer films were carried out under controlled condition using different enzymes for a time period. Percentage of biodegradation was calculated by monitoring the production of CO_2 from the polymer in waste water for 28 days. The details will be presented in the poster and talk.

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Electrostatic separation of Nanoplastics from wastewater

Amna Abdeljaoued[1,2], Beatriz López Ruiz[1,2], Yikalo-Eyob Tecle[1], Patrik Stenner[1], Nicolas Vogel[2]

1) Particle Processing, Process Technology & Engineering, Evonik Operations GmbH, Rodenbacher Chaussee 4, Wolfgang 63457, Germany.

2) Institute of Particle Technology, Friedrich–Alexander-Universität Erlangen–Nürnberg, Cauerstrasse 4, 91058 Erlangen, Germany.

Microplastics, generated by the degradation of plastic waste, have been found in nearly all ecosystems around the globe and continue to raise concerns as a widespread pollutant. Such micron-sized particles, however, may only be the tip of the iceberg. Nanoplastics, represent the nanoscale size of these tiny particles. With sizes much smaller than 1µm, they may be even more environmentally problematic as such particles may be taken up and interfere with individual cells of organisms. However, their small size makes identification and removal much more challenging compared to conventional microplastics. Therefore, the research field of Nano plastics is still in its infancy. In the current work, we aim to remove Nano plastic materials from wastewater by taking advantage of their colloidal properties. We employ electrophoretic deposition and particle-stabilized foams as techniques to remove such particles from an aqueous phase. A model system has been used as a starting point to have a control over all the influencing parameters and to provide a basic understanding of the separation mechanism. These insights are subsequently transferred to industrial wastewater and eye glass polishing wastewater as real environmental systems. Both model system and industrial wastewater have been efficiently treated and cleaned from nanoparticles. The recovery percentage reached 98% and 95% from the model system and the industrial wastewater systems. A roller system has been used to scale up the wastewater cleaning process. It consists of a cylindrical anode; that is replenished periodically by removing the deposited Nanoplastics via a collector. Different concentrations of the PMMA model system were treated, achieving 91% recovery at an initial concentration of 1 wt.%. An Industrial wastewater, highly loaded with Nanoplastics (7wt.%); resulted in an average of 86% Nanoplastics recovery in 2hours. The eyeglass polishing wastewater, representing an heterogenous system of both micro and nano-plastics from different materials, has reached a recovery up to 59% during an initial treatment despite its challenging complex composition and particles size.

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Plastic emission during strawberry cultivation in Germany

Based on the publication Galafton, Christina; Maga, Daniel; Sonnemann, Guido; Thonemann, Nils (under review): Life cycle assessment of strawberry production in Germany with a particular focus on plastic emissions. In Int J Life Cycle Assess.

Presenting author: Christina Galafton

In agriculture, the usage of plastics (so-called plasticulture) serves several purposes, such asadvancing or prolonging the cultivation period, inhibiting weed growth, lowering water and nutrient demand, and protecting plants from weather impacts. While these purposes are mostly driven by economic objectives, plasticulture may also influence the cultivation's environmental impacts and cause unintended emission of plastic pieces or particles to the environment via the erosion or incomplete removal of the plastic materials. We conducted a life cycle assessment (LCA) to assess and compare the environmental impacts of different plasticulture methods to help farmers determine the cultivation technique with the least environmental impact. We compared a baseline scenario without plasticulture to 11 plasticulture scenarios, considering also a rather new assessment method for plastic pollution.

Based on our findings, plasticulture during strawberry cultivation increases the yield and reduces the environmental impacts compared to open field cultivation. The lowest total environmental impact score is calculated for the scenario combining row covers with conventional mulch film. The impacts of the scenarios using a macro tunnel and greenhouse are the highest. To the farmers' convenience, the scenario with the highest yield has one of the lowest environmental impacts. When applying normalization and weighting, plastic pollution makes up a considerable share of the overall environmental impact of strawberry cultivation, indicating a need to include plastic pollution in LCA by further developing the methodology.

Keywords: PEF, environmental footprint, carbon footprint, agriculture, mulching, tunnel, greenhouse, plasticulture, plastic pollution

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The challenge of reducing (micro)plastic emissions: Possible contribution of consumers and recommendations for effective policy interventions

Linda Mederake, Doris Knoblauch

1 - Ecologic Institute (Pfalzburger Str. 43/44 10717 Berlin Germany)

Frequently, media communication and political measures to reduce (micro)plastic emissions focus on the responsibility of private consumers. But to what extent are those actually able to make a significant contribution to the reduction of (micro)plastic emissions? Drawing on results from several interdisciplinary research projects funded under the German research focus “Plastics in the Environment”, this presentation will share insights regarding the patterns of societal perception and behavior in dealing with (micro)plastics as well as the scope for action of different actors to reduce (micro)plastic emissions into the environment. The respective results show, for instance, that private consumers are generally highly aware of the environmental impact of microplastics. Nevertheless, their own contribution to the input of microplastics into the environment is only known in relation to certain product groups. Hence, their scope for action is rated very unevenly depending on the product group. What is more, a change in product demand by consumers alone does neither sufficiently stimulate companies to make plastics avoidance a key task in their product design, nor does additional information on products (e. g. on correct disposal) automatically lead to "correct", environmentally conscious behavior.

Appealing to the responsibility of private consumers, whose options for exerting influence are severely limited and mostly confined to the use phase of plastic products, is therefore not sufficient. Instead, (micro)plastics regulation should address all stages of the plastics life cycle including raw material extraction, plastic production, product design, trade, consumer behavior, recycling and waste management, wastewater management, as well as water and marine protection. Thus, (micro)plastics need to be regulated at the intersection of different policy fields including, among others, marine and water policy, chemical policy, and waste policy. Based on the findings from the various interdisciplinary research projects, the presentation sheds light on the crucial target points for future (micro)plastics regulation and provides policy recommendations for effective policy interventions to reduce (micro)plastic emissions in freshwater ecosystems and beyond, with a focus on the national and European level.

Keywords: microplastics, societal perceptions, consumer behavior, plastics regulation, policy interventions

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Keynote Speech: Prof. Richard Thompson
8th March - 14:00 – 14:30

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Plastic Litter: what progress are we making to solving this global environmental challenge?

Richard C. Thompson, University of Plymouth, UK

Plastic debris is widely distributed at the sea surface, on the sea bed and on shorelines. Over 700 species are known to encounter marine litter, with many reports of physical harm resulting from entanglement in and ingestion of plastic. At the same time it is very clear that plastic items bring many societal benefits. Can these benefits be achieved without emissions of waste to the environment? Progress requires systemic changes in the way we design, produce, use and dispose of plastic. Is the UN plastics treaty om track to deliver?

Keywords: microplastic, solutions, policy, sustainable production and consumption

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Posters

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The clone wars: *Daphnia magna* clones react differently to microplastic exposure under food limitation

Simona Mondellini[1,2,a], Michael Schwarzer[1,2,a], Gabriël Olthof[3], Marvin Kiene[1,2], Martin G.J. Löder[1,2], Martin Wagner[3], Christian Laforsch[1,2,*]

[1] Department of Animal Ecology I, University of Bayreuth (UBT), Universitätsstraße 30 95447, Bayreuth (Germany)

[2] BayCEER, University of Bayreuth (UBT), Universitätsstraße 30 95447, Bayreuth (Germany)

[3] Department of Biology, Norwegian University of Science and Technology (NTNU), 7491 Trondheim (Norway)

[a] These authors contributed equally to this publication

[*] Corresponding author

Investigations of the ecotoxicological effects of microplastics (MP) on the parthenogenetic freshwater organism *Daphnia magna* often report a wide variety of effects. While the different physicochemical properties of polymers produced by various manufacturers certainly contribute to this, variations of clonal sensitivities, as well as other interacting stressors, are hardly ever considered in experimental designs. Therefore, this work aims to investigate the sensitivity of two clonal *D. magna* strains (BL2.2 and Aig) to the effects of a chronic MP exposure combined with food limitation. The effects of a conventional polymer (PET, <20 µm) were compared to two biodegradable ones (PBS and PDLLA, < 20µm) using cellulose fragments (<20 µm) as a natural particle control. The parameters investigated were life-history traits, morphological parameters and mortality. Food limitation was induced by providing a food concentration of 0.5 mg C L^{-1} every other day. We found significant differences between the two clonal strains on all the measured sublethal parameters, showing that the Aig clone is more vulnerable to the selected stressors. Furthermore, biodegradable polymers appear to exert a higher negative impact on life-history traits compared to PET. Given these results, we believe that genetic variability and combined stressors need to be considered in MP ecotoxicological investigations on *D. magna*.

Keywords: Multiple stressors, microplastic, *Daphnia* clones, biodegradable, clone-specific differences

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Chronic poly(L-lactide) (PLA)- microplastic ingestion affects social behavior of juvenile European perch (Perca fluviatilis)

Azora König Kardgar[1], Dipannita Ghosh[2], Joachim Sturve[1], Seema Agarwal[2], Bethanie Carney Almroth[1]

[1]Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden

[2]Macromolecular Chemistry II, University of Bayreuth, Bayreuth, Germany

Juvenile perch were exposed to 2 % (w/w) poly(L-lactide) (PLA) microplastic particles (90-150 µm) in food pellets, or 2 % (w/w) kaolin particles, and a non-particle control food over 6 months. Chronic ingestion of PLA microplastics significantly affected the social behavior of juvenile perch, evident as a stronger reaction to conspecifics. PLA ingestion did not alter life cycle parameters, or gene expression levels. In addition to reactions to conspecifics, fish that ingested microplastic particles showed tendencies to decrease locomotion, internal schooling distance, and active predator responses. The ingestion of natural particles (kaolin) significantly downregulated the expression of genes related to oxidative stress and androgenesis in the liver of juvenile perch, and we found tendencies to downregulated expression of genes related to xenobiotic response, inflammatory response, and thyroid disruption. The present study demonstrated the importance of natural particle inclusion and the potential behavioral toxicity of one of the commercially available biobased and biodegradable polymers.

Keywords: biobased polymer, PLA, microplastic, toxicity, fish behavior, chronic exposure

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To buy (sustainable) or not to buy? Young consumer views on fashion purchases and microplastics in the UK

Maja Grünzner **1, *,** @ , Sabine Pahl **1,** @ , Mathew White **1,** @ , Kayleigh Wyles **2,** @ , Richard Thompson **2,** @

1 : University of Vienna (UniVie); 2: University of Plymouth (UoP)

Fashion contributes to pollution worldwide. Synthetic microfibres are one of the major microplastics sources in European rivers and experts working in the field of plastic research rated textile fibres as one of the riskiest microplastics sources for the natural environment and human health. Additionally, fast fashion – which is mainly using synthetic fibres and harmful chemicals – has taken over the clothing market and young fashion consumers (Millennials and Generation Z) are a demographic with great spending power in this market. Hence, exploring their motivations in clothing purchases can be the first step to find behavioural intervention entry-points to mitigate microplastics pollution. Therefore, we conducted semi-structured interviews with N = 17 participants (aged 19-33) to explore, in-depth, the perceptions and motivations of young fashion consumers concerning their purchases as well as their awareness of the potential environmental impact of their clothing choices. We carried out the interviews in Plymouth, UK between November 5th and December 14th 2021. The interview guide was partly inspired by the stage model of self-regulated behavioural change and the interview transcripts are analysed with reflexive thematic analysis. Preliminary analysis reveals that contextual constraints such as price as well as emotional motives and their coping strategies communicated as "retail therapy" play a role. The final analysis still needs to be completed in which we are categorising the consumer's perceptions towards their clothing purchases under consideration of sustainable purchase practices (e.g. reducing consumption, buying second-hand or purchasing recycled/ organic materials) and their thoughts on labelling as well as microplastics pollution. The results can inform about young fashion consumers – psychological and contextual – drivers and barriers of sustainable clothing consumption and foster the development of behavioural interventions to increase sustainable purchase practices within this target group.

Keywords: Clothing consumption, fashion, microplastics, behaviour change, sustainability, thematic analysis

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Microplastic abundance in the Rhine floodplains determined by local topography and flood frequency

Laermanns Hannes <h.laermanns@uni-koeln.de> (1), Rolf Markus <markus.rolf@uni-koeln.de> (1), Horn Julia <juhobr@gmail.com> (1), Kienzler Lukas <lulaskienzler@aol.com> (1), Dierkes Georg <dierkes@bafg.de> (2), Kernchen Sarmite <Sarmite.Kernchen@uni-bayreuth.de> (3), Möller Julia <julia.moeller@uni-bayreuth.de> (3), Laforsch Christian <christian.laforsch@uni-bayreuth.de> (3), Löder Martin <martin.loeder@uni-bayreuth.de> (3), Bogner Christina <christina.bogner@uni-koeln.de> (1)

1 - Institute of Geography, University of Cologne (Albertus Magnus Platz 50923 Köln Germany), 2 - Bundesanstalt für Gewässerkunde (Am Mainzer Tor 1 56068 Koblenz Germany), 3 - Animal Ecology I, BayCEER, University of Bayreuth (95540 Bayreuth, Germany Germany)

Rivers are major pathways for microplastic transport towards the ocean, but serve also as potential microplastic sinks. Especially their adjacent floodplains are influenced by reoccurring floodings that enhance the re-mobilization and deposition processes of microplastic particles. Through erosion and deposition processes, floods also have an impact on floodplain morphology and result in relatively flat topographies. Hence, local topography and flood frequency influence microplastics deposition in these important interfaces between fluvial and terrestrial ecosystems. In microplastic research, the aspect of the interplay between flood frequency and topography has not been fully considered yet. Therefore, we analysed a time series of Rhine water level and set up a hydrodynamic flood model to study the flood frequency of three different Rhine floodplains within the municipal area of Cologne, Germany. All sites are grasslands meadows within nature reserves or conservation areas with restricted use. We sampled soil in a depth of 5-20 cm along three transects in different distances parallel to the river in each Rhine floodplain. We analysed the samples for their microplastic abundance with pyr-GC/MS and FTIR. Our results indicate that the highest abundance of microplastics occurs in the farthest transects from the Rhine with the lowest flood frequencies and the highest flood water levels, depending on their local topography. Consequently, we are able to identify microplastic sinks with the most used analytical methods in microplastic research (pyr-GC/MS & FTIR) and explain their occurrence and distribution with the flooding frequency, local topography and distance to potential sources. This information is essential for ecological risk assessments at the interface of freshwater and terrestrial ecosystems.

Keywords: floodplains, flooding, topography, microplastic accumulation, pyr, GC/MS, FTIR

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Microplastics in waterbodies and its impacts on human blood components probed by Raman Tweezers Spectroscopy

Lukose Jijo <jijo.lukose@manipal.edu> (1), N Mithun <mithun.nelliat@learner.manipal.edu> (1), Nair Manju P <dr.manjupnair@gmail.com> (2), Gopinath Anu <dranugopinat@gmail.com> (2), Mohan Ganesh <drganeshmohan@gmail.com> (3), Shastry Shamee <shamee.girish@manipal.edu> (3), Chidangil Santhosh <santhosh.cls@manipal.edu> (1)

1 - Department of Atomic and Molecular Physics, Manipal Academy of Higher Education (Centre of Excellence for Biophotonics, India - 576104. India), 2 - Kerala University of Fisheries and Ocean Studies (India), 3 - Kasturba Medical College, Manipal, (India)

Microplastics detection and identification is a topic of utmost importance due to its impact in aquatic and terrestrial environment. It is also of paramount importance to investigate the toxicity impacts of microplastics and related additives on the aquatic animals (e.g. fish), and human beings. Raman Tweezers spectroscopy combines with optical tweezers with micro-Raman spectroscopy, where the micron sized particle in aqueous solution will be trapped using a laser beam and probed/characterized by using Raman spectroscopy. This technique can be of paramount importance since micro-Raman spectroscopy can be used for the identification of micro-plastics from various waterbodies, whereas the same technique can be extended to investigate the impacts of exogenous agents on blood components. MicroRaman spectroscopy makes it possible to determine the molecular level structural details of samples and this method involves minimum sample preparation and is non-destructive, enabling quick analysis. In the present work, we have used a lab-built Raman Tweezers setup for the identification of micro plastics from various waterbodies. The identification of Polystyrene (PS), Polyethylene Terephthalate (PET), High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Polypropylene, polyethylene vinyl acetate etc. have been found to be quite successful using the Micro-Raman spectroscopy. Due to changes in the CH stretching vibrations, the Micro-Raman analysis demonstrated the ability to distinguish between high-density polyethylene and low-density polyethylene microplastics. The same experimental setup has been also used to probe the adverse impact of Bisphenol A (BPA) on human red blood cells at single cell level. BPA is a potential endocrine disruptor which is widely used in the production of various plastics. BPA, one can enter the bloodstream both orally and non-orally through a variety of mechanisms, according to studies. Raman spectra showed significant intensity changes for oxygenated haemoglobin indicator peaks present at 1209, 1222, 1544, 1561, 1375, 1397 cm-1 etc. Moreover, Raman signature corresponding to haemoglobin depletion was also observed in the spectra. RBCs exhibit clear morphological changes as a result of BPA in vitro exposures, which eventually cause cell bursting at higher concentrations. This has proved the capability of Raman Tweezers spectroscopy for investigating the identity and adverse impacts of microplastics.

Keywords: Microplastics, Micro, Raman Spectroscopy, Bisphenol A, Optical Tweezers, Red Blood

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Artificial intelligence for predicting degradation of microplastics

Awade Mohnish <mohnishawade@gmail.com> (1)

1 - Mohnish Awade (Nanaoska Ulica 21 Slovenia)

Plastics thrown by humans will be converted into microplastics, eaten by animals and fish, and finally, entered into humans in micro or nano form once humans eat these animals, putting the entire life of humans at unprecedented risk. Our goal is to present approaches and models for the prediction of the degradation of microplastics using artificial intelligence and machine learning. From the input data of different types of plastic materials, such as FTIR spectroscopy to determine degradation patterns such as SAUB(Surface area under band) patterns, we are trying to develop the predictive models for these degradation properties. The web platform for all possible functionality in handling the data, preprocessing it, and modeling the data in order to classify and predict the time series(trends and cycle) of the microplastic life cycle and make the collective prediction of different types of samples. Over the platform,m will result as a catalyst in microplastics research and understanding. The model is also available in open-source licenses in the public domain.

Keywords: Degradation Prediction, AI/ML, Time, series

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A feeding assay based on microplastic ingestion

Giannouli Maria <maria.giannouli2@mail.dcu.ie> (1), Panagiotidis Konstantinos <konstantinos.panagiotidis@dcu.ie>, Grintzalis Konstantinos konstantinos.gkrintzalis@dcu.ie

1 - Dublin City University (School of Biotechnology, Glansevin campus, Ireland)

The toxicological hazard and safety assessment of chemical substances heavily relies on the outcome of animal testing. In such approaches a combination of mortality, phenotypic and molecular endpoints are employed. However, animal welfare considerations, societal concerns, regulatory action and the desire by industry to bring safe products to the market without the use of experimental animals has triggered the need to use new methodologies and approaches to risk assessment. In this context, non-invasive tests and models species which are not categorized as animals can be used to reduce the use of higher animals according to the 3Rs principle. Such tests can provide meaningful conclusions with faster and economical approaches. Focusing on the freshwater ecosystem and aquatic pollution, daphnids have been extensively used for toxicological studies. One parameter often neglected is feeding performance upon exposure to pollutants. Feeding impairment would reveal early alterations in the physiology, thus providing insight for further investigation. In this study, a novel and sensitive approach was develop to quantify feeding rate based on the ingestion of fluorescent microparticles. Volume, microparticle concentration and animal number was optimised for the performance of the test, which was applied to a number of exposure conditions.

Keywords: microplastics, feeding rate, ingestion, daphnids, risk assessment

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Investigation of microplastics from an urban river in Germany – solving the challenge of organic-rich suspended matter samples

Faikhaw Orasai <orasai.faikhaw@ufz.de> (1), Wagner Stephan <stephan.wagner@hs-fresenius.de> (2), Rynek Robby <robby.rynek@ufz.de> (1), Platzek Paul <paul.platzek@ufz.de> (1), Materic Dusan <dusan.materic@ufz.de> (1), Reemtsma Thorsten <thorsten.reemtsma@ufz.de> (3) (1)

1 - Department of Analytical Chemistry, Helmholtz Centre for Environmental Research (Germany), 2 - Institute for Analytical Research, Hochschule Fresenius (Germany), 3 - Institute of Analytical Chemistry, University of Leipzig (Germany)

In recent years, an increasing number of studies have documented the contamination of microplastics in the freshwater ecosystem including in lotic systems such as lakes and ponds and lentic systems such as streams and rivers. Rivers are often in close proximity to point sources, thus considered as a transport pathway of land-derived plastic to the ocean. Furthermore, they serve as both (temporary) sinks for land-based plastic pollution, as well as future sources due to remobilization. However, the research thus far mainly focuses on larger rivers, while the situation in smaller rivers is poorly understood.
Samples from freshwater bodies are often rich in natural particles, which complicate a subsequent microplastic analysis using micro-Fourier-transform infrared spectroscopy (μ-FTIR). The extraction of microplastics from the samples while preserving them is challenging, especially the removal of suspended organic matter particles, which mainly have a density in the same range as most common plastics and are also not possible to remove without chemical digestion. Thus far, several organic matter removal procedures for microplastic analysis have been established. However, each river has its own characteristics which vary spatially and temporally resulting in different compositions and concentrations of organic particles.
In the present study, the dynamics of microplastic contamination of an urban sub-catchment, the Parthe river, is investigated. The river originates southeast of the city of Leipzig, Germany, and passes through several towns mainly characterized by urban and agricultural land use. In this work, a fractionated filtration sampling device was developed to collect the suspended matter. Samples were collected every month for one year to cover all seasons. To find an appropriate procedure to remove the sample matrix, method optimizations were performed. Since the samples are rich in suspended organic matter, mainly plant debris, existing (ligno)cellulosic digestion/oxidation methods were tested and optimized including enzymatic-oxidative digestion, Fenton's oxidation, cellulose dissolution with a mixture of NaOH, urea, and thiourea prior to Fenton's oxidation, and oxidation by NaOCl. From these, NaOCl treatment showed the highest efficiency of organic matter removal particularly plant debris, eliminating up to 97 % weight of the organic matrix. To validate the plastic particle preservation, potential destructive effects on microplastics were analyzed. For this, virgin plastic particles sized 100 – 500 μm of polypropylene (PP), polyethylene (PE), and polystyrene (PS) as well as polyamide (PA) in a size range of 10 – 50 μm were used to investigate visual integrity and changes in the functional group on the plastic surfaces via attenuated total reflectance FTIR. In addition, changes in the morphological surface structure of microplastics were examined by using a scanning electron microscope. Exposure of the virgin plastics to NaOCl oxidation showed no FTIR spectra and surface structure changes. Consequently, samples were treated with NaOCl followed by density separation for determining microplastic concentration using μ-FTIR. According to preliminary results, microplastics in the Parthe river samples are predominantly PP and PE.

Keywords: sample preparation, freshwater, plastics pollution dynamics, river catchment, emission

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Microplastic particle properties and their correlation with cellular interactions

Jasinski Julia <julia.jasinski@bm.uni-bayreuth.de> (1), Völkl Matthias <matthias.voelkl@uni-bayreuth.de> (1), Wilde Magdalena V. <wilde@genzentrum.lmu.de> (3), Jérôme Valérie <valerie.jerome@uni-bayreuth.de> (1), Fröhlich Thomas <frohlich@genzentrum.lmu.de> (2), Freitag Ruth <ruth.freitag@uni-bayreuth.de> (1), Scheibel Thomas <thomas.scheibel@bm.uni-bayreuth.de> (1)

1 Biomaterials, University of Bayreuth, (Germany), 3 -Gene Center Munich, Laboratory for Functional Genome Analysis (LAFUGA), (Germany), 1

Background and novelty Microplastics (size range: 1 μm – 5 mm) can result from larger plastic fragments by abrasion or weathering due to environmental influences. Microplastic particles (MPP) can enter the organism through food uptake or the air we breathe. Various studies have already shown an accumulation of MPP in various organs. However, it is still not clear how long polymer particles remain in the body, under what conditions they can be excreted again, and what effects they cause in the organism. Since microplastics are very complex, it has not yet been possible to assess their effects fully. Numerous studies in recent years analysed the effect of commercially available MPP *in vitro* using model cell lines. Surprisingly, different and often even contradictory outcomes were revealed even when the same polymers or size ranges were used. In our work, we aimed to correlate cellular interaction and effects with well-characterized physicochemical properties of MPPs (e.g., surface properties and protein corona).

Experimental approach We used murine macrophages and epithelial cell lines and investigated the particle-cell interaction (PCI) using flow cytometry and the MPP ingestion using confocal microscopy. The particles' surface properties were investigated using DLS and ζ-potential measurements, as well as electron microscopy. LC-MS/MS-based proteomic analysis allowed to determine the protein corona composition.

Results and discussion

Particle ingestion and its effects on cells are highly dependent on the particles' physicochemical properties and the cell type. While epithelial cells showed only little PCI, macrophages engulfed a high number of particles (1). This interaction process could be shown to be sizedependent and highly related to the respective ζ-potential (2), as well as the protein corona (3). The particles' history influenced the protein corona formation and, based on that, the PCI with epithelial cells. Interestingly, not only the ζ-potential but also surface charge density played a crucial role in PCI. Subsequently, the number of engulfed MPs critically influenced the intensity of induced cellular responses. While there were few to non-noxious effects of the particles on epithelial cells, macrophages showed PCI-dependent various biological response effects.

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Keywords: microplastic particles, cellular ingestion, particle surface, protein corona

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Microplastics in food and drinking water: Knowledge and perceptions of different stakeholders along the human food chain

Fian Leonie <leonie.fian@univie.ac.at> (1), Pahl Sabine <sabine.pahl@univie.ac.at>, Felt Ulrike ulrike.felt@univie.ac.at

University of Vienna (UniVie)

While microplastics (MPs) have recently been found in different food products and drinking water, to date, considerable knowledge gaps exist regarding a standardised identification, relevant sources and pathways, quantities as well as potential toxicity for humans. Public concern, however, has been found to be high, although with so far limited studies investigating concern regarding human health. With respect to calls for higher involvement of public opinion into policy making, efforts to gain insight into different stakeholders' perspectives are pivotal. Specifically, we aim to explore (1) knowledge about characteristics, causes and consequences of MPs (in food and drinking water); (2) perceptions and thoughts on: perceived scientific consensus, concern, social norms, emotions; (3) thoughts about potential measures to avoid/reduce MPs in the food chain; and (4) people's willingness to accept policies aiming to avoid/reduce MPs.
Therefore, we will conduct *N* ˜ 30 semi-structured interviews with representatives of the areas of food production/harvesting, processing/packaging, distribution/hospitality, consumption and regulation in Austria. Data collection will start in November 2022. The interview guide was developed largely inspired by the Climate Change Risk Perception Model and the interview transcripts will be analysed using Thematic Qualitative Analysis.

Preliminary findings of the qualitative interviews will be reported.
In order to develop and implement measures that will be widely accepted, gaining knowledge of experiences of those affected is key, and of particular relevance when scientific knowledge is scarce. Our results will provide in-depth insight into relevant stakeholders' knowledge and perceptions of microplastics in food and drinking water, potential human health effects as well as ways to reduce or avoid microplastics in the human food chain.

Keywords: microplastics, food, drinking water, human health, policy support, thematic qualitative analysis

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The impact of amine and carboxyl functionalised microplastics on the physiology of daphniids

Panagiotidis Konstantinos <konstantinos.panagiotidis@dcu.ie> (1), Krauss Martin <martin.krauss@ufz.de> (2), Altenburger Rolf <rolf.altenburger@ufz.de> (3), Rochfort Keith D <keith.rochfort@dcu.ie> (4), Grintzalis Konstantinos <konstantinos.gkrintzalis@dcu.ie> (1)

1 - School of Biotechnology, Dublin City University (Ireland), 2 - Department of Effect-Directed Analysis [UFZ Leipzig] (Germany), 3 - Department of Bioanalytical Ecotoxicology [UFZ Leipzig] (Germany), 4 - School of Nursing, Psychotherapy and Community Health, Dublin City University [Dublin] (Ireland)

Plastic waste is considered a major threat for terrestrial, marine and freshwater ecosystems. Ingestion of microparticles resulting from plastic degradation can lead to their trophic transfer raising serious health concerns. Here, the effect of amine- and carboxy functionalized polystyrene microparticles on daphnid physiology was investigated. Carboxy functionalized microparticles showed higher toxicity in acute exposures compared to their amine counterparts. Accumulation of both microparticles in animal gut was confirmed by stereo-microscopy as well as fluorescent microscopy which showed no presence of particles in the rest of the animal. Fluorescence based quantification of microparticles extracted from animal lysates validated their concentration-dependent uptake. Additionally, daphnid exposure to amineand carboxy functionalized microparticles resulted in increased activity of key enzymes related to metabolism and detoxification. Finally, an untargeted metabolomic analysis revealed significant metabolic perturbations from exposure to microplastics.

Keywords: Daphnia magna, silver nano, inks, toxicity, mortality

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Can the invasive Zebra mussel (Dreissena polymorpha) be used as a biological indicator of microplastic contamination in the River Thames (UK) ecosystem?

Andrews Stephanie <sa728@exeter.ac.uk> (1), Lewis Ceri <c.n.lewis@exeter.ac.uk> (1), Galloway Tamara <t.s.galloway@exeter.ac.uk> (1)

1 - University of Exeter (Biosciences, United Kingdom)

Rivers are a major route for the translocation of microplastics from the terrestrial to the marine environment. It is important to understand the abundance and distribution of microplastics in these systems but despite this, we know little of the distribution of microplastics in rivers or of their bio-accumulation in freshwater organisms. This study aims to determine if the invasive Zebra mussel (*Dreissena polymorpha*) can be used as a biological indicator of microplastic contamination in the River Thames ecosystem. The River Thames is the second largest river in the UK and has multiple anthropogenic stressors and pathways of potential microplastic contamination along its trajectory. Zebra mussels are one of the many invasive species that are present in the waters of the River Thames. Zebra mussels were collected from the river in June 2021 and depurated for 48 hours, after which they were deployed in cages at the surface and bottom of the river at two sampling sites for a period of 7 days. Water samples were collected from both sampling sites and depths over the 7 day deployment. Resulting data is being used to compare microplastic contamination between native and invasive filter feeding species collected dirrectly from the river. It will also explore differences in microplastic contamination and morphology in deployed Zebra mussels, and surface and bottom waters across two locations. The results will establish if the invasive Zebra mussel can be used as a passive biological indicator of microplastic contamination in the River Thames ecosytem.

Keywords: Bioindicator, Monitoring, Invasive species, River Thames (UK).

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Assessment of microplastic pollution in the marine regions of Morocco, Phase I: table sea salt

Hamid Amsil[a], Nakach Farouk[b], Abdessamad Didi[a], Hamid Bounouira[a], Iliasse Aarab[a], Abdelwahab Badague[a], Khalid Laraki[a], Lalla Btissam Drissi[b], Rachid ahl lamara[b]

(a) National Centre for Nuclear Energy, Science and Technology (CNESTEN), B.P. 1382, R.P. 10001, Rabat, Morocco
(b) Faculty of Sciences, Mohammed, V University, 4 Avenue Ibn Battouta, B.P. 1014, Rabat, Morocco

In order to assess the level of plastic pollution in the two Moroccan marine regions (Mediterranean and Atlantic sides), an optimistic approach was followed by the analysis of table salt of marine origin. Eleven brands of table sea salt from 8 different regions of Morocco with 2 from two anonymous foreign countries brands are used for comparison. The preliminary preparation is based mainly on the separation of microplastics in relation to their sizes by a simple filtration process. Identification is first performed visually, then using an optical microscope and finally using a scanning electron microscope. All of the commercial salt samples analysed contained Microplastics in the form of fibres and/or aggregates, with concentrations ranging between 240.8 and 789.00 particles/Kg of salt weight.

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Chemicals in plastic food packaging target cell – surface receptors

Mcpartland Molly <molly.mcpartland@ntnu.no> (1), Stevens Sarah <sarah.stevens@ntnu.no> (1), Vardeberg Ingrid <ingridgv@stud.ntnu.no> (1), Völker Johannes <johannes.voelker@ntnu.no> (1), Wagner Martin <martin.wagner@ntnu.no> (1)

1 - Norwegian University of Science and Technology (Høgskoleringen 5 Norway)

Plastics contain complex chemical mixtures that leach into liquids or solids through migration or volatilization, and are, thus, a source of human exposure to synthetic chemicals. Such exposure is concerning as plastic chemicals mimic, block, or interfere with our bodies' cellular receptors thereby mediating responses associated with an increased prevalence of non-communicable diseases (reviewed by Kumar et al., 2020). Indeed, plastic chemicals have long been known to disrupt nuclear receptors, however, receptor-mediated toxicity also occurs via nongenomic pathways, specifically targeting G – protein coupled receptors (Le Ferrec & Øvrevik, 2018; Suteau et al., 2021). In this work, we provide the first large-scale screen to address if plastic chemicals are biologically active GPCR agonists. We further aim to investigate; (1) whether specific polymer types have higher incidences of GPCR agonism, and (2) whether specific GPCR agonists can be identified from the overall complex mixture. Using both well-known plastic chemicals and real-world mixtures of plastic chemicals, we performed an *in vitro* screen of 135 GPCRs. We identified several novel GPCRs as targets of plastic chemicals, including the Melatonin 1 (MT1), Melatonin 2 (MT2), and ADORA1 (AA1) receptors. We further demonstrate that specific polyvinyl chloride and polyurethane plastic products contain MT1 and ADORA1 agonists, however, generalized concentration addition modeling indicates the presence of antagonists as well. We attempted to further identify specific active chemicals within our mixture by docking all identified compounds (330) against three crystal structures of MT1. Using a process of elimination workflow, we identified bis(2-ethylhexyl) phthalate (DEHP) as a top hit within our mixture. Finally, to further understand the biological implications of our work, we performed a gene ontology analysis to identify the commonality between MT1, MT2, and ADORA1. The most prominent, shared biological processes function to align circadian and rhythmic behaviors, thereby indicating plastic chemicals may also act as circadian disrupting chemicals with the potential to alter cellular, physiological, and behavior processes that oscillate in a 24-hour cycle. Considering our continued and increasing production and usage of plastics (OECD, 2022), our results are a compelling demonstration of the necessity of continued research to identify active chemicals, downstream effects, and their overall contribution to non – communicable diseases.

Keywords: Plastic, chemicals, cell, surface receptors, endocrine disruption, circadian

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Developing nano plastics models to study their fate in the environment

Manju Sudheer Malavika <malavika.manjusudheer@iit.it> (1), Fragouli Despina <despina.fragouli@iit.it> (1)

1 - Smart Materials, Istituto Italiano di Tecnologia (Italy)

Plastic has become inevitable in our daily lives as it is used in myriad applications due to its excellent properties, such as its lightweight, durability, and versatility1. However, despite its outstanding features, the end-of-life fate of most plastics is currently less than ideal. The effects of the uncontrolled use of conventional plastics on the environment are multiple, including the depletion of petrochemical resources, greenhouse gas emissions, and, most importantly, the accumulation of plastic waste in the ecosystems. Once the plastic accumulates in the environment, it can undergo fragmentation and degradation due to biotic and abiotic processes, eventually forming microplastics and nanoplastics (NPs). These contaminants are of emerging concern, adversely affecting the ecosystem and human health. In this context, it is essential to have a deepened understanding of the environmental fate of these NPs. The strategy proposed herein offers the possibility to fabricate NPs, with similar characteristics as the ones expected to be found in the environment for detailed studies of their fate2. We focus on forming NPs from common plastics through a top-down approach with bulk polymeric film. Upon laser ablation (LA) in an aqueous environment, using a pulsed UV laser, the film releases polymeric fragments in the nanometric size range, with physicochemical properties similar to the ones of the NPs produced by micro and nano plastics following the photodegradation pathway that may occur in a realistic environment. Such a method allows the fabrication of NPs without using chemicals and precursors and has surface chemistry as one of the environmental samples2,3. This research offers the opportunity to perform realistic studies on NPs, such as their interaction with other pollutants, cytotoxicity, and the effects on organisms in a three-dimensional space.

Keywords: Laser ablation, nano plastics

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Interaction between agri-microplastics and agricultural pesticide residues

Sahai Harshit <harshit95@gmail.com> (1), Hernando María Dolores <dolores.hernando@csic.es> (1), Aguilera Del Real Ana M. <aaguiler@ual.es> (2), Fernández- Alba Amadeo R. <amadeo@ual.es> (2)

1 - National Institute for Agricultural and Food Research and Technology (Spain), 2 - Universidad de Almería (Spain)

The annual input of microplastics to farmlands in Europe and North America is approximately 63,000-430,000 and 44,000-300,000 tonnes, respectively (Nizzetto et al., 2016). The application of sewage sludge, reused wastewater from treatment facilities (WWTPs) for irrigation, atmospheric deposition, and the usage of plastics for diverse agricultural operations are the main sources of microplastics in the agricultural ecosystem. Some reports suggest that agricultural soils could be an even greater sink for microplastics than marine environments. Yet, the interactions, vector effects, and direct and indirect effects of these microand nano-plastics on agriculture remain largely understudied.

Due to their high specific surface areas, microplastics can interact with contaminants in the environment which may sorb onto the particle. This entire sorbate-MP interaction process is a complicated phenomenon that is influenced by a number of physicochemical parameters of the sorbate and MP particles and/or their combinations. It also involves a variety of underlying forces including hydrophobic partitioning, electrostatic forces, van der Waals forces, H-bonding, π-π interactions, and others. Furthermore, commercial agricultural plastics contain a variety of additives, such as plasticizers, pigments, UV stabilizers, flame retardants, antioxidants, and other substances that provide polymers with various physical, chemical, and structural properties depending on their intended use. This ultimately affects the interactions, and in turn, the long-term fate and bioavailability of these contaminants.

The current investigation looked at the sorption behaviour of several pesticides and polycyclic aromatic hydrocarbons (PAHs) on model and agricultural microplastic samples. Pure polyethylene microspheres showed sorption (0-84%) of these compounds; however, under the same conditions, there was a considerable increase in sorption in the case of agricultural microplastics (2-91%). A significant relationship was observed between the octanol-water partition coefficient (log Kow) of the compound and sorption capacity with a cut-off value of log Kow (around 3), below which no sorption was observed. Additionally, the ionic strength of the interactive media also affected the process with increased sorption (6-42%) upon increasing the ionic strength. The results of the desorption experiments showed that compounds with log Kow > 4 were retained in the plastic, whereas others were desorbed rapidly. Interestingly, desorption was faster at 40 ◦C than at 20 ◦C, indicating the effect of ambient conditions on the process.

Our study stresses the need to take a practical approach to investigate this issue by considering environmentally relevant concentrations of contaminants/microplastics for research. Our findings suggest that this issue may have a far greater impact than what was anticipated from research using model microspheres. The vector effects of micro- and nano-plastics could ultimately affect the transport, spread, and bioavailability of other residual contaminants in the agricultural ecosystem and, in turn, affect agricultural health. In this scenario, it is pertinent to further investigate this role along with the complete life cycle of such particles in agricultural fields.

Keywords: Microplastics, Pesticides, Sorption, Agriculture, Polymers, Food Safety

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Investigation and analysis of microplastics in sewage sludge and biosolids: A case study from one wastewater treatment works in the UK

Harley-Nyang Daisy <da383@exeter.ac.uk> (1), Memon Fayyaz <F.A.Memon@exeter.ac.uk> (1), Jones Nina <ninaj05@aol.com> (1), Galloway Tamara <t.s.galloway@exeter.ac.uk> (1)

1 - University of Exeter (United Kingdom),

There is an increasing concern about the impacts of microplastic pollution in the terrestrial environment. The recycling of biosolids to land can create a pathway for microplastic contamination of agricultural soils and the wider environment. In the UK alone, 3.5 million tonnes (wet weight) of biosolids from the wastewater industry are recycled each year to agricultural land. This raises the possibility that recycling of biosolids could be a significant source of microplastic pollution to the terrestrial environment and beyond. To address this issue, the present study determined the occurrence and characteristics of microplastics in sewage sludge (a liquid by-product produced from the wastewater treatment processes) and biosolids (sewage sludge that has undergone a treatment process) and assessed what this may mean in terms of soil contamination. We investigated microplastic concentrations and characteristics from samples collected at each stage of the sludge treatment stream from one wastewater treatment works, including from two different biosolid (end) products. The pre-treatment and extraction process for the isolation of microplastics from dried sludge and biosolid samples consisted of a catalytic wet peroxide oxidation process (30% H2O2 and 0.05 M FeSO4) followed by density separation with zinc chloride (1.5 g cm-3 ZnCl2). Samples were vacuum filtered for physical and chemical analysis. Each filter was then analysed using an Olympus SZX16 dissection microscope and a presumptive microplastic count was initially determined. Microplastics 5000 μm and 50 μm were quantified and characterised. A subsample of presumed micropalstics (39.5%–61.1%) was subjected to chemical analyses via micro-Fourier Transform-Infrared Spectroscopy (μFT-IR) for microplastic confirmation and polymer identification. The percentage of sub-sample confirmed as plastic was factored into the results. Microplastics were detected in all samples taken from across the treatment process with concentrations ranging from 37.7–286.5 MPs/g sludge (dry weight). The microplastic load in the final biosolid products produced at the site ranged from 37.7–97.2 MPs/g of sludge (dry weight). This study shows that anaerobically digested sludge cake (17.9 MPs/g ww) has a higher concentration of microplastics when compared to the limed cake (14.8 MPs/g ww). The wastewater treatment works in this study produces 900 tonnes of anaerobically digested sludge cake and 690 tonnes of lime stabilised cake per month. Based on the results from this study, the application of these biosolids to agricultural land as fertilisers can potentially release 16.1 billion and 10.2 billion microplastics in anaerobically digested and lime stabilised sludge respectively, every month (equivalent to the same volume as > 20,000 plastic bank cards). The microplastics then enter the terrestrial environment when the biosolids are recycled to agricultural land. The results illustrate the extent to which microplastics may enter the terrestrial environment through this route. The work carried out in this study was a preliminary investigation and paves the way for further research into the presence of microplastics in the whole sludge treatment stream.

Keywords: Microplastics, sludge, Biosolids

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How well can horizontal flow sand filters retain microplastics?

Gabriella Rullander [a*], Sahar Dalahmeh[a], Roger Herbert[a], Ann-Margret Hvitt Strömvall[b], Claudia Lorenz[c], Jes Vollertsen[c]

[a] Department of Earth Sciences, Uppsala University, Villavägen 16, SE-752 36, Sweden. Email: gabriella.rullander@geo.uu.se
[b] Water Environment Technology, Department of Architecture and Civil Engineering, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden.
[c] Aalborg University, Department of Civil Engineering, Thomas Manns Vej 23, 9220 Aalborg Øst, Denmark.

[*] Corresponding author

Microplastics (MPs) are a growing global concern, with alarming effects on aquatic life observed as a direct response to the increasing numbers of MPs in the environment. Stormwater is a mayor vector for the transport of MPs to aquatic recipients, and as a results, emphasis should be placed on quality control measures for the removal of MPs in stormwater. This study developed lab-scale horizontal flow sand filters of three filter lengths (25, 50 and 100 cm) to examine the retention and transport of MP mixtures containing PP, PE, PA and PET of different shapes (spheres, fragments and fibers), sizes and densities. The MPs were extracted after one-week operation at a constant flow of 1 ml/min and quantified and identified utilizing Fourier transform infrared spectroscopy (FTIR) imaging. Results show that 62-84% of initial MP mixtures can agglomerate in the first 2 cm of filter inlet. Moreover, up to 96% of high-density PET fibers were retained in filter inlets. In general, a high 99% removal efficiency was reached in the experiments, regardless of filter length. Particles of smaller size and low-density showed increased transport tendencies in comparison with larger sized, heavy-density fibrous or fragmented MPs. The study demonstrated promising retention of microplastics in simple horizontal flow sand filters, motivating further research on their application in stormwater management.

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Impacts of Microplastic-derived Endocrine Disrupting Chemicals on Seabird Epigenetics

Presenting author: Christina Biamis[1,4]. **Coauthors:** Dr Brian Quinn[2], Dr Philip McCarron[2], Dr Pierre Bize[3], Prof Paul Thompson[4], Prof Gary Hardiman[1]. **Affiliations:** [1]School of Biological Sciences, Institute for Global Food Security (IGFS), Belfast, Northern Ireland, [2]ASSET Technology Centre, IGFS, Belfast, Northern Ireland, [3]The Swiss Ornithological Institute, Sempach, Switzerland, [4]Institute of Biological and Environmental Sciences, University of Aberdeen, Scotland.

Plastics are a ubiquitous source of endocrine disrupting chemicals (EDCs) e.g. BPA and phthalates. The exposure of humans and wildlife to EDCs is recognised as a global environmental and health problem.

Plastic-derived EDCs are implicated in human disease including cancer, infertility and allergies and are thought to act through epigenetic mechanisms. However, as epigenetic mechanisms are not easily replicated in controlled laboratory environments, and as humans are uniformly exposed to plastics, it is difficult to understand how plastics are impacting our health.

The northern fulmar (*Fulmarus glacialis*) is used as a sentinel species in this work (fulmar hereafter). Fulmars are long-lived, high trophic level, pelagic seabirds, and are a robust indicator species for plastic pollution due to their unusually high levels of plastic ingestion and retention. Due to these characteristics, fulmars likely share similar patterns of adaptation to EDC exposure as humans, and thus the impacts of these contaminants in fulmars can shed light on how they impact humans. Wild sample cohorts from bycaught fulmars with known plastic stomach contents, as well as samples from live movement-tracked individuals, permitted understanding of the health effects of plastic exposure in both a short-term and long-term context. This research used a combination of analytical, molecular, transcriptomic and epigenetic signatures to help elucidate the mechanisms through which plastics induce negative health endpoints in a natural real-world context.

Firstly, best practice SOPs for nucleic acid and feather corticosterone extraction and analytical chemistry were established for fulmar samples. Experimental groups consisted of extreme plastic-related phenotypes such as disparate average wintering location and plastic stomach contents. Feather corticosterone analyses have revealed complex relationships between stress, foraging location and plastic stomach contents in this species. Due to these complexities, feather corticosterone may not represent a useful biomarker of fulmar plastic ingestion. Fulmar liver transcriptomics revealed differential gene expression in fulmars with and without plastic in their stomach, with higher plastic stomach contents associated with higher expression of inflammatory markers. Fulmar feather contaminant mass spectrometry analyses were carried out using a novel sample preparation method and revealed the presence of agricultural contaminants and plastic-derived EDCs in fulmar feathers.

Subsequent fulmar liver analysis using quantitative mass spectrometry and epigenetic sequencing (RRBS) will further elucidate the link between plastic exposure and health endpoints, in a manner that is applicable cross-species. Findings will ultimately be integrated into a systems-level analysis to ascertain how plastics exert negative health effects in organisms.

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Keywords: Microplastics, plastics, endocrine disrupting chemicals (EDCs), seabirds, sentinel, systems biology, marine, human, one health, corticosterone, transcriptomics, analytical chemistry, mass spectrometry, contaminant burden, epigenetics, bioinformatics, multidisciplinary.

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Assessing microplastic concentrations in surface water, sediment and the freshwater macroinvertebrate, *Gammarus duebeni* of Irish rivers

Stephen Kneel*, Caroline Gilleran Stephens[1], Alec Rolston[2], Niamh Tester[1], Ana Marques Mendes[3], Liam Morrison[3] Suzanne Linnane[1]

[1]Centre for Freshwater and Environmental Studies, Dundalk Institute of Technology, Dundalk, Co. Louth, Ireland

[2]Goyder Institute for Water Research, Adelaide, South Australia, Australia.

[3]Earth and Ocean Sciences, School of Natural Sciences and Ryan Institute, National University of Ireland Galway, Ireland

*Corresponding author: stephen.kneel@dkit.ie

Although Ireland has over 74,000 kilometres of rivers and streams and 128,000 hectares of lakes, research into the presence and effects of freshwater microplastic pollution in those systems is in its infancy with few studies carried out to date (e.g. Murphy et al., 2022; Cedro and Cleary, 2015; Mateos-Cárdenas et al., 2021). This study examined the microplastic presence in the surface waters of 7 rivers that flow into the Special Protected Area (SPA) and Special Area of Conservation (SAC) of Dundalk Bay on the East Coast of Ireland during Winter 2019-20 and 2020-21 at both headwater and outflow sites. One of those rivers, the River Flurry displayed large differences in microplastic levels in its surface waters between headwater and outflow sites and the freshwater macroinvertebrate *Gammarus duebeni* (n = 80) along with riverbank sediment were collected from both sites. Although a benthic species, *G. duebeni* can swim in the water column and feed on floating plant material, this in turn means they are potentially susceptible to microplastic contamination found in surface water of rivers and lakes and in the sediment. Therefore, *G. duebeni* has potential as a biomonitor of microplastic pollution of freshwater environments. Furthermore, *Gammarus* sp. are considered model ecotoxicological freshwater species (Consolandi *et al*., 2019). This study adds to the growing body of work detailing microplastic contamination of Ireland's freshwater environments and highlights a potential starting point of microplastics entering the food web. Microfibres represented the dominant microplastic shape found for each surface water sample collected (200 litres), for both sampling campaigns and in riverbank sediment and in *G. duebeni*.

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Sex-dependent predatory avoidance behaviour in hermit crabs, *Pagurus bernhardus*, when exposed to microplastics

Alix McDaid [a]*, Eoghan M. Cunningham [a b], Andrew Crump [a c], Gary Hardiman [a], Gareth Arnott [a]
[a] Institute for Global Food Security, School of Biological Sciences, Queen's University Belfast, BT9 5DL, Northern Ireland, UK
[b] Department of Zoology, University of Oxford, Zoology Research and Administration Building, 11a Mansfield Road, Oxford OX1 3SZ, UK
[c] Centre for Philosophy of Natural and Social Science, London School of Economics and Political Science, London WC2A 2AE, UK

Microplastics (<5 mm) are a threat to marine biodiversity however their effects on animal cognition and behaviour are unclear. We investigated whether microplastic exposure affects shell selection behaviour and motivation in the common European hermit crab, *Pagurus bernhardus*. Subjects were maintained for 5 days in tanks containing either: polyethylene microplastic spheres (n = 40), or no plastic (n = 40). They were then placed in low-quality shells and presented with an alternative high-quality shell. When they first touched the high-quality shell, the hermit crabs were startled using visual and aural stimuli. We recorded the post-startle latency to re-contact the high-quality shell, quantifying motivation to explore and acquire a better shell. Plastic-exposed females were more likely to select the high-quality shell than control females. As hypothesised, female hermit crabs had longer initial contact latencies, startle durations, and shell entry latencies than males. We also found an interaction effect on shell investigation duration: females from the control treatment spent longer investigating the high-quality shell compared to males. This was absent in the microplastic treatment with females behaving similar to males. This controlled study serves as a starting point to investigate the effects of microplastics and sex differences on behaviour when under predatory threat and demonstrated sex dependent sensitivity to an environmental pollutant of global concern.

Keywords: Microplastics, Behaviour, Cognition, Motivation, HDPE, Polyethylene, Sex-dependent

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Adsorption mechanisms of Cd(II) on different types of pristine and aged polypropylene microplastics

Narhayanan Thaiyal Nayahi <thaiyalnayahi.n@gmail.com> (1), Janjaroen Dao <dao.s@chula.ac.th> (1)

1 - Chulalongkorn University (Department of Environmental Engineering, Thailand),

Improper disposal of plastics led their way into the environment in the form of smaller plastics called microplastics (MP). The presence of MPs and heavy metals in freshwater is apparent from previous research works. Their acclimation, interaction with other pollutants and wider effects on organisms make them a particularly important research topic. Polypropylene (PP) is the most widely used plastic-type and is highly detected MPs in almost all environments. Most of the previous works concentrated either on studying the interaction of heavy metals either with different types of polymers or with one polymer and varying pollutant types. In this work, we studied the interaction and uptake of one type of cationic heavy metal ion, Cd(II) with PP MPs generated from different commercial plastic products. The shortlisted types of PP plastics are disposable food trays (PPT), coloured (PPS) and coloured (PPSc) straws, which are commonly used in our daily life. To replicate the MPs from the environment, the MPs aged under thermal treatment were used as aged MPs and also the results were compared with the pristine ones. We investigated their varying interaction behaviour and mechanism with Cd(II) under different physical and chemical conditions. From the characterization, artificial ageing shows a drastic change in the physical appearance and properties of non-coloured PP MPs compared to pigmented straws. The order of adsorption of pristine MPs is PPS> PPSc> PPT, even the same order prevails in the aged MPs. In the kinetics and isotherms study, it is clear that the adsorption between PP MPs and Cd(II) it was clear that the adsorption was both physical and chemical and it was mostly in multilayers except for pristine PPS and PPSc. Moreover, the interaction is highly pH- dependent and the presence of other organic and inorganic contaminants play a key role in determining the adsorption capacity of Cd(II) on MPs. The prime adsorption mechanism of pristine and aged MPs was found to be electrostatic interaction and also surface complexation and van der Waals force in aged MPs. From this study, we can determine that the varied MPs of the same polymer type with different additive compositions and physical characteristicsinteract differently with the pollutants. Also, the different ageing mechanisms cause varying adsorption capacities under varying environmental conditions and carry them in contrasting concentrations.

Keywords: polypropylene, thermal ageing, physical characterization, cadmium, adsorption

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