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µMED Conference – IV edition
Ischia, Italy
19 – 22 October 2025

BOOK of ABSTRACTS

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About

Following the success of the previous editions of the “International Conference on Microplastic Pollution in the Mediterranean Sea” – µMED – the Local Scientific Committee and International Advisory Board are pleased to share with the scientific community and stakeholders the book of abstracts of the IV edition of the µMED Conference, held in Ischia (NA), Italy, from 19th to 22th October 2025.

The µMED Conference is a leading event on microplastic pollution. The conference brings together experts from diverse disciplines, including the scientific and industrial sectors, policy makers and environmental organizations, to explore all aspects of micro- and nanoplastic pollution. The conference offers a valuable opportunity to share the latest developments, highlight recent advancements, and identify innovative materials, technologies and strategies to detect and mitigate this pressing environmental challenge.

Conference topics

To deepen the understanding of micro- and nanoplastic pollution, the main topics of the IV µMED conference have been expanded to encompass a broad range of multidisciplinary fields, various environmental compartments, and issues related to human health.

1. Analysis of micro- and nanoplastics, encompassing monitoring approaches, sources, environmental distribution (freshwater, marine, air, sediment, compost and soil), fate, ecological effects, and their role in the adsorption and transport of pollutants.
2. Development and implementation of innovative and sustainable solutions to address plastic pollution, including mitigation approaches, remediation technologies, marine plastic recovery and recycling, waste valorisation into chemicals or fuels, green polymer synthesis, enhanced degradation/biodegradation of plastics and micro/nanoplastics, and safe and sustainable by design strategies.
3. Impacts of micro- and nanoplastics on organisms and ecosystems, including their accumulation and transfer to the food chain.
4. Effects of micro- and nanoplastics on human health, including their interactions with biomolecules, cellular uptake, biodisposition, exposure and risk analysis.
5. Environmental and health policies, public awareness and perceptions, socio-economic and environmental impact.

Programme

19 October	
19 October AFTERNOON SESSION	
4:00 PM 6:00 PM	**Registration**
Chairman	**Maurizio Avella** **Institute of Polymers, Composites and Biomaterials - CNR, IT**
6:00 PM 7:00 PM	**Grammenos Mastrojeni** Union for the Mediterranean, ES The Mediterranean Hotspot
6:00 PM **7:00 PM**	**Welcome Party**

20 October	
8:30 AM 9:00 AM	**Registration**
20 October MORNING SESSION **Chairwoman:**	**Mariacristina Cocca** **Institute of Polymers, Composites and Biomaterials - CNR, IT**
9:00 AM 9:30 AM	**Welcome and Introduction** **Edoardo Bemporad** Institute of Polymers, Composites and Biomaterials - CNR, IT **Silvestro Greco** Stazione Zoologica Anton Dohrn, IT
9:30 AM 10:00 AM	**Andy Booth** SINTEF, NO The Importance of Plastic Additive Chemicals in Hazard Assessment of Micro- and Nanoplastic
10:00 AM 10:15 AM	**Francesca Coccia** University G. d'Annunzio of Chieti-Pescara, IT Polystyrene enhances the release of Cu^{2+} and Zn^{2+} ions from metal oxides under UV light: implications for microplastic-mediated toxicity in marine systems
10:15 AM 10:30 AM	**Daura Vega Moreno** University of Las Palmas de Gran Canaria, ES Origin, fate and transport of microplastics in the Atlantic Region down to 1200 meters depth

10:30 AM 10:45 AM	**Evelia Schettini** University of Bari, IT Environmental potential risk of microplastic pollution due to agricultural plastics: a case study in Apulia region
10:45 AM 11:00 AM	**Massimiliano Mariani** Institute of Intelligent Industrial Technologies and Systems for Advanced Manufacturing -CNR, IT Environmental impact of fibrous microplastics emitted from textiles during washing under the life cycle assessment framework
11:00 AM 11:30 AM	**Coffee Break**

20 October MORNING SESSION **Chairman:**	**Joao Frias** **Marine and Freshwater Research Centre** **- Atlantic Technological University, IE**
11:30 AM 12:00 AM	**Maria Cristina Fossi** University of Siena, IT Biodiversity at Risk in the SPAMI Pelagos Sanctuary: the Impact of Marine Litter on Biota
12:00 AM 12:15 AM	**Francesca Garaventa** Institute of Anthropic Impact and Sustainability in the Marine Environment - CNR, IT Early biofilm development in biodegradable and traditional plastics through a mesocosm approach
12:15 AM 12:30 AM	**Alessandro Cau** University of Cagliari, IT Marine heat waves can modulate the effects of microplastics on microbial communities and biogeochemical cycling in coastal sediments
12:30 AM 12:45 AM	**Teodora Babos** National Institute of Marine Geology and Geo-ecology, RO Microplastics in fish species from the Romanian deltaic coast
12:45 AM 1:00 PM	**Giorgia Sciutto** **University of Bologna, IT** Chemometrics and hyperspectral imaging for a standardized and rapid monitoring of microplastics in the environment
1:00 PM 2:30 PM	**Lunch**

20 October AFTERNOON SESSION Chairman:	Emanuele Fiore Institute of Polymers, Composites and Biomaterials - CNR, IT
2:30 PM 3:00 PM	**Roberto Rosal** University of Alcalá, ES Impacts of Micro- and Nanoplastics on Organisms and Ecosystems: Bridging Knowledge Gaps in Pollution Research
3:00 PM 3:15 PM	**Anna Martinez** Southern Higher School, IT Microplastic detection in soil by THz Time-Domain Hyperspectral Imaging combined with Unsupervised Learning Analysis
3:15 PM 3:30 PM	**Sara Criollo** Aalborg University, DK Detection of microplastics in environmental compartments near a traffic-intensive road
3:30 PM 3:45 PM	**Achu Kuriakose** University of Urbino, IT Micro and nanoplastics as evolving contaminant carriers: Benzodiazepine sorption on virgin, aged and biofilm-coated particles characterized by MOI-LEI-QQQ MS
3:45 PM 4:00 PM	**Milica Velimirovic** Flemish Institute for Technological Research, BE Progress in analytical strategies for micro- and nanoplastics detection and characterisation
4:00 PM 4:30 PM	**Coffee break**

20 October AFTERNOON SESSION Chairwoman:	Margherita Ferrante Department of Medical, Surgical and Advanced Technologies “G.F. Ingrassia” - University of Catania, IT
4:30 PM 4:45 PM	**Stefania Gorbi** Marche Polytechnic University, IT Chemical characterization and biological effects of leachates from commercial and naturally weathered plastics
4:45 PM 5:00 PM	**Jacopo La Nasa** University of Pisa, IT Exploring the potential of one-pot microwave-assisted pretreatments coupled with Py-GC-MS for the quantification of MPs and associated contaminants

	Andara Manage Shashini Methsara
5:00 PM	University of Kelaniya, LKA
5:15 PM	Microplastic Contamination in water and sediment in Anawilundawa Mangrove restoration site, Sri Lanka
	Leonardo Barlucchi
5:15 PM	University of Pisa, IT
5:30 PM	Breathing plastic: quantifying indoor airborne microplastics in industrial workplaces using Py-Gc-MS and fluorescence microscopy
	Viktoria Parobkova
5:30 PM	Brno University of Technology, CZ
5:45 PM	X-ray computed tomography: a novel approach for investigating microplastics in the fish digestive system
	Valentina Giglio
5:45 PM	National Research Council of Italy, IT
6:00 PM	From plastic to soil: tracing the leaching of additives from biodegradable mulch films into the surrounding soil
6:00 PM **7:00 PM**	**POSTER SESSION**

21 October	
21 October MORNING SESSION **Chairman:**	**Roberto Rosal** **Department of Chemical Engineering - University of Alcalá, ES**
9:00 AM 9:30 AM	**Nicolas Keller** Institute of Chemistry and Processes for Energy, Environment and Health - CNRs/UdS, FR Light-Driven Advanced Oxidation Processes as Sustainable Technologies for Remediation and Upcycling of Micro/Nanoplastics
9:30 AM 9:45 AM	**Annamaria Vujanović** University of Maribor, SL Advanced cascade treatment system for retention and elimination of microplastics from wastewater effluent
9:45 AM 10:00 AM	**Silvia Merlino** Institute of Marine Sciences - CNR, IT Preventing microplastic formation: the EPIC project's integrated response to marine macrolitter accumulation
10:00 AM 10:15 AM	**Immacolata Liotta** Institute of Polymers, Composites and Biomaterials - CNR, IT Degradation studies of biodegradable polymers in simulated marine environments

	Silvia Galafassi
10:15 AM	Water Research Institute - CNR, IT
10:30 AM	Plastic degradation and biofilm formation in freshwater environments: insights from short- and long-term studies
	Stefania Piarulli
10:30 AM	SINTEF Ocean, NO
10:45 AM	Towards a smarter aquacolture: safe and sustainable by design approaches to reduce microplastic emissions from nets and ropes
	Davide Poletto
10:45 AM	Venice Lagoon Plastic Free, IT
11:00 AM	'Ghost boats' in venice: environmental concerns, green chemical fingerprint, circular and sustainable end-of-life-solutions
11:00 AM 11:30 AM	**Coffee Break**

21 October MORNING SESSION **Chairman:**	**Andy Booth** **Department of Climate and Environment - SINTEF OS, NO**
	Giuseppe Suaria
11:30 AM	Institutes of Marine Research ISMAR - CNR, IT
12:00 AM	Occurrence, Sources, Fate, Accumulation and Transport Dynamics of Textile Fibres in Oceanic Environments
	Stefania Federici
12:00 AM	University of Brescia, IT
12:15 AM	True-to-life microplastics: bridging laboratory and environmental relevance
	Gabriela Kalcikova
12:15 AM	University of Ljubljana, SI
12:30 AM	Biodegradable but persistent? Insights into the environmental implications of microplastics from biodegradable plastics
	Erika Baldini
12:30 AM	University of Ferrara, IT
12:45 AM	Microplastics in mussels (Mytilus Galloprovincialis): a nationwide survey of marine pollution in italian coastal waters
	Sara Vencato
12:45 AM	Institute of Anthropic Impact and Sustainability in the Marine Environment - CNR, IT
1:00 PM	Imprinted by plastic: tracing site-specific microplastics and phthalates in Parapenaeus Longirostris
1:00 PM 2:30 PM	**Lunch**

21 October AFTERNOON SESSION Chairman:	Nicolas Keller Institute of Chemistry and Processes for Energy, Environment and Health - CNRs/UdS, FR
2:30 PM 3:00 PM	**Margherita Ferrante** University of Catania, IT Micro and Nano-Plastics a new Concern for Public Health?
3:00 PM 3:15 PM	**Eloísa Toscan Massignam** Istituto Zooprofilattico Sperimentale delle Venezie, IT Unmasking the resistome on microplastics in marine habitats: potential routes of antibiotic resistance to humans via shellfish
3:15 PM 3:30 PM	**Giulia Nannini** University of Florence, IT Impacts of nano and microplastic mixtures on the microbiota-immunity axis in C57BL/6J wild-type mouse model
3:30 PM 3:45 PM	**Maria Della Valle** Institute of Cristallography - CNR, IT Molecular insights into protein recognition and toxicological mechanisms of nano-plastics
3:45 PM 4:00 PM	**Serena Ducoli** University of Brescia, IT From biomolecules to biofouling: the broad-spectrum adsorption capability of true-to-life micro- and nanoplastics
4:00 PM 4:30 PM	**Coffee break**

21 October AFTERNOON SESSION Chairman:	Giuseppe Suaria Institutes of Marine Research - CNR, IT
4:30 PM 4:45 PM	**Gea Oliveri Conti** University of Catania, IT A correct waste management for the health protection: a focus on microplastics
4:45 PM 5:00 PM	**Maria Teresa Gentile** University of Naples Federico II, IT Polystyrene nanoparticles induce DNA damage and apoptosis in HeLa cells

	Vincenzo Donnarumma
5:00 PM	University of Cagliari, IT
5:15 PM	Microplastics alter microbial communities and biogeochemical cycling in coastal sediments
	Chiara Maria Motta
5:15 PM	University of Naples Federico II, IT
5:30 PM	Polystyrene toxicity: comparative effects of microbeads of 1 and 3 micrometers on Xenopus laevis embryo development
5:30 PM **7:00 PM**	**POSTER SESSION**

22 October	
22 October MORNING SESSION **Chairman:**	**Gennaro Gentile** **Institute of Polymers, Composites and Biomaterials - CNR, IT**
	Joao Frias
9:00 AM	Atlantic Technological University, IE
9:30 AM	Fashion Fades, Microplastics are Eternal – A Literature Review into the Colours of Microplastic Fibres Worldwide
	Giuseppe Milano
9:30 AM	University of Naples Federico II, IT
9:45 AM	Modeling nanoplastic in action: molecular structure, dynamics, interactions, and environmental fate
	Luca Fambri
9:45 AM	University of Trento, IT
10:00 AM	4 years monitoring plastics contamination in fresh water of lake Garda with Seabin – seasonal effects, microplastics and alien species
	Isam Sabbah
10:00 AM	Braude, College of Engineering, IL
10:15 AM	Nature-inspired physicochemical process: Jellyfish mucin for efficient removal of nanoplastics from water
	Valentina Marturano
10:15 AM	Institute of Polymers, Composites and Biomaterials - CNR, IT
10:30 AM	Functionalization of natural polymers with vanillic acid derived from PET waste
	Banu Yoho
10:30 AM	Ege University Institute of Nuclear Sciences, TR
10:45 AM	An Innovative Method for Microplastic Studies in Marine Organisms: Radiolabeling and Radioimaging (PET)

	Raffaele Bruschi
10:45 AM	University of Trieste, IT
11:00 AM	Enzymatic synthesis and structural modeling of bio-based oligoesters as an approach for fast screening of marine biodegradation and ecotoxicity
11:00 AM 11:30 AM	**Coffee break**
	Teresa Cecchi
11:30 AM	ITT G. e M. Montani
11:45 AM	Green and Rational microplastics assessment in sand: a best practice proposal with safe and effective density separation media
	Esther Kentin
11:45 AM	Leiden University, NL
12:00 AM	The right of consumers to information: what should we know about plastic?
	Filippo Vaccari
12:00 AM	Università Cattolica del Sacro Cuore, IT
12:15 AM	Microplastics and human gut health: in-vitro fermentation and shotgun metagenomics reveal microbiome and functional shifts in healthy and ALS individuals
	Awards ceremony
12:15 AM	
12:30 AM	**Federico Olivieri**
	Institute of Polymers, Composites and Biomaterials - CNR, IT
	Conclusions
12:30 AM	
12:45 AM	**Mariacristina Cocca**
	Institute of Polymers, Composites and Biomaterials - CNR, IT

POSTER SESSIONS 20 October - 6:00 – 7:00 PM 21 October - 5:30 – 7:00 PM	
P1	**Lorena Affatato** Institute of Polymers, Composites and Biomaterials - CNR, IT Impact of micro and nano plastics in our life
P2	**Sarai Agustin-Salazar** Institute of Polymers, Composites and Biomaterials - CNR, IT From soil to sea: environmental degradation of pla–glass fibre composites
P3	**Rachid Amara** Université du Littoral Côte d'Opale - FR Emergence and sustainability of bioplastics in the maritime sector: environmental, economic, and social insights
P4	**Roberto Avolio** Institute of Polymers, Composites and Biomaterials - CNR, IT Vegetable based water resistant coatings for the realization of sustainable food packaging and containers: results from the “NEW SKIN” project
P5	**Irene Bonadies** Institute of Polymers, Composites and Biomaterials - CNR, IT Algae-loaded microparticles for plastic capture and nutrient removal for environmental remediation
P6	**Chiara Anastasia Bruno** Institute for Marine Biological Resources and Biotechnology - CNR, IT Occurrence of anthropogenic particles in sea cucumbers from the Capo Peloro Natural Reserve
P7	**Raffaele Bruschi** Department of Chemical and Pharmaceutical Sciences - University of Trieste, IT Towards regulatory readiness: adapting microplastic monitoring strategies in water services for upcoming EU directives
P8	**Erika Caianiello** Institute of Polymers, Composites and Biomaterials - CNR, IT Bacterial cellulose as a sustainable adsorbent for pollutants and microplastics in water
P9	**Claudia Campanale** Italian National Institute of Health, IT Indoor airborne microplastics: insights from a literature review study

P10	**Rachele Castaldo** Institute of Polymers, Composites and Biomaterials - CNR, IT Green biomass-derived porous systems: multifunctional and lightweight materials
P11	**Antonia Cerbone** Institute of Polymers, Composites and Biomaterials - CNR, IT Efficient removal of dyes using bio-based hyper-crosslinked resins
P12	**Laura Ciarralli** Italian Institute for Environmental Protection and Research, IT Two seas, one risk: trophic ecology insights into microlitter ingestion in Callinectes sapidus from the Adriatic and Tyrrhenian Sea
P13	**Mariacristina Cocca** Institute of Polymers, Composites and Biomaterials - CNR, IT Environmental friendly foams to remove microplastics released from textile to wastwater
P14	**Joao Da Costa** Department of Chemistry and Center for Marine and Environmental Studies - University of Aveiro, PT How road traffic fuels microplastic contamination
P15	**Roberta D'Auria** Institute of Polymers, Composites and Biomaterials - CNR, IT Biodegradable polymer blends with lignin as UV stabilizer for eco-sustainable fishing nets
P16	**Cristina De Monte** Institute for Chemical and Physical Processes - CNR, IT Towards sustainable solutions based on bioplymeric blends for containment nets in the aquaculture sector
P17	**Cristina Grazia De Nido** Department of Medical and Surgical Sciences - University of Foggia, IT Microplastics in sea salts from Mediterranean and Atlantic Ocean salt pans: a comparative study
P18	**Maria Emanuela Errico** Institute of Polymers, Composites and Biomaterials - CNR, IT Biodegradable functional composites containing agricultural byproducts: results from the “NEW SKIN” project
P19	**Camilla Fantasia** SRA Instruments SpA, IT Recent developments on microplastics analysis in marine sediments and air involving GCMS-pyrolisis and Agilent LDIR spectroscopy

P20	**Berenice Garcia** Department of Biotechnology and Bioengineering - Centro Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, MX Sustainable-to-go cups: eco-friendly or a hidden plastic hazard under thermal stress?
P21	**Gennaro Gentile** Institute of Polymers, Composites and Biomaterials - CNR, IT Design of hyper-cross-linked cellulose nanofibrils as renewable sorbents for chlorophenol removal from water
P22	**Anita Grozdanov** Faculty of Technology and Metallurgy- University SS Cyril and Methodius, NMK Heavy metal ions sorbents based on flyash/MWCNT
P23	**Ilaria Guardamagna** Institute for Marine Biological Resources and Biotechnology - CNR, IT A comparative study on anthropogenic particles in Anemonia viridis between the Capo Peloro Natural Reserve and the Aeolian islands
P24	**Natalia Hernandez Montero** Chemical Engineering Department - University of Costa Rica, CR Microwave-assisted hydrogen peroxide degradation of polystyrene microplastics
P25	**Valeria Ippolito** Institute of Polymers, Composites and Biomaterials - CNR, IT Multicomponent platforms integrating fibers and nanoparticles for environmental remediation
P26	**Alessandra La Pietra** Department of Biology - University of Naples Federico II, IT Zebrafish to study microplastics and Trojan Horse effect
P27	**Beatrice Luzi** Water Research Institute - CNR, IT Invisible threads, visible impact: microfibers in domestic appliances
P28	**Francisco Machin** Physical Oceanography and Applied Geophysics - University of Las Palmas de Gran Canaria, ES Characterization of the composition and types of marine microplastics in the Canary islands
P29	**Chiara Magnabosco** Water Research Institute - CNR, IT Impact of biodegradable plastics on freshwater environments

P30	**Loredana Manfra** National Institute for Environmental Protection and Research, IT Unveiling the size effect on hazard of commercially derived microplastics
P31	**Lucia Therese Marcianò** Department of Earth and Marine Sciences - University of Palermo, IT Impact of PET nanoplastics on immune homeostasis and cellular function in Mmytilus Galloprovincialis
P32	**Susanna Mesghez** Institute of Marine Sciences - CNR, IT Abundance and characteristics of microplastics in surface waters of two transitional ecosystems: the Venice lagoon and the Po delta
P33	**Ljiljana Milosevic** Faculty of Environmental Protection - Educons University, RS Advancing microplastic mitigation through Life Cycle Assessment: policy integration challenges in the republic of Serbia within the EU accession context
P34	**Eleonora Monfardini** Department of Environmental Biology - Sapienza University of Roma, IT Microplastic ingestion in three deep-water fish species: ecological insights from stable isotope analysis
P35	**Tommaso Mosca** Dipartimento di Scienze della Vita e dell'Ambiente - Università Politecnica delle Marche, IT Greenplasma: a mobile waste-to-energy system for marine plastic recovery and valorisation
P36	**Lorenzo Palumbo** Deptartment of Environment & Health, National - Institute of HealthNational Institute of Health, IT Integrated assessment of airborne microplastics in plastic processing facilities
P37	**Monia Renzi** Department of Life Sciences, University of Trieste, IT Frontiers in microplastics and nanoplastics research: principal gaps and future perspectives
P38	**Alberto Santi** Institute of Marine Sciences - CNR, IT Microplastics in the drainage basin of the venetian lagoon: an assessment of an emergeing pollutant in water surface and sediments

P39	**Serena Santonicola** Department of Medicine and Health Sciences “V. Tiberio” - University of Molise, IT Preliminary investigation of microplastic and microfiber contamination in raw milk from Italy: implications for food safety
P40	**Lisa Zanetti** Institute of Anthropic Impact and Sustainability in the Marine Environment - CNR, IT Meso- and microplastics in beach sediments with Posidonia oceanica: a preliminary assessment from Ligurian Sea
P41	**Rosa Zullo** Water Research Institute - CNR, IT Preliminary results on microplastic pollution in the Ticino River and its urban tributaries in Pavia: insights from the MINOSSE project

Abstracts

THE MEDITERRANEAN HOTSPOT

Grammenos MASTROJENI*

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Microplastics? Just one facet – but a paradigm – of what the historically most exploited sea is undergoing. How, in what context, with what foreseeable consequences, we place plastic and other pollutions in the rapidly degrading situation of the fastest warming and fastest rising sea; within the second fastest warming region in the world? Doing the right thing can deliver much more than effective environmental protection; going the wrong way can cause much worse than a once flourishing but potentially dead and poisonous common sea.

THE IMPORTANCE OF PLASTIC ADDITIVE CHEMICALS IN HAZARD ASSESSMENT OF MICRO- AND NANOPLASTIC

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Micro- and nanoplastics (MNPs) are widespread environmental contaminants with growing evidence of biological toxicity. While size, shape, and polymer type have traditionally dominated hazard discussions, plastic additive chemicals are increasingly recognized as key drivers of MNP toxicity [1]. Additives such as plasticizers, stabilizers, flame retardants, and colorants are intentionally added during manufacturing but are not chemically bound to the polymer, enabling their release into surrounding media, including water and biological fluids. The role of additives is complex, especially considering over 16,000 different chemicals are in use globally [2]. These vary significantly by polymer type and individual consumer product, and many lack comprehensive toxicological data. Additionally, non-intentionally added substances (NIAS), such as production chemicals and degradation by-products, also contribute to the chemical profile and potential toxicity of MNPs. The leaching of these substances is influenced by environmental conditions and particle surface area, which is particularly relevant for nanoplastics [3]. Despite these concerns, most MNP hazard assessments rely on poorly characterized or additive-free test materials, limiting ecological and regulatory relevance. There is a critical need for test and reference materials that reflect real-world plastic products, both chemically and physically [4]. Car tyres exemplify the issue: composed of rubber and a large number of additives, their leachates are known to be toxic [5]. Understanding whether observed toxicity originates from the particles, the leached chemicals, or both is crucial [6]. Therefore, standard methods to separate particle and chemical toxicity—such as leachate testing or chemical extraction—must be implemented in hazard assessment. Without such approaches, the true drivers of observed toxicity remain unclear. Chemical additives and NIAS are central to the hazard profile of MNPs. Future research and regulation must incorporate additive chemistry to provide accurate environmental and health risk assessments and inform effective mitigation strategies.

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POLYSTYRENE ENHANCES THE RELEASE OF CU^{2+} AND ZN^{2+} IONS FROM METAL OXIDES UNDER UV LIGHT: IMPLICATIONS FOR MICROPLASTIC-MEDIATED TOXICITY IN MARINE SYSTEMS

Andrea MASCITTI[1], Lucia TONUCCI[2], Michele CIULLA[3], Stefano DI GIACOMO[3], Nicola d'ALESSANDRO[4], Francesca COCCIA[2,*]

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Polystyrene (PS), a widespread component of microplastic pollution, can influence the environmental fate of co-occurring inorganic contaminants. In this study, we examine the role of PS in enhancing the release of toxic Zn^{2+} and Cu^{2+} ions [1] from their respective oxides (ZnO and Cu_2O) under simulated UV irradiation. Although these metal oxides— commonly originating from antifouling paints of ships [2,3] and sunscreens—are typically considered stable and sparingly soluble in marine environments, our findings demonstrate that the presence of PS significantly increases ion dissolution for both ZnO and Cu_2O. The effect is further amplified under UV exposure: in the most pronounced case, the combination of PS and UV light led to a 26-fold increase in Cu^{2+} release from Cu_2O compared to dark conditions. SEM, FTIR and Raman analyses showed no significant degradation of the plastic, suggesting an indirect, possibly surface-mediated mechanism, further supported by EDX results. This study highlights the role of PS not just as a passive pollutant, but as an active environmental modulator, capable of transforming inert materials into bioavailable and potentially toxic ionic species. These findings raise new concerns about the synergistic ecotoxicological effects of microplastics and metal-based materials in light exposed coastal and marine ecosystems.

References

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ORIGIN, FATE AND TRANSPORT OF MICROPLASTICS IN THE ATLANTIC REGION DOWN TO 1200 METERS DEPTH

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The presence of various types of microplastics (MPs) in the Atlantic Ocean has been extensively documented, with data from the Canary Islands revealing high concentrations of MPs at four beach “hot spots.” However, critical knowledge gaps remain regarding MP abundance across open-ocean regions, at varying depths, and their transport dynamics and origins. Since 2017, the OpenPLAS group—comprising the University of Las Palmas de Gran Canaria, the University of La Laguna, and the Spanish Institute of Oceanography (IEO-CSIC)—has been assessing the presence of microplastics in open waters around the Canary Islands down to 1200 meters deep (Vega-Moreno 2021, 2024). The group also studies large-scale (>100 km) and mesoscale (10–100 km) ocean dynamic processes and their role in MP transport across the region. This study examines surface current velocities between 27–32°N and correlates them with MP accumulation observed at various beaches across the archipelago. Rather than focusing solely on the dominant currents, this work incorporates finer-scale spatial and temporal data collected over two years. In parallel, previous and ongoing research indicates a high concentration of small microplastics (SMPs, <1 mm) at depths of around 1100 meters. By combining vertical MP profiles with decades of knowledge on the physical oceanography of the Canary region, we present a novel model describing how SMPs sink and are transported by deep water masses in the open ocean. This integrated approach not only deepens our understanding of the complex processes governing MP distribution but also offers valuable insights to address the growing challenge of microplastic pollution in the Atlantic Ocean.

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ENVIRONMENTAL POTENTIAL RISK OF MICROPLASTIC POLLUTION DUE TO AGRICULTURAL PLASTICS: A CASE STUDY IN APULIA REGION

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The use of plastic products has brought significant benefits to agricultural activities. It led to the production of huge amounts of agricultural plastic waste (APW), contributing to environmental pollution. A major challenge is the effective management of agricultural plastics, particularly at the end of their useful life. A serious and increasingly concerning issue is that these plastics are a potential source of microplastics (MPs) release into the soil. This study points out environmental potential risks of MPs based on a territorial analysis, supported by a Geographic Information System. An agricultural area in the Apulia region (Italy) composed by four municipalities was considered as a case study. Different agricultural uses were identified through land use maps. These, combined with plastic waste indices developed specifically for each crop and plastic application, allowed for the APW estimation and georeferencing. Further efforts were made to qualitatively assess patterns of MPs contamination from agricultural plastics using risk indices present in literature. The study found that while the area is dominated by olive groves, this crop is not the main contributor to APW production. Orchards were identified as the most significant contributors due to the combination of area covered and a high plastic waste index. Orchards account for 60% of the approximately 11,000 tons of APW produced annually in the whole area. Based on this result and on the scientific literature, a qualitative risk map of MPs pollution from agricultural plastics was developed as well. Orchards are the main cause of pollution due to their broad distribution and high risk index. The study could be useful in drawing attention and promoting effective actions toward the sustainable management of APW and MPs. The potential risk maps could contribute to public awareness and perceptions on the impact of microplastics due to the use of plastic in agriculture.

ENVIRONMENTAL IMPACT OF FIBROUS MICROPLASTICS EMITTED FROM TEXTILES DURING WASHING UNDER THE LIFE CYCLE ASSESSMENT FRAMEWORK

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The massive employment of plastics in various industrial sectors has led to an uncontrolled increase and mismanagement of plastic waste, contributing to the rampant presence of plastics in the environment [1]. Primary and secondary microplastics are a significant environmental and health concern due to persistence and ability to cross biological barriers [2,3,4]. Additionally, microplastics are an excellent vehicle for chemical additives and pollutants [5,6]. Microplastics represent a concerning environmental problem currently not addressed by the Life Cycle Assessment (LCA) methodology, the most common tool in evaluating the environmental impact of products, services, and activities. In recent years, several works have emerged to present a scientific approach to the quantification of the unitary environmental effects of microplastics through existing and novel impact categories [7,8,9]. In this project, a cohesive procedure was established, based on ISO 4484 series, for the simulation of a washing process, collection and filtration of effluents on silicon filters, and optical and chemical classification of emitted fibrous microplastics through μ-FT-IR spectroscopy. Spectroscopy results were compared to a gravimetric analysis. The spectroscopy analysis of PA6, PA6.6, PET, and PP samples revealed that fibrous microplastics of the same chemical species as the sample are equal to or less than 0.3% of the total emitted matter, confirming an extensive organic and synthetic material contamination. The quantity of emitted microfilaments doesn't significantly change between the first and third wash. An environmental assessment through the impact category "Physical effects on biota" [10], revealed that the direct emissions to the marine compartment of PET microfilaments from the polyethylene terephthalate sample have the largest impact at the midpoint and endpoint level, equal to 9.72e-01 PAF m3 day/kgsample and 2.65e-05 PDF m2 year/ kgsample.

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BIODIVERSITY AT RISK IN THE IN THE SPAMI PELAGOS SANCTUARY: THE IMPACT OF MARINE LITTER ON BIOTA

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The Mediterranean basin is the second largest biodiversity hotspot in the world; however, is under threat related to a plethora of anthropogenic stress. Biodiversity in the Special Protection Area of Mediterranean Importance (SPAMI) “Pelagos Sanctuary” coexists with many of anthropic impacts. This study focuses on the potential risks posed by marine litter to the Mediterranean biodiversity using Pelagos Sanctuary as a case study, shedding the light on the intricate interplay between marine litter pollution and ecosystem health. In detail, the main objective of this study is to propose a new methodological survey and an innovative strategy of data analysis to evaluate the potential impact of marine litter (including microplastics) on Mediterranean biota. More than 25 species (ranging from invertebrates to cetaceans) have been analyzed using two approaches: 1) the visual survey of 8 large vertebrate species (elasmobranchs, sea turtles, seabirds and cetaceans) throughout the study area, and the overlapping of their core density with the levels of abundance of microplastics and macrolitter monitored simultaneously in the same studied area; providing also data on the species richness of the marine megafauna inhabiting the SPAMI; 2) the evaluation of the presence of marine litter, microplastics and plastic additives in 10 bioindicator species (sea turtles, seabirds and cetaceans) accidentally stranded in the study area and 7sampled during the sampling activities or with the support of fisheries (invertebrates and fish). The final data processing, merging the data of biodiversity and marine litter abundance in the environment, as well as the analysis of marine litter, microplastics and plastic additives in bioindicator species, allowed to create risk maps for the biodiversity that inhabits this area of great ecological value and to identify critical areas to be preserved for habitat and biodiversity conservation.

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EARLY BIOFILM DEVELOPMENT IN BIODEGRADABLE AND TRADITIONAL PLASTICS THROUGH A MESOCOSM APPROACH

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To reduce the widespread diffusion of traditional not degradable and petroleum-derived plastics, the use of innovative bio-polymers (bioplastics) is proposed. These latter are considered sustainable and eco-friendly, but knowledge on bioplastics associated biofilm is still scarce; increasing this issue is mandatory to understand bio-polymers'degradation behaviour in the environment and to select more ecofriendly materials, prone to environmental dispersion. In this work, we characterized biofilm formation on two biodegradable plastics, namely Poly(3-hydroxybutyrate)- hydroxyvalerate (PHBv) and polylactic acid (PLA), in the marine environment and we compared it with traditional plastics (polypropylene, PP) . Specifically, biofilm colonization on PHBv, PLA and PP fragments was investigated in mesocosms in the Baltic Sea for three weeks (June 2023). Plastic samples were thermoformed in sheets, cut into 20x20 mm and assembled in a frame holder, where 9 samples of each polymer were attached. Biofilm colonization, prokaryotic abundance and community composition were assessed through 16S rRNA gene metabarcoding. Reads identified as eukaryotic were also analyzed. Results showed biofilm colonization on both bioplastics and traditional ones; biofilm increased along time and photosynthetic organisms appeared after 3 weeks. All polymers and controls had a specific associated prokaryotic community and prokaryotic abundance decreased according to the exposure time, except for PLA. The composition of prokaryotic communities differed among biofilms formed on the different polymers: the microbial community associated with conventional plastic PP was more similar to that of the seawater in the control treatment, while biofilms on PLA and PHBv shared a higher degree of similarity with each other. These findings suggest that microbial communities selectively colonize different plastic types, with bioplastics supporting distinct and specific bacterial biofilm assemblages over three-week exposure.

MARINE HEAT WAVES CAN MODULATE THE EFFECTS OF MICROPLASTICS ON MICROBIAL COMMUNITIES AND BIOGEOCHEMICAL CYCLING IN COASTAL SEDIMENTS

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Microplastics (MPs) pollution and global warming are usually considered and studies as separate threads, while they are closely related. A significant manifestation of heat accumulation on Earth is represented by marine heatwaves (MHWs), which are positive and persistent sea surface temperature anomalies. While it has been documented that either MPs or MHWs have the potential to affect ecosystem functioning, knowledge on the effects deriving by their contemporary occurrence is still unknown. To fulfill this knowledge gap, we conducted a short-term manipulative experiment (21 days) on temperate coastal marine sediments. We assessed changes in sedimentary OM quantity and biochemical composition, extracellular enzymatic activities (aminopeptidase, β-glucosidase, alkaline phosphatase), and microbial community profiles through 16S rRNA gene sequencing. We incubated sediments with particles of polyethylene (PE) and polystyrene (PS) particles (0.05% in weight), of size range 210 - 500, and we resembled a MHW cycle (+5◦C; 7 days) to evaluate possible effects of the two threats combined. We report that sedimentary biochemical composition significantly varied among treatments, especially lipid content, which was higher in PS-treated sediments than in controls, regardless of the temperature. Moreover, the exposure to the MHW affected sedimentary biogeochemistry, particularly degradation rates in PE-treated sediment, after two weeks. Specifically, alterations in degradation rates and OM turnover, mainly due to microplastic contamination at constant temperature, decreased in intensity with the occurrence of the MHW, except for beta-glucosidase activity, whose effects in sediments contaminated with PE were enhanced by the temperature anomaly. Effects of MP exposure were visible in microbial community already after 1 week of incubation, resulting in significant differences between the two temperature regimes through time. Significant differences were found also among control and treated samples and among the two treated samples. The effect of MP exposure seemed to have impaired the rare biosphere of the community, in particular potential animal and human pathogens and hydrocarbonclastic genera. Our results show that these two threats can combine their effects on sedimentary biogeochemistry, thus having possible far-reaching consequences on global biogeochemical cycles (i.e. carbon, nitrogen and sulfur).

MICROPLASTICS IN FISH SPECIES FROM THE ROMANIAN DELTAIC COAST

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The increasing presence of microplastics (MPs) in marine environments poses a significant threat to aquatic life and human health. This study evaluates the presence of MPs in gills and digestive tract (stomach and intestines) of *Alosa immaculata* (Pontic Shad), a migratory fish species of ecological and economic relevance in the Black Sea region. 20 individuals were collected near the Sf. Gheorghe branch of the Danube Delta, and analyzed using standard protocols involving chemical digestion and stereomicroscope identification. The results reveal a high presence of microplastics, mostly microfibers, with 85% of individuals exhibiting contamination, primarily in the digestive tract. The colors and morphologies suggest anthropogenic sources such as fishing gear or textiles while the comparison between samples collected in 2023 and 2024 highlights an increasing trend in intestinal MPs load. To further characterize the polymer types and confirm the synthetic nature of the particles, spectrometric analyses were conducted. The findings provide insights into MPs ingestion pathways (feeding and respiration) and raise concerns about the bioaccumulation of synthetic particles in commercially exploited fish species in the Western Black Sea.

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CHEMOMETRICS AND HYPERSPECTRAL IMAGING FOR A STANDARDIZED AND RAPID MONITORING OF MICROPLASTICS IN THE ENVIRONMENT

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Due to the uncontrolled global production of synthetic polymers and their improper disposal, microplastics (MPs) pollution now pervades all major environmental compartments, from terrestrial systems to freshwater and marine environments.
The analysis of MPs represents an increasing challenge in both environmental and analytical contexts, requiring robust and standardized approaches for their sampling, quantification, and characterization, as well as the development of harmonized and integrated protocols for inter-laboratory comparative studies.
Micro and macro hyperspectral imaging systems represent potential cost and time effective methods, enabling a direct detection of MP when applied directly on filters without heavy sample purification and manipulations, thus avoiding potential procedural bias related to particle pre-sorting steps. However, monitoring campaigns and the use of hyperspectral imaging techniques, which enable extensive characterization and localization of MPs within samples may generate large volumes of data difficult to process and interpret.
In this context, chemometric methods are emerging as essential tools for the processing and interpretation of chemical data obtained through spectroscopic techniques. These methods enable not only data dimensionality reduction and visualization, but also the classification and quantification of polymers in complex mixtures.
This contribution reports the application of different hyperspectral imaging systems operating in different spectral ranges, such as Near Infrared (1000-2500 nm) and Mid Infrared (4000-675 cm^{-1}) applied on cellulose filter, in combination with different tailored chemometric methods for data processing were proposed, also significantly reducing the time required for data processing and evaluation and able to enhance spectral differences between the cellulose background of the filter and the polymer of the MPs. In particular, an automated normalised difference image (NDI) strategy, Principal Component Analysis (PCA) and Multivariate Curve Resolution – Alternating Least Squares (MCR-ALS) were applied and compared.

IMPACTS OF MICRO- AND NANOPLASTICS ON ORGANISMS AND ECOSYSTEMS: BRIDGING KNOWLEDGE GAPS IN PLASTIC POLLUTION RESEARCH

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Risk assessment of plastics faces several critical gaps. One of the most critical is the limited data on exposure levels, particularly for small microplastics and nanoplastics, which fall below the detection limits of standard spectroscopic techniques. Exposure data are especially needed in terms of mass concentration for these smaller size fractions. There is also a significant knowledge gap regarding the environmental fate, degradation, and transport of plastic particles, especially those small enough to be internalized by organisms. Understanding exposure requires insight into plastic accumulation, uptake rates, additive leaching, and transport within environmental compartments. Notably, the scarce and often contradictory data on nanoplastic exposure demand urgent attention

The toxicological effects of plastics are still poorly understood, especially given the wide range of chemicals they contain, either as additives or as non-intentionally added substances. This gap is particularly critical for long-term, low-dose exposures and for highly hydrophobic additives. For meaningful risk assessment, more data is needed on sublethal effects, chronic exposure, and interactions with other environmental stressors. Additionally, most existing studies do not provide exposure–response data in a format suitable for Bayesian risk assessment, which requires mapping exposure–response curves to derive probability distributions. Another major limitation in current research is the widespread use of non-realistic test particles, which reduces the relevance and applicability of many nanoplastic toxicity studies. An important, and often overlooked, challenge is that findings must be interpreted considering potential internalization mechanisms: any detection of plastics in organisms must be accompanied by a plausible explanation of how the particles reached that location. Several other critical aspects remain poorly understood. These include the potential genotoxicity, mutagenicity, and carcinogenicity of plastics and their associated chemicals, as well as the role of plastics as carriers of pollutants, especially their ability to transport microorganisms such as pathogens and antibiotic resistance genes. Additionally, the fate and toxicity of emerging products, particularly bioplastics, their additives and their degradation products, require further study. The potential for plastics to move through food webs and agroecosystems, leading to human exposure through food consumption, is a major cause for concern that requires more investigation.

MICROPLASTIC DETECTION IN SOIL BY THZ TIME-DOMAIN HYPERSPECTRAL IMAGING COMBINED WITH UNSUPERVISED LEARNING ANALYSIS

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This study introduces a novel method for detecting and spatially mapping polyethylene microplastics in soil using Terahertz Time-Domain Hyperspectral Imaging (THz-TDHSI). Initially, we assess whether increasing microplastic concentrations (1%, 5%, and 10% by volume) causes systematic changes in THz signals across time and spectral domains. Averaged responses across the sample area reveal that higher plastic content correlates with increased peak-to-peak amplitude, longer signal duration in the time domain, and attenuation or narrowing of spectral features—most notably the loss of the 0.4 THz absorption peak. To distinguish plastic from soil, we employ a similarity analysis comparing sample spectra with reference spectra of pristine soil and polyethylene. This produces heatmaps that clearly separate the two materials spatially. However, this approach requires prior knowledge of reference materials, which limits its use in unknown or naturally mixed soils. To address this, we implement three unsupervised techniques—Principal Component Analysis (PCA), K-means clustering, and Gaussian Mixture Models (GMM)—which identify patterns within the data without relying on external references. Each method segments the hyperspectral data into distinct regions corresponding to different material compositions. By averaging the spectra from these segments and comparing them to known reference spectra, we confirm the presence of polyethylene microplastics. Notably, all three unsupervised methods converge on similar spatial patterns and spectral distinctions, underscoring the reliability of the analysis. This integrated approach—combining THz spectral imaging, similarity analysis, and unsupervised learning—offers a robust, label-free strategy for detecting microplastics in complex, heterogeneous soils. It holds significant promise for environmental monitoring and diagnostics in real-world settings where prior material knowledge is unavailable.

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DETECTION OF MICROPLASTICS IN ENVIRONMENTAL COMPRARTMENTS NEAR A TRAFFIC-INTENSIVE ROAD

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Traffic-intensive roads have recently been recognized as significant sources of microplastic (MP) pollution in surrounding environments. Non-exhaust emissions, including tire and brake wear, pose potential risks to human health, similar to those from exhaust particles, but remain comparatively underexplored. While the health effects of exhaust-related air pollution have been widely studied, the impacts of airborne microplastics from traffic abrasion are still poorly understood, especially in relation to their presence in air, stormwater, and road dust. This study investigates MP contamination across these three matrices near a highly trafficked highway in southern Norway. Air samples were collected using passive samplers; road dust was sampled with a custom-built device; and road runoff was retrieved via a dedicated drainage station. Samples were prepared using matrix-specific protocols and analyzed by micro-FTIR imaging to determine polymer identity, particle size, and estimated mass. Pyrolysis-GC–MS was applied in parallel to quantify tire wear particles (TWP), a subset of MPs not easily detectable by FTIR. MPs were identified in all matrices. Polypropylene and polyamide dominated stormwater samples, while polyester and polyamide were most prevalent in air. Road dust showed the highest concentrations of MPs and TWP mass, reinforcing its role as a key source and reservoir. Airborne MPs varied between sampling periods, influenced by weather conditions and traffic patterns. These findings emphasize the importance of adopting a multi-matrix approach when assessing traffic-related microplastic pollution. The results provide valuable baseline data for future monitoring and underline the need for targeted mitigation strategies in urban and peri-urban transportation corridors.

MICRO AND NANOPLASTICS AS EVOLVING CONTAMINANT CARRIERS: BENZODIAZEPINE SORPTION ON VIRGIN, AGED AND BIOFILM-COATED PARTICLES CHARACTERIZED BY MOI-LEI-QQQ MS

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Microplastics (MPs) and nanoplastics (NPs) are emerging environmental contaminants that can act as vectors of many pharmaceuticals, including widely misused benzodiazepines (BZDs). BZDs are the highly prescribed psychotropic drugs worldwide and their extensive use has led to their detection in aquatic environments [1]. The co-occurrence of pharmaceutical residues and MPs/NPs raises concerns about their interactions and effects on contaminant fate. The study investigates the sorption behaviour of four different BZDs including clonazepam, diazepam, oxazepam, and lorazepam, onto virgin, photo-oxidized (aged), and biofilm-coated polypropylene, low-density polyethylene MPs and polyvinyl chloride NPs. This study introduces an innovative analytical approach combining Solid Phase Microextraction (SPME) with Microfluidic Open Interface (MOI) and Liquid Electron Ionization Mass Spectrometry (LEI-MS) to investigate the adsorption of BDZ onto MPs/NPs. LEI-MS offers reduced matrix effects, allowing external calibration for a direct-MS technique and providing an effective tool for continuous monitoring of organic contaminants in aquatic environments [2]
Using SPME desorbed in the MOI and directly coupled with the LEI-triple quadrupole mass spectrometry (MOI-LEI-QqQ MS), we assessed how polymer type, particle size, and environmental conditions influence BZD sorption. Results show significant variation in sorption capacity by different polymers, with smaller NPs exhibiting higher affinities than MPs. These findings suggest that weathered and biofilm-laden plastics may act as effective vectors for BZDs, increasing their mobility and ecological impact in aquatic systems.

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PROGRESS IN ANALYTICAL STRATEGIES FOR MICRO- AND NANOPLASTICS DETECTION AND CHARACTERISATION

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The widespread presence of micro- and nanoplastics (MNPs) in environments such as water, soil, air, and biota has raised concerns about their persistence, ecological effects, and health risks. Originating from products or degradation of larger plastics, MNPs are challenging to detect due to their varied size, shape, polymer type, and surface properties.
This contribution presents recent progress in advanced analytical strategies for the detection, quantification, and characterization of MNPs. It highlights the application of emerging and established techniques such as pyrolysis-GC-MS, DLS, NTA and AFM with the emphasis on the detection of nanoplastics, which remain especially difficult to study.
By showcasing different case studies, this work aims to support reliable data generation for environmental monitoring and risk assessment. Continued innovation and standardisation in this field are essential to improving our understanding of MNP distribution, behavior, and interactions with co-occurring pollutants.

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CHEMICAL CHARACTERIZATION AND BIOLOGICAL EFFECTS OF LEACHATES FROM COMMERCIAL AND NATURALLY WEATHERED PLASTICS

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Plastics in aquatic environments can exert both mechanical and chemical effects, the latter involving the transport and release of potentially harmful substances, including additives and adsorbed contaminants. Polymer type, physical properties of plastics, and degree of weathering influence the composition, leaching potential, and toxicity of released chemicals.
This study analyzed PFAS, BFRs, bisphenol A, phthalates, PAHs, and heavy metals in leachates obtained from polystyrene (PS) sheets, polyurethane (PUR) pipes, polypropylene (PP) mussel nets, and polyvinyl chloride (PVC) pipes, both commercial sourced and weathered at sea for 3 months. Leachates were produced by agitating plastic fragments (1 cm^2) for 72 hours in artificial seawater (plastic-to-water ratio: 100 g/L for PUR, PP, and PVC; 30 g/L for PS). Most target compounds were below the limit of detection in both commercial and weathered leachates, except bisphenol A, which was detectable in all samples; phthalates were found at higher concentrations in commercial PUR leachates.
Effects organism-level were assessed using bioluminescence inhibition in *Aliivibrio fischeri*, algal growth inhibition in *Phaeodactylum tricornutum*, and embryotoxicity in *Crassostrea gigas*, testing both undiluted and diluted leachates (from 0.1 to 100 g/L). Results showed higher toxicity for commercial plastics compared to weathered ones, with significant effects observed at concentrations as low as 10 g/L.
Cellular and biochemical effects were further investigated through the analysis of a battery of biomarkers in *Mytilus galloprovincialis* directly exposed for 21 days to commercial and weathered plastic fragments (10 g/L for PUR, PP, and PVC; 3 g/L for PS). Immune and antioxidant responses, and neutral lipid content, were the most significantly affected parameters with commercial-PS inducing the most pronounced effects. Integration of bioassay and biomarker data using a Weight of Evidence model indicated a higher risk for organisms exposed to commercial plastics, highlighting the need for improved management of plastic pollution in marine environments.

EXPLORING THE POTENTIAL OF ONE-POT MICROWAVE-ASSISTED PRETREATMENTS COUPLED WITH PY-GC-MS FOR THE QUANTIFICATION OF MPS AND ASSOCIATED CONTAMINANTS

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Microplastic (MP) pollution has been acknowledged as a global threat and presently one of the most pressing environmental issues. Different analytical techniques have been applied and optimized for the analysis of MP and of non-polymeric organic compounds associated with them, such as additives, persistent organic pollutants, and polymer degradation products. Nevertheless, there is still a major lack of understanding of the interaction mechanisms between these classes of pollutants and ecosystems. Analytical pyrolysis-based techniques have proven to be effective in the analysis of MP in environmental samples, providing mass-based quantification of different polymers, along with the quantification of MP-associated organic contaminants. However, depending on the environmental matrix, sample pretreatment before analysis can require numerous and time-intensive steps. In this work, we tested and optimized a new one-pot microwave sample pretreatment that allows for a comprehensive overview of the contaminants and microplastics present in the sample. The method was developed using mussels fed with microplastics (PP, PE, and N6), in order to work with a complex and challenging matrix rich in protein and lipids. We combined microwave-assisted extraction with thermal desorption and analytical pyrolysis coupled with gas chromatography and mass spectrometru (Py-GC-MS) to characterize and quantify different classes of pollutants frequently associated with MPs in biological samples [1,2], such as phthalate plasticizers, as well as contaminants including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and other contaminants of emerging concern (CECs). The same sample was subsequently processed through microwave digestion in order to characterize and quantify the MPs content. Different conditions were tested to obtain the most efficient digestion approach while limiting polymer degradation. This new rapid method paves the way for future applications to other biological samples, particularly human samples. Such an extension would enable direct assessment of human exposure to microplastics and related pollutants, offering valuable data for public health research and environmental risk assessment.

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MICROPLASTIC CONTAMINATION IN WATER AND SEDIMENT IN ANAWILUNDAWA MANGROVE RESTORATION SITE, SRI LANKA

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Mangrove ecosystems could trap microplastics (MPs) due to their structural complexity and dense root systems. This study assessed microplastic (MP) abundance and characteristics in surface water and sediment from locations (in triplicate) covering the Accelerated Natural Regeneration of Mangroves (ANRM) restoration site in Anawilundawa, Sri Lanka, in 2024. MPs were extracted from surface water (30 L) and sediment (400 mL) samples by organic matter digestion (10% KOH and 30% H_2O_2), and density separation (saturated NaCl and NaI) and filtration (0.45 µm) then, classified based on shape, color, and size, using a stereomicroscope. Overall, sediment samples exhibited a significantly higher MP abundance (50.5 ± 39.3 items/L) than water samples (0.4 ± 0.2 items/L; ANOVA, df,1,29, $p < 0.001$). A man-made canal within the southern border had the highest MPs count in sediment (89.2 ± 43.5 items/L), while a recently dug canal in mid-section had the highest MPs in water (0.77 ± 0.58 items/L). Fibres were dominant in both water (87.1%) and sediment (82.8%), with black being the most recorded colour (27.9% in water, 32.7% in sediment).
Observed spatial variations suggest the anthropogenic influences on MPs accumulation in this sensitive environment. This research represents the first detailed baseline study in the Anawilundawa ANRM mangrove restoration site in Sri Lanka that combines microplastic distribution, particle characterisation, and statistical spatial analysis in an actively restoring mangrove ecosystem. These findings highlight the urgent need for targeted mitigation strategies, increased public awareness, and continuous monitoring to reduce plastic pollution impacts and support the long-term success of mangrove restoration efforts.

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BREATHING PLASTIC: QUANTIFYING INDOOR AIRBORNE MICROPLASTICS IN INDUSTRIAL WORKPLACES USING PY-GC-MS AND FLUORESCENCE MICROSCOPY

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Workplaces that process plastics have a high potential for airborne microplastics (MPs) exposure due to their activities. These environments are ideal for developing and validating methods to detect and characterize MPs [1]. This study investigated the presence of airborne MPs to achieve a comprehensive understanding of potential exposure. Air sampling was strategically conducted at three distinct locations within each facility, with each site selected to represent a specific exposure scenario. In addition, personal sampling and external (ambient) air monitoring were performed to capture both individual exposure levels and background concentrations. We developed and applied a dual-technique approach, combining pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS) and fluorescence microscopy, to measure both mass and number concentrations of MPs in indoor air and settled dust. Active sampling was carried out in three different waste processing plants in central Italy using quartz and polycarbonate (PC) filters in parallel for subsequent Py-GC-MS and fluorescence microscopy analyses, respectively. Quartz filters were punched and directly analysed by Py-GC-MS. Airborne particulate matter collected on PC filters was recovered and chemically digested using Fenton's reagent to degrade the organic components. Subsequently, the solution was filtered onto cellulose ester filters, stained with fluorescent Nile Red, and analysed by fluorescence microscopy. By using this integrated approach, we accurately quantified airborne MP concentration across different areas of the working environment. Py-GC-MS analysis enabled the determination of eleven different polymers: polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), polymethyl methacrylate (PMMA), acrylonitrile butadiene-styrene (ABS), styrene-butadiene rubber (SBR), polyethylene terephthalate (PET), PC, nylon 6 (N6), and nylon 66 (N66). Preliminary results of Py-GC-MS quantification at one waste processing plant revealed concentrations of PP, PMMA, PS, PVC, and ABS varying from 1 to 93 µg/m³, in different working areas.

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X-RAY COMPUTED TOMOGRAPHY: A NOVEL APPROACH FOR INVESTIGATING MICROPLASTICS IN THE FISH DIGESTIVE SYSTEM

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Micro-computed tomography (microCT) has emerged as a transformative tool in microplastics (MPs) research, offering unprecedented non-invasive 3D imaging capabilities that surpass traditional analytical methods. This advancement is particularly significant in studying the fate of MPs within the digestive systems of aquatic organisms, such as fish. Traditional techniques like spectroscopy and pyrolysis often fail to provide a detailed spatial distribution of MPs within biological tissues. MicroCT addresses this gap by enabling precise localization of MPs as small as 30 µm in the gastrointestinal tract of zebrafish. By employing contrast agents like iodine staining, microCT enhances the visibility of MPs against soft tissue backgrounds, facilitating accurate tracking of particles movement and accumulation sites. A novel application of microCT is its ability to monitor MPs post-digestion, providing insights into their translocation and potential impacts on internal organs. This capability is crucial for understanding how MPs interact with biological barriers and accumulate in tissues, essential for assessing their toxicological effects. Furthermore, microCT's non-destructive nature preserves tissue integrity, allowing subsequent histological analyses to correlate structural changes with MPs exposure. Integrating microCT into MPs research represents a significant leap forward, offering a comprehensive approach to study the complex interactions between MPs and biological systems. As this technology continues to evolve, it holds promise for advancing our understanding of environmental pollution and its implications for aquatic life and human health.

FROM PLASTIC TO SOIL: TRACING THE LEACHING OF ADDITIVES FROM BIODEGRADABLE MULCH FILMS INTO THE SURROUNDING SOIL

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Biodegradable film (BF) are emerging as a more sustainable alternative to conventional polymers, particularly in agricultural and food packaging applications, to mitigate longterm environmental accumulation and microplastic pollution. Unfortunately, the progressive deterioration of BFs when buried in soil, characterized by surface erosion and changes in mechanical properties, can still lead to the release of microplastics into the soil [1]. Furthermore, despite the degradability of the polymer backbone, biodegradable plastics often contain a variety of chemical additives such as antioxidants, plasticizers, stabilizers, and processing aids, that may be released into the environment during the polymer degradation process resulting persistent or toxic for the ecosystem. In addition, the fate and behavior of these additives during biodegradation remain poorly understood, partially due to the complexity of soil matrices and the lack of sensitive and comprehensive analytical tools.
Here, we report, an integrated analytical approach to identify and quantify selected additives released from biodegradable mulch films into the soil under specific soil burial condition, with the aim of tracking their preferential leaching pathways and environmental behavior.
Through this approach, we address a critical gap in the current assessment of biodegradable plastics, allows for a more comprehensive understanding of the chemical fate of these substances, their persistence, and their potential to affect soil ecosystem.

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LIGHT-DRIVEN ADVANCED OXIDATION PROCESSES AS SUSTAINABLE TECHNOLOGIES FOR REMEDIATION AND UPCYCLING OF MICRO/NANOPLASTICS

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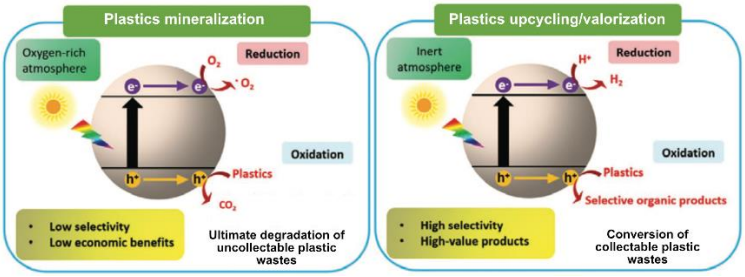
Nowadays, the disposal of plastics which end up in landfills or the environment, causes severe ecosystem pollution and poses significant risks to human health. Despite advances in treatment/recycling technologies, current methods still remain insufficient so far. Moreover, the need for decarbonization of our society, spurred by the depletion of fossil resources and the effects of global warming, has made the search for sustainable solutions for plastic waste reduction and valorization a critical priority within the broader context of the energy transition and environmental protection.

This talk will present the background and rationale for using light-assisted advanced oxidation processes (AOPs) as sustainable photochemically-driven methods in which solar light activates photocatalysts with or without the help of additional oxidants like H_2O_2 or peroxysulfates, with the consequent generation of reactive oxygen species (e.g. $^{\bullet}OH$, $O_2^{\bullet-}$, $^1O_2$, $SO_4^{\bullet-}$). It will examine how these species can either non-selectively mineralize plastics in water to CO_2 and H_2O [1,2], or oxidize them selectively to value-added compounds like fuels (H_2) or chemicals [3]. Advances in the field will be shown.



Photodegradation of (uncollectable) plastics vs. upcycling/valorization of collectable plastics into value-added products (H_2, fuels, chemicals). Adapted from Adv. Energy Mater. 2022, 12, 2200435

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ADVANCED CASCADE TREATMENT SYSTEM FOR RETENTION AND ELIMINATION OF MICROPLASTICS FROM WASTEWATER EFFLUENT

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Microplastics have emerged as persistent pollutants, posing ecological and potential human health risks once released into aquatic environments. Wastewater treatment plants (WWTPs) are recognized as key control points for preventing their discharge into natural water bodies. However, current treatment technologies are not specifically designed for microplastic retention, resulting in partial removal and continuous emissions to receiving waters. Addressing this challenge requires innovative and scalable treatment concepts capable of achieving near-complete elimination of microplastics from effluents.

Within the Horizon Europe INSPIRE project under the Mission Ocean, a pilot cascade system integrating advanced treatment technologies has been developed through technologies of project partners WNW, DELVEC, CLERA, and KTH, and coordinated by partners MINDS and UM, with the goal of evaluating its performance under real operating conditions. The system was installed at the Domžale–Kamnik WWTP (Slovenia), where wastewater was treated sequentially through multiple pilot units, each employing distinct removal mechanisms. This configuration allows for direct comparison of individual unit performance as well as assessment of cumulative effects across the cascade.

Comprehensive sampling campaigns were conducted at each treatment stage to determine microplastic concentration. Samples will proceed to be analyzed by laboratories of project partners VITO and VLIZ, using harmonized analytical methods to quantify both particle counts and polymer mass.

The expected outcomes include identification of optimal technology combinations and operational parameters that maximize microplastic retention efficiency, with the end goal of total elimination of microplastics from treated water bodies. The study provides an evidence-based foundation for future implementation of advanced treatment solutions and contributes to the broader European efforts to mitigate microplastic pollution and protect aquatic ecosystems.

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PREVENTING MICROPLASTIC FORMATION: THE EPIC PROJECT'S INTEGRATED RESPONSE TO MARINE MACROLITTER ACCUMULATION

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EPIC (un marE PrIvo di plastiCa) project, funded by the Italy–France Interreg Maritime Programme 2021–2027, brings together 16 Italian and French partners to address plastic pollution in marine/coastal areas through cross-border collaboration. Target areas include Tyrrhenian Sea, Sea of Sardinia, Gulf of Lion, Ligurian Sea, and Strait of Bonifacio, with actions tailored to local contexts and built on best practices, promoting circular economy solutions, early plastic waste collection and innovative monitoring to prevent microplastic (MP) formation from accumulated macrolitter (ML). The contribution of the involved CNR institutes (IAS, ISMAR, IBE and IPCF) is aimed at identifying pollution sources and accumulation zones –both submerged [1] or on coastal areas [2] using aerial and marine drones, complemented by the creation of highdefinition circulation models, which will help to determine the contribution of local rivers and the connectivity between coastal and offshore areas [3]. Finally, as EPIC goal is to identify the locations and causes of ML accumulation and to optimize their removal –preventing MP formation while encouraging their potential reuse– an additional key aspect is the investigation methods for reusing recovered polymeric materials, ranging from fuel production to recycling, along with an evaluation of their degradation state [4,5].

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DEGRADATION OF BIODEGRADABLE POLYMERS IN SIMULATED MARINE ENVIRONMENTS

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Global plastic production has increased rapidly over the past two decades and has reached 400 million tons in 2023, of which 8.4% comes from recycled plastic and 0.7% from bio-based materials [1]. Due to poor management, 10 to 20 million tons of plastic end up in the oceans every year, and by 2050, the amount of plastic could exceed fish stocks. Plastic waste is a source of secondary microplastics and nanoplastics as larger fragments decompose and fragment through a combination of photochemical, biological, mechanical, and chemical degradation depending on environmental conditions. Biodegradable plastics made from renewable or fossil resources, such as polylactic acid (PLA), polyhydroxyalkanoates (PHA), poly(ε-caprolactone) (PCL), polybutylene succinate (PBS), and polybutylene succinate-co-adipate (PBSA), are seen as alternatives to non-degradable plastics. However, some of these polymers have been found in the marine environment in the form of microplastics. For example, PCL fragments have been found in the Mediterranean Sea [2], suggesting that biodegradable plastics may not be readily degradable under natural conditions and therefore cannot completely solve the marine pollution problem. Long-term use of biodegradable plastics may lead to similar problems as with conventional plastics due to their improper handling and their accumulation in the environment. Further research is needed to evaluate whether biodegradable plastics truly degrade in marine conditions or risk accumulating in ecosystems.

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PLASTIC DEGRADATION AND BIOFILM FORMATION IN FRESHWATER ENVIRONMENTS: INSIGHTS FROM SHORT- AND LONG-TERM STUDIES

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The persistence of plastic materials in ecosystems raises growing concern due to their potential to degrade and break down into microplastics and/or toxic substances, while serving as substrates for microbial colonization. Understanding how different plastic types interact with aquatic environments is essential for assessing their long-term ecological impact. This contribution explores the interplay between polymer degradation and biofilm development in freshwater, drawing from both short-term and long-term in situ experiments conducted in Lake Maggiore (Northern Italy). A range of plastic materials—including conventional polymers and biodegradable alternatives—were exposed to surface waters and sediments. Over incubation periods ranging from several weeks to multiple years, we investigated material changes using spectroscopic and thermal analyses and examined biofilm communities, with a focus on microbial diversity, functional potential, and diatom colonization. Preliminary and previously published findings reveal that degradation is both material- and environment-dependent, with microbial communities showing distinct composition and structure across substrates. These observations raise questions about the environmental behavior of so-called “biodegradable” plastics and the ecological roles of biofilms formed on synthetic surfaces. The discussion will be grounded in case studies from Lake Maggiore and highlight methodological approaches, challenges, and future directions in freshwater plastic pollution research.

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TOWARDS A SMARTER AQUACOLTURE: SAFE AND SUSTAINABLE BY DESIGN APPROACHES TO REDUCE MICROPLASTIC EMISSIONS FROM NETS AND ROPES

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Microplastic (MP) emissions from aquaculture nets and ropes, especially during *in-situ* cleaning operations, are a growing environmental concern. The SMARTER project evaluated these emissions by combining laboratory abrasion tests and field assessments using elements of a safer-and-sustainable-by-design (SSbD) approach. Laboratory abrasion testing simulating abrasion damage from net cleaning operations revealed clear material-/age-dependent MP emission patterns. Conventional nylon nets released up to five times more MPs than monofilament high-density polyethylene (HDPE) or ultra-high-molecular-weight polyethylene (UHMWPE), underscoring the vulnerability of multifilament structures to mechanical wear. Coating–substrate compatibility further influenced emissions, where premium antifouling coatings significantly increased MP release from nylon, likely due to thicker, less integrated layers, while UHMWPE nets showed no such increase, suggesting superior coating adhesion and abrasion resistance. Furthermore, used nets shed more MPs than new nets. Rope assessments showed similar trends. Recycled polyolefin ropes released more MPs than virgin equivalents, and aged UHMWPE ropes released substantially higher amounts, primarily due to degradation of the residual coating. Additionally, the architecture of ropes played a notable role in modulating MP release. Accelerated net cleaning experiments found MP concentrations in surrounding water to be near background levels for pressure washing, cavitation and autonomous underwater vehicle (AUV) brushing, however, microscopy showed that AUV brushing inflicted the least coating damage. Field campaigns during routine net cleaning with pressure washing captured sporadic, highly variable MP emissions influenced by net age, cleaning history and site conditions. At on-shore net-cleaning service stations, detectable MPs were generated, but high-capacity filtration successfully retained particles, preventing discharge to the marine environment. These studies demonstrate that MP emissions depend by polymeric composition, coating compatibility, product ageing and maintenance practices, therefore by adopting design-informed choices the aquaculture industry has the potential to reduce MP emissions at the source, aligning with SSbD principles to minimize environmental impact while maintaining operational performance.

‘GHOST BOATS’ IN VENICE: ENVIRONMENTAL CONCERNS, GREEN CHEMICAL FINGERPRINT, CIRCULAR AND SUSTAINABLE END-OF-LIFE-SOLUTIONS

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Abandoned leisure boats undergo weathering and progressively fragment into scraps releasing microplastics, various chemicals, and fiberglass dusts. We tackle this problem via a multiple level citizen science involving chemistry students, personnel assigned for Public Utility Work by the Venice court, and SMEs, within the sustainable business concept of the Triple Bottom Line [1]. For the very first time an analytical procedure was optimized to scrutinize the leaching of a variegated assortment of chemicals from ‘ghost boats’ via a green analytical approach (AGREE Prep score 0.8, Analytical Eco-scale score 91). We studied the marine contamination at the molecular level, via HS-SPME-GC-MS, deciphering the volatiles fingerprint of three representative kind of samples (water, soil, and mud) in a remote environment of the iconic Venice Lagoon, contaminated by decaying fiberglass boats. Among the forty-three positively identified analytes, fifteen are related to polymers chemistries. The chromatographic signatures of the volatile organic compounds are dominated, in all cases, by polyurethane related markers, such as isocyanates and polyols. This can be rationalized by the pervasive presence of polyurethane in recreational boats due to its high thermal and electrical resistance, low weight, rigidity or flexibility. Fossil fuels volatiles, pharmaceuticals and other common chemicals were also detected. Seventeen analytes come from the biotic environment. Among them, sarcosine, ethanolamine, methoxy-phenyl oxime, and phytone are specific to the marine biotic environment. According to a Precautionary Principle, this study prompts the removal of these ‘ghost boats’ for environmental and health reasons, beyond aesthetics and safety motivations. It sheds lights on the origin of the problem from the governance level and it recommends solutions. Finally, it draws insights from an operational sustainable circular economy model preventing the contamination of the biosphere by the plastisphere, showcasing a repurposing of ‘ghost boats’ with carbon negative emissions certified by an Environmental Product Declaration.

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OCCURRENCE, SOURCES, FATE, ACCUMULATION AND TRANSPORT DYNAMICS OF TEXTILE FIBRES IN OCEANIC ENVIRONMENTS

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Global production of synthetic and natural textile fibres has more than doubled in the last 20 years, reaching 107 million tonnes in 2018 and is expected to reach 145 million tonnes in 2030 if business continues as usual. Synthetic fibers now account for nearly two-thirds of global fiber production and 14.5% of plastic production, although it is now clear that most of the fibers found in the environment are natural fibers of animal or plant origin, such as cotton and wool. The increasing consumption of textile products has led to the accumulation of large quantities of microfibers in the marine environment, with impacts and degradation times currently unknown. Textile fibers are now the most prevalent type of anthropogenic particle detected in microplastic pollution surveys worldwide, often accounting for 80-90% of microplastic counts. Substantial concentrations of microfibers have been detected globally in surface and subsurface waters, polar regions, deep-sea and coastal sediments, as well as terrestrial and freshwater ecosystems. Recent studies have reported the presence of these particles in atmospheric samples even in the most remote areas of the planet. Given their abundance, it is not surprising that fibers have also been found in food, drinking water, and human lungs, as well as in the digestive system of many aquatic and terrestrial organisms. The potential impacts of microfiber ingestion on marine organisms are still under investigation, but concerns exist regarding physical damage, reduced feeding, and the transfer of adsorbed pollutants. Furthermore, a wide variety of chemicals, including dyes, additives, and flame retardants, are used during natural and synthetic textile production, raising concerns about the role of fibers as carriers of hazardous substances in the environment. Future research should focus on understanding the degradation rates of different fiber types, the effects of microfibers on marine ecosystems, and the development of strategies to reduce microfiber pollution. This talk will review and summarize available information on the occurrence, sources, fate, accumulation, and transport of natural and synthetic fibers in the marine environment. Results and research experiences dealing with the distribution, movements, long-range transport, degradation, and sinking dynamics of fibers in ocean environments will be presented. The main methods used to quantify this contaminant in the marine environment and the critical knowledge gaps that require further research will also be discussed. By understanding the extent of microfiber pollution and its potential impacts on marine ecosystems, we can work towards sustainable textile production and consumption practices.

TRUE-TO-LIFE MICROPLASTICS: BRIDGING LABORATORY AND ENVIRONMENTAL RELEVANCE

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Understanding the behavior and impacts of micro- and nanoplastics (MNPs) requires test materials that realistically reproduce the properties of particles found in the environment. In this work, true-to-life MNPs were produced and characterized to provide reliable test materials for ecotoxicological studies. Expanded polystyrene (EPS) and polyester (PET) were chosen due to their widespread environmental occurrence. EPS-MNPs were generated through cryogenic mechanical fragmentation of construction materials, while PET microfibers were obtained from controlled washing tests of polyester textiles. A multitechnique analytical approach—optical and electron microscopy (SEM), atomic force microscopy (AFM), microFTIR, microRaman spectroscopy, advanced Raman techniques, thermogravimetric analysis (TGA), and microX-ray diffraction (microXRD)—was applied to evaluate morphology, chemical composition, and structural integrity, confirming the preservation of polymer identity and revealing heterogeneity in size, shape, and degradation features.
Environmental samplings complemented the laboratory work, with EPS debris from cleanup campaigns fragmented and used to increase the environmental relevance of the test materials. Mussels were experimentally exposed to EPS particles to investigate uptake, accumulation, and egestion dynamics. Overall, these true-to-life MNPs represent reliable materials for realistic ecotoxicological testing and improved risk assessment. Their environmentally relevant features also make them suitable for supporting harmonized protocols and for studies on degradation, contaminant sorption, and trophic transfer, thus contributing to a better understanding of MNP behavior in real scenarios.

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BIODEGRADABLE BUT PERSISTENT? INSIGHTS INTO THE ENVIRONMENTAL IMPLICATIONS OF MICROPLASTICS FROM BIODEGRADABLE PLASTICS

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Biodegradable plastics are increasingly promoted as a sustainable alternative to conventional plastics. However, little is known about their actual behavior in open environmental systems. In recent years, we have investigated the environmental fate and ecotoxicological impacts of microplastics derived from biodegradable plastics, focusing on both aquatic and terrestrial ecosystems. Our results showed that the biodegradation potential of various biodegradable plastics (e.g. polybutylene adipate terephthalate and poly(3-hydroxybutyrate)) ranges from low to moderate and is highly dependent on environmental conditions and pre-treatment. Exposure to UV radiation increased degradation to a certain extent but also resulted in leaching of additives. Complete degradation was not achieved under environmentally relevant conditions. As a result, even plastics labelled as biodegradable may persist in the environment. Ecotoxicological assessments in the aquatic environment showed low effects in acute tests, while the effects increased under chronic exposure. Additionally, indirect effects were observed, primarily due to microbial activity during biodegradation processes, which can alter nutrient availability for aquatic plants. In terrestrial systems, biodegradable microplastics produced similar impacts to those of conventional plastics, particularly in terms of effects on soil organisms. We also observed alterations in important soil properties such as pH and water holding capacity, which could have a long-term impact on soil health and function. These results indicate that the term “biodegradable” does not always reflect the actual degradation behavior of plastics in the natural environment. Further testing under environmentally relevant conditions would help to improve our understanding and support informed decisions in material development and environmental policy.

MICROPLASTICS IN MUSSELS (*Mytilus galloprovincialis*): A NATIONWIDE SURVEY OF MARINE POLLUTION IN ITALIAN COASTAL WATERS

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Plastic marine litter is a growing environmental concern, and microplastics (MPs) represent one of the most pervasive and insidious forms of pollution affecting marine ecosystems. This study assessed MPs contamination in *Mytilus galloprovincialis*, a widely consumed bivalve and recognized bioindicator species, across several Italian coastal regions subject to intense anthropogenic pressure from urban, industrial, and agricultural activities. The research involved a coordinated effort among ten Experimental Zooprophylactic Institutes in Italy, exploiting data from two national surveillance programs funded by the Italian Ministry of Health. MPs were detected from 7% to 13% of mussel samples, predominantly in the form of polypropylene and polystyrene fragments and fibers. Our results are consistent with previous studies highlighting the widespread distribution of MPs in marine environments. Given that mussels are consumed whole, the presence of MPs in their tissues raises potential concerns for human exposure. The study emphasizes the urgent need for harmonized detection protocols, improved monitoring of marine debris, and strengthened waste management strategies. Raising public awareness and promoting cross-sectoral policies are essential to mitigate the ecological and health risks posed by microplastic pollution. Further research is warranted to explore the long-term impacts of MPs on both marine ecosystems and public health.

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IMPRINTED BY PLASTIC: TRACING SITE-SPECIFIC MICROPLASTICs AND PHTHALATES IN *PARAPENAEUS LONGIROSTRIS*

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Microplastics (MPs) and their additives, phthalates (PAEs), are among the most pervasive contaminants, posing risks to aquatic ecosystems and human health [1,2]. This study investigates MPs ingestion by *Parapenaeus longirostris* - a key trophic connector and commercially important crustacean in the Mediterranean Sea - and the presence of PAEs in its muscle tissue, offering a broader understanding of the ecological implications of MPs contamination in marine organisms. Sampling was carried out at three sites in the Central Tyrrhenian Sea, along a gradient from the Tiber River mouth, a major source of land-based contaminants. MPs were found in specimens from all sites, with ingestion rates varying spatially and peaking (78%) near the river mouth, suggesting anthropogenic influence. Polymeric composition differed among sites, indicating site-specific contamination. PAEs were detected in 32% of the subsample (5–1122 ng/g w.w.), with the highest average concentration (68.26 ± 55.74 ng/g w.w.) at the site showing the greatest MPs ingestion. Although no significant differences in PAE concentrations were observed among sites, the similar spatial patterns of MPs and PAEs suggest a potential link, with PAEs possibly deriving from ingested MPs and reflecting local environmental pollution. These results highlight the need for integrated monitoring under the One Health framework and the relevance of *P. longirostris* as an intermediate species potentially mediating MPs transfer through trophic levels.

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MICRO AND NANO-PLASTICS
A NEW CONCERN FOR PUBLIC HEALTH?

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Plastic and its degradation products are growing and becoming a global emergency. The biogeochemical cycles of the planet and the ecosystems are largely contaminated and influenced by plastic materials and micro and nanoparticles that now day are distinctive element in the Earth's geology at every latitude, so much so that the term "Plasticene" has been used to define the geological era characterized by this massive presence. The degradation of plastic, exacerbated by climate change, generates plastic particles, called microplastics (MP) and nanoplastics (NP). Due to their small size, they are transported everywhere, and therefore we find them increasingly in the air, in the sea and in fresh water, in the soil, and bioconcentrated in the food chain. Food consumption is one of the most important human exposure pathways to MPs that have been found in fishery and aquaculture products, in vegetables and in other important food products. MPs, due to their oxidative stress and inflammatory effects, are a growing concern for human health. Furthermore, due to their hydrophobic surface, they act as a Trojan horse for other types of environmental contaminants that are known to be toxic and endocrine disruptors. This is a concern for human health as MPs and NPs enter the human body mainly through ingestion of food, water and other beverages, as well as through inhalation and direct contact with the skin. They have been found in the placenta, urine, follicular fluid, atheromatous plaques, seminal fluid as well as in blood which transports them throughout our body. Several studies in mammals indicate that MPs smaller than 10 µm can cross cell membranes, posing potential health risks through oxidative stress, inflammation, immune dysfunction, neurotoxicity, altered metabolism, impaired cell proliferation, alteration of the gut microbiota, abnormal tissue development and carcinogenicity. Our studies on human populations have highlighted the negative role of MPs in male and female fertility, in dialysis subjects, in groups with bowel diseases and colorectal cancer and in subjects with major depression. The topic in question is currently at the centre of scientific research, posing an urgent need for prevention interventions at all levels and requiring legislative and cultural interventions to reduce plastics from production to consumption according to a One Health perspective in a Planetary Heart vision.

UNMASKING THE RESISTOME ON MICROPLASTICS IN MARINE HABITATS: POTENTIAL ROUTES OF ANTIBIOTIC RESISTANCE TO HUMANS VIA SHELLFISH

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Microplastics are pervasive pollutants in marine environments and might act as reservoirs of antibiotic resistance genes (ARGs). Their rough surfaces facilitate the adsorption of antibiotics and other chemical contaminants [1], creating selective pressures that promote the proliferation of antibiotic-resistant bacteria within the plastisphere [2]. In this study, we investigated the resistome associated with microplastic particles collected from a marine coastal area in the northern Adriatic Sea, a region used for commercial bivalve mollusk harvesting. We used Fourier Transform Infrared Spectroscopy (FTIR) to identify the polymer composition of the particles and identified polyethylene (HDPE and LDPE), polypropylene, polystyrene, polyolefins, and composite materials. We measured particle sizes ranging from 1 µm to over 5 mm and classified them as fibers, fragments, and sheets. We applied a metagenomic approach to characterize the resistome present on these microplastics using the Resistance Gene Identifier (RGI) [3] on the shotgun sequence reads. We detected antibiotic resistance genes (ARGs) that confer resistance to several clinically relevant antibiotic classes, including aminoglycosides, fluoroquinolones, macrolides, carbapenems, cephalosporins, and penicillins. This rich resistome highlights the potential role of microplastics as vectors for antibiotic resistance in marine ecosystems. Additionally, 16S rRNA gene amplicon sequencing revealed a microbial community that includes several genera with known pathogenic potential, including *Vibrio* spp. The presence of these bacteria on microplastics suggests a direct pathway for the transmission of antibiotic-resistant pathogens to humans through the consumption of contaminated shellfish [4]. Our findings underscore the urgent need to understand microplastics not only as chemical pollutants but also as dynamic platforms for the spread of antibiotic resistance, representing a significant threat to human health via the seafood supply chain.

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IMPACTS OF NANO AND MICROPLASTIC MIXTURES ON THE MICROBIOTA-IMMUNITY AXIS IN C57BL/6J WILD-TYPE MOUSE MODEL

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Environment plastics degrade into microplastics and nanoplastics due to biological, chemical, and physical processes. Smaller particles may enter the bloodstream via the lungs and influence the gut-lung immune axis, while larger ones interact with the intestines and potentially disrupt immune function. However, data on N/MPL accumulation in mammalian tissues is limited but crucial for assessing human health risks. Airborne N/MPLs can affect respiratory, digestive and immune systems.
Aim: to investigate the impact of N/MPLs on the microbiota-immunity axis in vivo C57BL/6J wild-type mouse model
Methods: we administrated PE and PET particles (0.5 mg/day) via gavage to C57BL/6J wild-type mice. The sequencing of 16S rRNA V3-V4 hypervariable region was performed in lung and colon mice samples while the short chain fatty acids (SCFA) and the inflammatory cytokines were evaluated in plasma samples. In addition, we characterized the T lymphocytes in the mice spleen.
Results: in the colon, at genus level, we noted an increased abundance of *Lachnospiraceae* with PE treatment respect to the control and an increase of *Turicibacter* with PET treatment respect to control and PE treatment. In addition, we observed an increase of plasma amounts of IL-1β in PE treatment respect to control and PET treatment.
Conclusions: we documented some significant change in the microbiota-immunity axis after the treatment with N/MPLs. Finally, the assessment of MP and NP exposure in mice models offers a valuable tool to assess health risk of plastic exposure to animals and parallel to humans.

MOLECULAR INSIGHTS INTO PROTEIN RECOGNITION AND TOXICOLOGICAL MECHANISMS OF NANO-PLASTICS

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Nano-plastics (NPs) are tiny plastic particles, usually smaller than 100 nm, originating from everyday products as well as the breakdown of larger plastic waste. Their small size and chemical composition allow them to interact with living organisms differently compared to bigger plastic fragments. [1] Humans are constantly exposed to these NPs, and numerous studies have highlighted their potential harmful effects on health. Among these, polystyrene and PTFE (polytetrafluoroethylene) nano-plastics are the most commonly found in the environment. [2] When taken up by cells, they can induce toxicity damaging cellular compartments and altering biomolecules structure.
Here, a description of the significant molecular events regulating protein/nano-plastics will be presented. Specifically, we investigated the molecular determinates underlying the NPs binding mechanisms by proteins through a multidisciplinary strategy that combines low-resolution Transmission Electron Microscopy (TEM) and Circular Dichroism (CD) data with high-resolution Nuclear Magnetic Resonance (NMR) techniques. [3] Moreover, to explore the potential cytotoxic and genotoxic effects of NPs exposure on HeLa cell lines [3,4], the collected structural data were further complemented by *in vitro* and *in cell* studies.

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FROM BIOMOLECULES TO BIOFOULING: THE BROAD-SPECTRUM ADSORPTION CAPABILITY OF TRUE-TO-LIFE MICRO- AND NANOPLASTICS

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This study presents the production of true-to-life micro- and nanoplastics, along with their identification, characterization, and impact assessment. In particular, we compared two mechanical fragmentation techniques for preparing true-to-life materials, examining how each method affects the morphology and structural properties of the resulting microplastics [1]. Through centrifugation protocols, we isolated nanosized fractions from micrometric plastic powders. In addition, we investigated the broad-spectrum adsorption capabilities of true-to-life micro- and nanoplastics, including eco- and protein-corona formation on nanoplastics, and biofilm formation on microplastics [2, 3]. The results showed that microplastics produced using different milling techniques exhibit varied morphology and degree of crystallinity, and age differently. The importance of using realistic test micro- and nanoplastics for eco-toxicological studies was highlighted by comparing the protein corona adsorbed on true-to-life nanoplastics and pristine nanobeads upon incubation in human plasma. The protein corona profile adsorbed on true-to-life nanoplastics differed from that of nanobeads, with further differences observed among various types of nanoplastics. Eco-corona formation on nanoplastics was also demonstrated using microFTIR analysis, which revealed characteristic peaks of humic acids in the polystyrene spectrum. DLS measurements revealed an increase in the hydrodynamic diameters of nanoplastics due to the formation of this coating, suggesting a partial destabilization of nanoplastic suspensions.
This study highlights the importance of employing true-to-life materials with greater environmental relevance as a crucial step toward bridging the gap between experimental laboratory investigations and real-world observations.

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A CORRECT WASTE MANAGEMENT for the HEALTH PROTECTION: A FOCUS ON MICROPLASTICS

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Waste generation has increased drastically worldwide in the last decades. Less than 20% of waste is recycled each year, and one-third of all food is wasted. While a fair level of knowledge exists concerning the general risks, there are notable gaps in understanding specific aspects of human health risks related to improper waste disposal and recycling, such as plastics by all types of wastes, and metallic nanoparticles from urban and sanitary wastewaters, representing both emerging pollutants with a large broad of human health impacts. A life cycle assessment (LCA) conducted on the environmental impact of recycling plastic waste support toward plastic wastes management. However, a notable limitation in several standard LCA methodologies lies in omitting a crucial factor such as the long-term fate of chemicals and particulates released during recycling of plastic [1]. The missing of short-term LCAs studies in disregarding the consequences of chemical and particulate releases raises concerns about the overall efficacy of plastics recycling as a solution to plastic pollution. Despite the current and innovative technologies to recycle plastic waste, non-recoverable nanoplastics and microplastics cannot easily catch with existing reclaim or treatment technologies due to their exceptionally small size. Further, the size reduction and washing during mechanical recycling facilities cause the release of significant quantity of microplastics into the environment, reaching water or air as microplastics from recycling facilities increasing environmental pollution and risk for environmental and human health [2].
The purpose of this minireview is to critically review the impact of improper waste management of plastic wastes, sanitary and urban wastewater for their environmental inputs of plastic nanoparticles, their health impacts currently shown, and the benefit or not integrating a circular economy into waste management to address these specific wastes problems.

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POLYSTYRENE NANOPARTICLES INDUCE DNA DAMAGE AND APOPTOSIS IN HELA CELLS

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Polystyrene nanoplastics (PS-NPs) are plastic particles, typically less than 100 nm in size, that result from daily life products as well as the degradation of larger debris of polystyrene. Humans are continuously exposed to NPs and several studies have shown the potentially toxic effects of these latter on health. [1] Polystyrene nanoplastics are the main form of nanoparticles found in the environment [2] and their cellular uptake can cause cytotoxicity and structural alteration of biomolecules. Thus, there is an urgent need for the evaluation of the genotoxic effects of PS-NPs on human cell models. Through different and complementary experimental approaches, we investigated the PS-NPs exposure-induced cell damage on HeLa cell lines. We highlighted the genotoxic effects of polystyrene nanoplastics by showing the formation of multinuclei and micronuclei, also at short incubation time (6 h) and low concentration. At higher concentrations, we demonstrate the presence of apoptotic and necrotic cells, outlining the acute cytotoxic effects of nanoplastics. The genotoxic potential is further highlighted by the presence of low molecular weight DNA fragments in PS-NPs-treated cells, and by the relationship between polystyrene nanoplastics and γ-H2AX. [3] In the same cell model, we demonstrated that PS-NPs are able to affect the human ubiquitin structure, impairing protein ubiquitination activity, a crucial event in protein degradation, signaling, and cellular homeostasis. [4] Thus, our data provide important insights at a cellular level into the possible risks produced by these nanoparticles and recommend further research studies to address the impacts of nanoplastics on human health.

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MICROPLASTICS ALTER MICROBIAL COMMUNITIES AND BIOGEOCHEMICAL CYCLING IN COASTAL SEDIMENTS

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Microplastics (MP) accumulated in marine sediment can alter both the composition and functions of bacterial communities, with a range of effects depending on the type of the polymer (Seeley et al., 2020). This work I am presenting investigates how MP pollution alters sedimentary organic matter pools, degradation dynamics, and bacterial community structure in a Mediterranean coastal ecosystem.
We conducted a 14-day microcosm experiment using coastal sandy sediments from Campulongu Bay (Sardinia, Italy), exposing them to polyethylene (PE) and polystyrene (PS) particles. We assessed changes in sedimentary OM quantity and biochemical composition, extracellular enzymatic activities (aminopeptidase, β-glucosidase, alkaline phosphatase), and microbial community profiles through 16S rRNA gene sequencing.
Our results reveal a two-phased microbial response. After one week, MP exposure—particularly PS—stimulated microbial colonization, increased OM content, and elevated β-glucosidase activity, suggesting an initial priming effect or enhanced biofilm formation. However, by day 14, a significant decline in species richness and degradation efficiency was observed, indicating functional impairment. This was coupled with an accumulation of refractory OM, particularly under PS exposure, despite unaltered overall degradation rates.
Microbial community analyses showed a significant shift in community structure across MP treatments and time points. While core sediment taxa (e.g., Proteobacteria, Bacteroidota, Actinobacteriota) remained dominant, MP exposure led to a marked decline in hydrocarbon degraders and nitrogen cyclers, paralleled by an increase in rare taxa associated with sulfate reduction. Notably, the relative abundance of sulfate-reducing bacteria (SRM, for instance Desulfobacteraceae, Desulfobulbaceae) increased consistently under MP exposure, with ratios of SRM to sulfur-oxidizing taxa exceeding at all time points.
This microbial shift may promote sulfide production, potentially inhibiting nitrification-denitrification pathways and thus altering nitrogen cycling. Enhanced sulfate reduction under MP exposure raises questions about broader implications for sedimentary carbon cycling and ecosystem resilience. These results highlight how MPs not only affect microbial diversity but may fundamentally rewire biogeochemical pathways, favoring anaerobic metabolism and refractory OM accumulation.
Future research, including transcriptomic analyses of key sulfur-cycle genes, will clarify whether these community shifts translate into altered functional expression. Given the ecological role of benthic microbial communities in carbon sequestration and nutrient cycling, our findings underscore the need to integrate microplastic pollution into models of sedimentary biogeochemical processes.

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POLYSTYRENE TOXICITY: COMPARATIVE EFFECTS OF MICROBEADS OF 1 AND 3 MICROMETERS ON *XENOPUS LAEVIS* EMBRYO DEVELOPMENT

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Microplastics are persistent pollutants known for their detrimental effects on aquatic wildlife. When ingested as prey, they disrupt physiological processes, including development and growth. Many aspects of their toxicity remain unclear, especially regarding the significance of particle sizes. In this multidisciplinary study, we compared the effects of commercial microbeads (PSMBs) with diameters of 1 µm and 3 µm on *Xenopus laevis* embryos exposed from the blastula stage to stages 45/46. This amphibian model is ideal for ecotoxicological research due to its sensitivity to environmental stressors and the relevance of findings to higher vertebrates [1]. The concentrations tested were 0.1, 1.0, and 10 mg/L [2]. Results indicated that both particles significantly increased mortality and malformation rates and induced tachycardia, suggesting systemic physiological stress. Elevated reactive oxygen species further confirmed this state. The effects were dose-dependent. Histological analyses revealed considerable toxicity to the gut epithelium, particularly after exposure to 1 µm beads, with severe damage to the brush border and cell junctions. Initial gene expression studies revealed substantial deregulation of inflammatory markers. In summary, the results indicated that 1 µm beads are more toxic, aligning with the observed higher release of volatile organic compounds (VOCs) in cultures exposed to these particles compared to those exposed to 3 µm particles. Both particle size and concentration impact microplastic toxicity, with effects related to VOC levels. This highlights an underexplored pathway of microplastic toxicity, underscoring the need for further investigation to understand the risks to both ecological and human health.

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FASHION FADES, MICROPLASTICS ARE ETERNAL – A LITERATURE REVIEW INTO THE COLOURS OF MICROPLASTIC FIBRES WORLDWIDE

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Microplastic (MP) pollution is a growing environmental concern, and of the many variables recorded to assess MPs, colour is often an overlooked parameter in environmental monitoring. A systematic literature review was carried out over two decades to determine whether there is a relationship between MP fibre colours across environmental compartments, globally. The analysis revealed that transparent and/or translucent (T&T), blue, black and white are the most frequent colours worldwide, with notable variation depending on environmental compartment and geographical region. Blue fibres dominated biota (~32%) and water (~28%) samples, while T&T fibres were predominant in sediments (~35%). Yellow was the dominant colour in air (~27%), however we only found one study that fit the literature review criteria. Europe and Asia have the highest colour variability. Blue fibres are prevalent in the Americas (North and South) and in Oceania, while red and green hues are prevalent in the African continent. No correlation was found between fashion colour trends and fibre colours in the environment. The review highlights gaps in reporting fibre origin differences (natural vs. synthetic), and in how data is aggregated for comparison studies. This talk will explore the importance of employing harmonised colour categorization methodologies to reduce data biases and improve data quality in environmental monitoring efforts.

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MODELING NANOPLASTIC IN ACTION: MOLECULAR STRUCTURE, DYNAMICS, INTERACTIONS, AND ENVIRONMENTAL FATE

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Understanding the environmental fate and the effect of nanoplastics on living organisms requires an understanding at the molecular level of their structure and interactions. In principle, molecular simulations are a proper tool for these investigations [1], but a key challenge lies in modeling aggregates in the 10–100 nm range, where fully atomistic simulations become unfeasible, yet features such as crystalline domains, surface chemistry, and interactions with specific type of molecules remain critical. To tackle this, we adopt a multiscale approach that combines coarse-grained molecular dynamics with hybrid particle-field techniques [2-4], enabling the simulation of structured nanoplastics with molecular specificity and mesoscopic reach.
Molecular models for nanosized polar crystalline fragments generated during the degradation of semicrystalline polyethylene (PE), suitable for hybrid particle-field molecular dynamics simulations, will be discussed [5]. These models can provide detailed thermodynamic and structural characterization of the agglomeration of fragments constituting nanoplastics in aqueous media. The effects of aging and environmental conditions, including surface chemistry, pH, and counterion valence, will be systematically discussed. We further examine interactions of semi-crystalline nanoplastics with biological membranes and surfactant-rich interfaces, where surface morphology can strongly influence adhesion, insertion, and perturbation mechanisms. Thanks to their molecular resolution and computational efficiency, the proposed models pave the way for a deeper understanding of the behavior of nanoplastics from semicrystalline polymers in realistic biological and environmental conditions, aiming to bridge the gap between polymer physical-chemistry, colloid science, and ecological modeling.

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4 YEARS MONITORING PLASTICS CONTAMINATION IN FRESH WATER OF LAKE GARDA WITH SEABIN – SEASONAL EFFECTS, MICROPLASTICS AND ALIEN SPECIES

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Object of this presentation is the description of Seabin use for collecting floating waste in the north side of Lake Garda. Seabin is a basket capable of capturing various debris floating in surface water, properly designed to remove plastic waste from environment. A Seabin V5 was installed on June 17th, 2021 in Fraglia della Vela harbour of Riva del Garda (https://www.fragliavelariva.it/en), at a strategic confluence of winds and water corrents. The working time varied according to the observed waste accumulation, ranging from 2 to 72 hrs, mainly 24 and 48 hrs. Several collection campaigns were carried out between June 2021 and September 2025. The collected material was weighed prior and after drying. A first sorting was performed to separate plastics (P) and microplastics (MP) from vegetation and animal fraction. The collected materials were examined at different levels, number, weight, size, type of polymer. The max number of microplastics, 408 MP/day, was found in Summer 2021, and progressively decreased to 96-45 MP/day in the following summers (2022, 2023 and 2024); and lower values in Autumn and Winter, 15 and 13 MP/day, respectively. Plastic products were distinguished in macro-, meso- and micro- according to GESAMP 2019, and then assigned to a product category: foams, cups, packaging, wires/ropes/threads, butts, bottle caps, bottles. A direct identification of plastics by FTIR evidenced the main dimensional categories: polyethylene (PE), polypropylene (PP), polystyrene (PS), and “other”. Waste collection was also compared to data on the weather, with a slight correlation between plastics, rain and wind. In 2025, five alien species were also collected and identified, i.e. *Lagarosiphon major, Ceratophyllum demersum, Dikerogammarus villosus, Dreissena polymorpha*, and *Dreissena bugensis*. In conclusion, the installed Seabin appears to be an efficient system and low-cost novel methodology for monitoring the plastic pollution and the alien species presence in calm waters at the same time.

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NATURE-INSPIRED PHYSICOCHEMICAL PROCESS: JELLYFISH MUCIN FOR EFFICIENT REMOVAL OF NANOPLASTICS FROM WATER

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Addressing the escalating environmental threat posed by nano and microplastics (NPs and MPs) in aquatic ecosystems demands innovative solutions throughout the value chain. This study investigates the synergistic interactions between jellyfish mucus and commercial coagulants on the removal rate and capacity of microplastics and MPs and nanoplastics (NPs) from water. The results reveal that combining low doses of jellyfish mucus (0.8 and 2 mg L^{-1}) with the commonly used coagulants ferric chloride ($FeCl_3$) or polyaluminum chlorohydrate (PAC) dramatically enhances MPs and NPs removal rate and efficiency and reduces particle settling times to <5 minutes. Mechanistic insights reveal differing interactions between polystyrene (PS-NPs) and carboxylate-modified PS microspheres (PS-CA-MPs). These insights demonstrate that jellyfish mucus facilitates entrapment and bridging mechanisms, which play a key role in the aggregation and removal of plastic particles. Zeta potential measurements further confirm the neutralization of particle surface charges, with optimal conditions observed at 2 mg L^{-1} jellyfish mucus and 2.5 mg L^{-1} coagulant. Additionally, the Deryagin–Landau–Verwey–Overbeek (DLVO) theory explains these interactions, highlighting the entrapment and bridging effects for polystyrene nanoplastics (PS-NPs) and polymethyl methacrylate nanoplastics (PMMA-NPs), while a significantly higher interaction energy for carboxylate-modified PS microspheres (PS-CA-MPs) suggests the involvement of additional forces. This study underscores the promising role of jellyfish mucus-coagulant synergy in enhancing the removal of NPs and MPs from water, offering a sustainable and effective alternative to conventional water treatment technologies for plastic pollution mitigation.

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FUNCTIONALIZATION OF NATURAL POLYMERS WITH VANILLIC ACID DERIVED FROM PET WASTE

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Polyethylene terephthalate (PET) is one of the most used polyesters, however recycled PET contains high amounts of contaminants and shows worse mechanical and thermal properties than the pristine polymer. Recently, organic upcycling has been actively studied and is considered a powerful technology to overcome the economic problems associated with conventional recycling methods [1].
In this work, Bacterial and Enzymatic cascades were employed to depolymerize PET debris found in Lake Como resulting in bioactive molecules such as vanillin (V) and vanillic acid (VA) [2].
Vanillic acid was then employed for the formation of vanillic acid-chitosan (VA-g-Ch) and vanillic acid-alginate (VA-g-Alg) conjugates using three grafting methods: free radical-induced grafting method, microwave-assisted grafting and EDC/NHS-Coupled Mediated Grafting. The resulting polysaccharides, grafted with VA were characterized by UV-vis, FTIR spectroscopy and thermogravimetric analysis (TGA) to confirm the grafting was successful and to determine the optimal grafting method. VA shows antimicrobial and antioxidant properties as a compound, therefore tests were performed to evaluate if such properties were transferred to the polymers after the grafting process. VA-g-Ch and VA-g-Alg can be employed as shell material for the preparation of microcapsules used to entrap, protect and release easily oxidizable molecules such as vitamins and fatty acids.

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AN INNOVATIVE METHOD FOR MICROPLASTIC STUDIES IN MARINE ORGANISMS: RADIOLABELING AND RADIOIMAGING (PET)

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Over ten million tons of plastic waste have entered the world's oceans and seas. These plastics fragment into micro-sized particles that accumulate in marine ecosystems and pose a significant threat to the global food supply. Microplastics have been shown to impair reproduction in oysters and fish, disrupt growth, and induce liver damage. Filter-feeding species such as sardines and anchovies are particularly vulnerable due to their high-water intake. Realistic and sensitive studies examining pharmacokinetic effects in-vivo are needed to determine future impact on the food supply.

This study reports the use of radiolabeling and positron emission tomography (PET), a highly sensitive method widely used in nuclear medicine, to track microplastics in fish. Polystyrene (PS) microplastics (1 µm) were modified with the chelator desferrioxamine (DFO) and labelled with ^{89}Zr (half-life of 3.3 days) to create [^{89}Zr]Zr-DFO-PS. These labelled microplastics were then fed to sardines and anchovies caught and acclimatized from the Aegean Sea. Fish were sampled at intervals up to 24 hours. Microplastic biodistribution was determined destructively by radiation counting and non-destructively by PET imaging.

In-vitro stability experiments conducted in saline, fish ringer solution, blood, simulated gastric fluid, and simulated intestinal fluid demonstrated that compounds remained stable up to 48 hours, a result confirmed in-vivo by the absence of ^{89}Zr in the fish bones. Both chelator binding and radiolabeling efficiencies were found to be >99%. The first PET images of fish containing radiolabeled microplastics were successfully acquired, demonstrating that PET can be used to non-destructively investigate microplastic dynamics in fish. Negligible amounts of microplastics were found outside of the gastro-intestinal tract after 24 hours. This work demonstrates that the advantages of nuclear imaging including low detection limits, limited cross-contamination due to non-destructive analysis, and good chemical stability can be a rigorous and sensitive tool in the study of microplastics in marine systems.

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ENZYMATIC SYNTHESIS AND STRUCTURAL MODELING OF BIO-BASED OLIGOESTERS AS AN APPROACH FOR FAST SCREENING OF MARINE BIODEGRADATION AND ECOTOXICITY

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The widespread use of esters and polyesters in products such as cosmetics, fishing nets, food packaging, lubricants, and adhesives raises concerns about their dispersion in open environments. This study highlights the urgent need for stringent eco-design criteria based on biodegradability and ecotoxicity evidence to guide the sustainable development of bio-based polymers. By integrating experimental and computational approaches focused on short oligomers, we propose a rapid screening tool for identifying environmentally friendly monomers and oligomers, with particular attention to bio-based alternatives. Our findings reveal that aromatic monomers, such as terephthalic acid and 2,5-furandicarboxylic acid, tend to accumulate under OECD 306 test conditions. However, slight biodegradation is observed in environments affected by industrial and urban pollution, suggesting that ecosystems adapt to non-natural chemical pollutants. Paradoxically, clean marine environments appear more vulnerable to some chemicals, underscoring the need for effective mitigation strategies. While biodegradability is an inherently desirable property of plastic materials, it does not automatically confer sustainability. This research provides insights into the relationship between the chemical structure and properties of bio-based polymers, facilitating the rational design of materials tailored to specific applications. Our approach contributes to advancing sustainable polymer science, bridging the gap between biodegradability, toxicity assessment, and real-world environmental impact.

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GREEN AND RATIONAL MICROPLASTICS ASSESSMENT IN SAND: A BEST PRACTICE PROPOSAL WITH SAFE AND EFFECTIVE DENSITY SEPARATION MEDIA

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Microplastics (MPs) pollution assessment must not pollute. Inspired by this catchphrase, we critically evaluated the environmental impact, safety, and effectiveness of various analytical strategies currently used to assess MPs contamination on sand. No consensus has been reached about MPs determination, despite they are ubiquitous and extensively studied pollutants [1]. Density separation enables MPs isolation from sand; hence it is a crucial step in the analytical procedure. Widespread density separation media have major drawbacks. For example, many common plastics are denser than the safe saturated sodium chloride solution (density 1.2 g/ml) and would not float, thereby leading to an underestimate of total MPs. On the converse, prevalent effective reagents, namely zinc chloride and sodium polytungstate (density, respectively, 1.6 and 3.1 g/ml) raise numerous health and environmental hazard concerns. Hence their use cannot be recommended. As we recognized there is room for greenness improvement in this hot research field, we explored the efficacy of a number of environmentally friendly reagents (including, e. g., sucrose, xylitol, sodium silicate, among others) to put forward a best practice about a sustainable MPs determination. The analytical workflow was optimized studying MPs contamination of sand specimens representatively sampled from a large beach-dune complex in a WWF oasis in Venice. This case study enables the establishment of a preeminent green and logical approach to the quantitative determination of MPs in sand. We suggest calcium nitrate as the best trade-off between greenness and efficacy. We accurately focus on all other critical control points of the procedure, namely the correct and quantitative recovery of the floating mixture, the best removal of the organic matter, and MPs classification; in this respect we propose a cascade sieving in order to separate MPs of different sizes in an objective way, limiting potential observation bias that are very common in this time-consuming and error-prone final step. MPs have been quantified and characterized. The total average MPs (100-5000 µm) abundance is 219 MPs/kg. The most abundant size class is the 100-300 µm one. Fibers confirms to be the most abundant MPs type in the area [2]; dark blue/black fibers dominate the chromatic MPs range.

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THE RIGHT OF CONSUMERS TO INFORMATION: WHAT SHOULD WE KNOW ABOUT PLASTIC?

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This contribution examines the current state of consumer information on microplastics and plastic composition in products in the European Union (EU). Despite the EU's commitment to a high level of consumer protection under Article 38 of the Charter of Fundamental Rights, there remain substantial gaps in transparency regarding the materials and additives used in everyday plastic products. In contrast to the detailed information required for food products and cosmetics, where labelling is relatively comprehensive, consumers have limited access to data on the composition of plastic packaging, toys, textiles, and household goods. While intentionally added microplastics will be phased out in several product groups under REACH in the coming years, information on the composition of plastics and the presence of microplastics in many other products remains limited and difficult for consumers to access. The current legal framework on consumer information, including the Consumer Rights Directive and the Modernisation Directive, does not uniformly require producers to disclose detailed material and chemical, including plastic-related, information. The average consumer is expected to make informed, sustainable choices, yet is left without the necessary data [1]. Promisingly, the forthcoming Ecodesign for Sustainable Products Regulation (ESPR) and the Digital Product Passport (DPP) offer opportunities to enhance transparency, provided they impose specific, enforceable disclosure obligations for plastic-containing product groups [2]. These instruments could significantly improve consumer awareness and accountability across the supply chain. Regarding microplastics two product parameters have been proposed: the release of nano- and microplastics during the product's life cycle and the amount of waste generated, including plastic and packaging waste. The DPP will contain information on substances of concern as well as compliance with sustainability requirements. The workplan for the coming years prioritises several products commonly made of plastic, including textiles, furniture, tyres, detergents and paints. For the textile industry in particular, this could mark a turning point, both by increasing transparency and by providing consumers with essential information [3].

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MICROPLASTICS AND HUMAN GUT HEALTH: IN-VITRO FERMENTATION AND SHOTGUN METAGENOMICS REVEAL MICROBIOME AND FUNCTIONAL SHIFTS IN HEALTHY AND ALS INDIVIDUALS

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Micro- and nanoplastics (MNPs) are emerging contaminants of concern due to their potential impacts on human health, particularly through interactions with the gut microbiome [1]. In this study, we investigated the effects of environmental and pure microplastics on the gut microbial ecosystem using a static in-vitro gastrointestinal digestion and fermentation model (INFOGEST) [2], followed by both 16S rDNA amplicon sequencing and shotgun metagenomic profiling. Fecal inocula for the in-vitro fermentation were obtained from healthy individuals and patients with amyotrophic lateral sclerosis (ALS). Samples were subjected to digestion of microplastic-contaminated matrices, including commercial bottled water, tap water, and polystyrene microspheres (20 and 200 particles/mL). Control treatments without plastic exposure were included for each donor type. All samples underwent standardized oral, gastric, and intestinal digestion phases, followed by 20-hour anaerobic fermentation [3]. DNA was extracted post-fermentation and processed for both 16S rRNA sequencing and whole-genome shotgun sequencing. Results revealed distinct differences in microbial composition between ALS and healthy donors, with significant shifts induced by microplastic exposure. 16S analysis indicated alterations in community diversity and key taxa, while shotgun metagenomics provided a higher-resolution view of gene-level changes and functional pathways [3]. Environmental microplastics, particularly from bottled and tap water, induced measurable changes in the abundance of microbial genes, with some genes found to be more or less represented following exposure. These effects were more pronounced in ALS-associated microbiota, suggesting a disease-modulated susceptibility to plastic contamination. This integrative approach highlights the potential for microplastics to alter gut microbial function and composition in a host-dependent manner. Ongoing metabolomic analyses aim to correlate these shifts in gene abundance with metabolic outputs. Our findings contribute to understanding exposure risks and microbiome-mediated mechanisms involved in the health impacts of plastic pollution.

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Abstracts
Poster sessions

IMPACT OF MICRO AND NANO PLASTICS IN OUR LIFE

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The concentration of MPs/NPs in the ocean is increasing at an alarming rate, particularly in the past few decades. Several factors influence the degree of MP/NP pollution in the ocean, including population density, proximity to urban centres, waste management, the residence time in water, water body isze, and amount of sewage overflow. MPs and NPs have a negative environmental effect due to their high degree of fragmentation. The high level of waste and degradation resistance makes MPs/NPs a significant global environmental issue. The marine food products produced from marine plants, organisms, or animals then enter the human body as food [1]. The use of nano-plastic items such as mascaras, scrubs, shampoo, lipsticks, dust as well as medicine enables plastics to penetrate human bodies [2]. MPs accumulation and contamination can occur in humans through food (seafood, packaging), drinking water, and air (inhaling polluted air) causing cytotoxicity, an acute response like hemolysis and hypersensitivity, and unwanted immune responses.
MPs/NPs significantly affect the socio-economic life of humans. Social harm related to microplastics and nanoplastics involves a decline in a given area's recreational, architectural or educational standards and threats to human health. Economic harm includes direct costs and income loss due to MPs/NPs in the form of marine litter, affecting several marine sectors including aquaculture, agriculture, fisheries, transportation, power generation, local authorities, industrial use, and tourism. National policy and legislative responses can help to manage the marine debris problem [3]. Plastics are one of the most influential material families in the 21st century since they are widely used and have a significant impact on our everyday life. Whilst the socioeconomic advantages of plastics are commendable, these products are one of the main sources of environmental pollution.

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FROM SOIL TO SEA: ENVIRONMENTAL DEGRADATION OF PLA–GLASS FIBRE COMPOSITES

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Bio-based plastics are increasingly explored as sustainable alternatives to conventional petroleum-based plastics, given their origin from renewable resources and potential to reduce carbon footprint and plastic pollution [1]. Among them, polylactic acid (PLA) is one of the most studied candidates, although its end-of-life behavior remains a key limitation. In this study, a PLA-based composite containing 20 wt.% degradable glass fibre (PLA-DGF) was subjected to long-term degradation in Mediterranean seawater (up to 12 months), soil burial, and accelerated photo-oxidation (POx) in a climatic chamber [2]. Thermal (DSC, TGA) and mechanical (tensile) properties were evaluated. In seawater, PLA-DGF showed minimal variations in thermal stability, although crystallinity decreased from 54% to 38%. Mechanical performance progressively declined, with ~50% reductions in elastic modulus and stress at break after 12 months. Films prepared from PLA-DGF degraded faster under soil and POx conditions (~1000 h), with soil exposure leading mainly to surface opacity and erosion, while POx caused rapid yellowing, thermal transitions' alteration, and significant mechanical decay. Tensile strain decreased by ~52% after only 160 h of POx, highlighting its stronger impact compared to soil burial. Overall, PLA-DGF exhibited slow degradation in natural seawater but higher susceptibility to accelerated ageing, underlining both its potential and challenges for sustainable applications.

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EMERGENCE AND SUSTAINABILITY OF BIOPLASTICS IN THE MARITIME SECTOR: ENVIRONMENTAL, ECONOMIC, AND SOCIAL INSIGHTS

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The maritime sector plays a key role in the global economy by supporting trade, food security, tourism, and offshore energy production. However, as the ocean economy continues to expand to meet rising global demands, the use of conventional plastics in maritime industries is increasing in parallel. Conventional plastics, derived from fossil fuels, contribute to the depletion of non-renewable resources and greenhouse gas emissions, while their persistence in the environment leads to long-term plastic pollution. Maritime activities are responsible for approximately 20% of marine plastic pollution, with the fisheries sector alone contributing around 10–18% of this total. Together, they represent one of the major sources of threats to marine ecosystems, including entanglement, ingestion by marine organisms, and habitat degradation. Thus, as part of strategies to mitigate the environmental impacts of conventional plastics, bioplastics are increasingly promoted as eco-friendly alternatives. Herein, we provide an overview of the application of bioplastics in fisheries, aquaculture, packaging, and marine infrastructure, with a focus on environmental and socio-economic considerations, as well as sustainability assessment methods. Pilot-scale trials have evaluated bioplastics in fisheries and aquaculture, while their use in packaging, particularly active packaging, is advancing. Bio-composites are also being developed for boats and offshore structures. However, key challenges, including incomplete degradation in marine environments, high production costs, and limited mechanical performance, still remain to be addressed. Furthermore, analytical methods for their sustainability assessment reveal key limitations, where Techno-Economic Assessment (TEA) highlights high production costs, while Life Cycle Assessment (LCA) remains challenging due to methodological inconsistencies and lack of standardization. Overall, sustainability assessments must address environmental trade-offs and socio-economic feasibility to guide future developments.

VEGETABLE BASED WATER RESISTANT COATINGS FOR THE REALIZATION OF SUSTAINABLE FOOD PACKAGING AND CONTAINERS: RESULTS FROM THE "NEW SKIN" PROJECT

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Coats and skins of edible seeds (CS) represent a class of food waste with high potential for valorization and use in the materials field. To achieve the complete valorization of all CS components (structural cellulosic fibers, lignins, proteins and functional compounds such as antioxidants and pigments), avoiding extaction/separation processes, high energy mechanochemical treatments were carried out in wet conditions, obtaining a partial destructuration of the hierarchical structure of the biomass.
Different CS have been selected, including coffee silverskin, hazelnut, pine nut, and almond peels. Treatment of the skins carried out in a planetary ball milling system, with water as suspension medium and a water soluble polymer as binder (polyvinyl alcohol, PVA), led to the obtainment of highly homogeneous and fine CS based "inks".
By deposition of such inks onto different substrates, followed by a suitable heat treatment to achieve the partial crosslinking and stabilization of the structure, well adhered functional coatings with high gas barrier and good water resistance were obtained.
The good stability of our biobased coatings against warm water suggests their use for, as an example, the impermeabilization of cellulosic food containers, in particular beverage cups, in substitution for fossil-based polymeric liners. In this way, the overall sustainability of cellulosic containers will be increased, ideally approaching the 100% of biobased constituents. Moreover, the release of microplastics from the internal plastic layer, observed by different studies, will be greatly reduced by the use of CS based coatings, whose structure is mainly composed of cellulose and proteins.

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ALGAE-LOADED MICROPARTICLES FOR PLASTIC CAPTURE AND NUTRIENT REMOVAL FOR ENVIRONMENTAL REMEDIATION

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Recently, algae have attracted significant attention as a promising and eco-friendly solution for capturing microplastics, as they require less energy than traditional methods [1]. They enhance plastic removal by forming aggregates and extracellular polymeric substances and can facilitate the biodegradation of synthetic polymers by producing enzymes that lower the activation energy needed for degradation [2].
Conventional algal wastewater treatment systems typically utilize suspension cultures. Nevertheless, alternative approaches, such as algal biofilms or immobilized/entrapped algal systems like artificial biofilms or beads, where microalgal cells are trapped in polymer matrices, are also gaining popularity. Immobilized algal systems offer several advantages, including easy harvesting and separation from the media. To achieve long-term and efficient performance in these systems, a high-performing, mechanically stable matrix is essential. The proposed approach involves integrating microalgae into hydrogel beads for bioremediation. Starting with a solution of sodium alginate, a fatty acid was added to introduce specific functional properties. Microalgae were then directly incorporated into the alginate solution. The beads were formed through ionic cross-linking by dropping the alginate-based solution into a calcium chloride solution.

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OCCURRENCE OF ANTHROPOGENIC PARTICLES IN SEA CUCUMBERS FROM THE CAPO PELORO NATURAL RESERVE

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Sea cucumbers, as detritivorous benthic organisms, play a vital role in maintaining the ecological balance of marine ecosystems. However, increasing plastic production and inadequate waste management have led to growing exposure to anthropogenic particles (APs) in their habitats. This study presents the first investigation of AP occurrence in two sea cucumber species, *Holothuria sanctori* and *H. tubulosa*, within the transitional waters of the Capo Peloro Natural Reserve. A total of 127 APs was found in *H. sanctori* and 107 in *H. tubulosa*, with mean abundances of 6.89 and 10.6 items/specimen and frequencies of occurrence of 85.2% and 80.0%, respectively. A mix of APs—including plastics, elastomers, rubbers, semisynthetic, and natural particles was identified, comprising 17 types in *H. sanctori* and 16 in *H. tubulosa*. Neoprene and cotton were the most frequently detected materials. These findings highlight the greater complexity of AP contamination in transitional ecosystems compared to marine environments and support the potential use of sea cucumbers as bioindicators for monitoring plastic pollution in such habitats.

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TOWARDS REGULATORY READINESS: ADAPTING MICROPLASTIC MONITORING STRATEGIES IN WATER SERVICES FOR UPCOMING EU DIRECTIVES

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In the context of the EU's emerging regulatory framework on microplastics—culminating in the Delegated Decision (EU) 2024/1441 on drinking water monitoring—this work presents the development, implementation, and first analytical results of a field protocol for microplastic sampling in urban water infrastructures. The project, carried out through a collaboration between the University of Trieste, CAFC S.p.A. (a regional water utility), and BsRC, focused on creating a technically robust and operationally feasible methodology applicable to both drinking water and wastewater systems. A dual sampling approach was employed: a pressure-driven, closed-cartridge device for potable water, and a custom pump-based system for treating effluents. Both devices were engineered to minimize contamination, ensure sample integrity, and comply with EU recommendations regarding filtered volume, duration, and materials. The protocol integrates strict field and lab contamination controls, process blanks, and validated cleaning procedures. Pilot sampling campaigns were completed on six sites (three drinking water supply points and three wastewater treatment plants) across the Friuli-Venezia Giulia region. The microplastic particles collected were extracted and analyzed at BsRC using standardized protocols, yielding the first data on particle loads, types, and filter performance. These results, together with operational observations, are being used to refine the final monitoring framework. Our presentation will showcase the structure and rationale of the protocol, present the first field results, and demonstrate how this initiative places regional stakeholders in a position of strategic readiness for upcoming EU monitoring requirements. The protocol offers a replicable model for water operators aiming to anticipate and align with future legislative scenarios.

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BACTERIAL CELLULOSE AS A SUSTAINABLE ADSORBENT FOR POLLUTANTS AND MICROPLASTICS IN WATER

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Cellulose is an extremely abundant polymer in nature. Among its various sources, bacterial cellulose (BC), an extracellular metabolic product of bacteria, stands out for its nanofibrous structure, which provides a high surface area, high crystallinity, and excellent mechanical properties, making it a promising material for a wide range of applications [1]. In this study, BC was purified through NaOH treatments to remove bacterial residues and subsequently investigated for its effectiveness in removing organic contaminants and microplastics from water [2]. Two different morphologies were tested, obtained through appropriate preparation methods: porous BC spheres with average sizes ranging from 400 µm to 800 µm (beads), and BC biofilms. The effect of BC functionalization with graphene oxide (GO) was also evaluated. Material characterization was carried out using different techniques, including thermogravimetric analysis (TGA), scanning electron microscopy (SEM), and Raman spectroscopy, while adsorption efficiency tests were performed using UV-Vis spectroscopy to assess removal performance. Filtration tests with BC biofilms were performed using a vacuum system to capture microfibers from synthetic textile washing water. The results show that: (i) GO-functionalized systems extend the range of pollutants adsorbed by BC, mainly cationic, by including anionic and neutral contaminants; (ii) BC biofilms are effective in filtering microplastics released during the washing of synthetic fabrics.
These findings confirm the potential of BC for the development of advanced water purification systems that combine organic pollutant adsorption with microplastic capture.

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INDOOR AIRBORNE MICROPLASTICS: INSIGHTS FROM A LITERATURE REVIEW STUDY

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Airborne microplastics (AMPs) are emerging contaminants of global concern due to their persistence, small size, and potential for inhalation. Despite increasing evidence of their presence in the atmosphere, their occurrence, behavior, and health implications in indoor environments remain poorly understood. Given that individuals spend the vast majority of their time indoors, these spaces represent critical, yet underexplored, exposure scenarios. This work provides a critical overview of the current state of knowledge on AMPs in indoor environments. Scientific databases were searched using a combination of keywords with Boolean operators. About 60 publications were identified from 2017 to 2025. Studies underscore the increasing identification of MPs in indoor air, primarily linked to synthetic materials used in daily life such as textiles, furniture, and cleaning products. AMPs have been detected in various indoor spaces, including living spaces—such as homes, houses, dormitories, and apartments—as well as non-living indoor environments, including hospitals, schools, workplaces, public transportation. It appears clear that indoor environments, whether workplaces or residential settings, can concentrate AMPs by one to two orders of magnitude above outdoor levels, likely due to indoor sources which contribute to MP emissions. Several studies highlight that human activities, such as vacuuming, ventilation, and the use of air conditioners, significantly influence AMP concentrations. The predominant fibre morphology suggests resuspension from indoor sources. The size distribution also indicates that larger particles are more prevalent indoors, whereas outdoor air contains smaller AMPs, possibly due to atmospheric fragmentation and transport processes. Different studies have reported varying AMP concentrations in indoor spaces, both living and non-living. Non-living indoor environments exhibit values that can exceed hundreds of particles per cubic meter, with a mean value of 576 MPs/m3 detected in seventeen studies. AMPs in living spaces exhibited a mean value of 1558 MP/m3 calculated based on sixteen studies. Inhalation exposure is significantly higher indoors, highlighting potential health concerns. However, advancing understanding of human AMP inhalation requires standardized protocols, including harmonized sampling strategies, consistent dose normalization, and routine reporting of demographic factors (age, gender, activity level). These steps are essential to accurately identify high-risk environments and populations, and to support targeted mitigation strategies.

GREEN BIOMASS-DERIVED POROUS SYSTEMS: MULTIFUNCTIONAL AND LIGHTWEIGHT MATERIALS

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The growing demand for sustainable solutions and circular economy strategies has promoted the valorization of lignocellulosic biomass as a renewable resource for advanced materials. Cellulose, the most abundant biopolymer on Earth, offers unique structural features and a wide range of applications. Agricultural by-products such as grape pomace, draff, rice husk, and hemp were used as precursors for lightweight porous systems. Fibers were extracted and pre-treated via eco-friendly mechano-chemical methods, including planetary ball milling, to obtain interconnected networks of micro/nanofibrillated cellulose [1]. Freeze-drying enabled the fabrication of macroporous structures, which were further combined with micro/mesoporous biomass-derived hyper-crosslinked resins [2] to create hierarchically porous systems. Characterization by scanning electron microscopy and N_2 adsorption analysis confirmed well-interconnected fibrillar architectures with preserved high specific surface area and accessible porosity. These green biomass-derived porous systems exhibit multifunctionality beyond their lightweight nature. Incorporation of hyper-crosslinked resins provides significant adsorption capacity for aromatic molecules, including textile dyes. This approach provides a versatile, sustainable, and scalable route to transform biomass waste into advanced multifunctional materials with potential for diverse environmental applications.

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EFFICIENT REMOVAL OF DYES USING BIO-BASED HYPER-CROSSLINKED RESINS

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The increasing presence of dyes in water is an urgent issue due to their pseudo-persistence and harmfulness [1]. Recently, hyper-crosslinked (HCL) polymers have emerged as efficient, easy-to-synthesise and cost-efficient adsorbents [2,3]. High specific surface area (SSA) and tailorable porosity and functionalisation make HCL resins suitable for dyes uptake. In this work, bio-based HCL resins were obtained through extensive crosslinking of ligno-cellulosic precursors employing eco-friendly solvents and mild reaction conditions, resulting in high SSA resins (Langmuir SSA ~ 1500 m^2/g). Furthermore, doped CeO_2 nanoparticles (NPs) were embedded into the porous structure of the resin to provide a solar light-driven degradation of the pollutants. Finally, the nanocomposite HCL resins/CeO_2 NPs were included in cellulose-based light transparent films able to absorbe large amount of water. The structural, morphological and textural properties of the developed multifunctional adsorbents were investigated. Adsorption capacity towards different dyes was tested. Equilibrium adsorption isotherms and kinetics of adsorption were assessed, as well as their reusability through repeated adsorption/regeneration cycles.

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TWO SEAS, ONE RISK: TROPHIC ECOLOGY INSIGHTS INTO MICROLITTER INGESTION IN CALLINECTES SAPIDUS FROM THE ADRIATIC AND TYRRHENIAN SEA

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Plastic pollution represents an escalating threat to marine ecosystems, particularly in areas experiencing intense anthropogenic pressure [1]. Among the most pervasive contaminants, microplastics (MPs) pose potential hazards to marine organisms, as ingestion can cause a range of adverse physiological and ecological effects [2]. This study investigates microlitter ingestion and the trophic ecology of the invasive blue crab *Callinectes sapidus* in two Mediterranean regions: the Adriatic and Tyrrhenian Seas. A total of 216 specimens (108 per site) were collected, measured (carapace length, total weight), and selected for analysis. Fifty individuals per site underwent microlitter analysis in stomach and intestine contents using 15% H_2O_2 digestion, followed by filtration, MPs characterization, and µFT-IR polymer identification, as described by Galgani et al. (2023) [3]. An additional 40 specimens per site were analysed through stable isotope analysis (SIA) on freeze-dried, pooled muscle tissue ($\delta^{13}C$, $\delta^{15}N$). Diet analysis was performed through stomach content DNA metabarcoding. Microlitter was detected in 39% of Adriatic and 50% of Tyrrhenian individuals (123 total items), with an overall frequency of occurrence of 44.5%. Fibres were predominant (94.3%), confirming patterns previously reported for *C. sapidus* [4]. A clear geographic contrast emerged in both microlitter abundance and composition: Tyrrhenian individuals contained more than twice as many particles, mostly synthetic (61.4%), whereas Adriatic specimens ingested fewer items, primarily natural fibres (62.5%, cellulose-based). Isotopic analysis revealed distinct trophic niches: Adriatic individuals showed higher $\delta^{15}N$ and less negative $\delta^{13}C$ values, suggesting higher trophic positions and different carbon sources. Differences among the trophic resources used by the two populations was detected by DNA metabarcoding analysis. This site-specific variety likely reflect variation in local environmental loads and exposure pathways, and are consistent with previous evidence of an east–west gradient in microlitter exposure across the Mediterranean Sea [5]. Diverse trophic ecology reveal *C. sapidus*' ecological plasticity and confirm its invasive potential. The integration of microlitter ingestion analysis with ecological data in *C. sapidus* offers new insight into how feeding ecology can influence microlitter uptake, emphasising the value of localised monitoring and cross-scale ecological assessments.

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ENVIRONMENTAL-FRIENDLY FOAMS TO REMOVE MICROPLASTICS RELEASED FROM TEXTILES TO WASTEWATER

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The wide diffusion of microplastics (MPs) in aquatic environment, exacerbated by the release of microfibers during the washing of synthetic textiles, requires sustainable and effective solutions. In this regard, this study proposes environmentally friendly composite foams based on poly(vinyl alcohol) (PVA) and bacterial cellulose (BC) crosslinked with citric acid (CA), for the retention of MPs present in textile washing waters. Different degrees of hydrolysis and molecular weights of PVA were tested for realization of foams and compared to optimize the formulation. Results reveal that foams realised using PVA 30-70K present the best properties in term of workability, thermal stability, and interconnected porous structure allowing us to select it to realize foams containing BC. The integration of BC, derived from Kombucha fermentation, further improved the porous morphology, water absorption capacity, and mechanical resilience, with MP removal efficiencies of up to 75% for high-cellulose-content foams. This approach integrates renewable materials and eco-compatible processes to address one of the main sources of microplastic pollution.

Acknowledgement: The research activities were performed in the framework of the PRIN 2022 BACK APP Project “Production of bacterial cellulose from agrifood residues by Kombucha culture: enhancing cellulose productivity and tailoring its techno functional properties for advanced applications” funded by European Union – Next Generation EU, CI 2022AEXJL7.

HOW ROAD TRAFFIC FUELS MICROPLASTIC CONTAMINATION

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Microplastics represent a growing global concern due to their widespread presence and potential risks to both environmental and human health. Understanding their sources and behavior across aquatic, terrestrial, and atmospheric systems is essential. Beyond their physical characteristics, microplastics pose additional hazards through associated chemical additives, particularly plasticizers.
Herein, we investigated the presence of microplastics and plasticizers in air samples collected from the Marquês tunnel in Lisbon, Portugal. The primary objectives were to extract and identify airborne microplastics and to develop an optimized methodology for the extraction and quantification of both phthalate and non-phthalate plasticizers.
Microplastics were quantified by staining filters with Nile Red and visually identifying suspected particles. For plasticizer analysis, gas chromatography–mass spectrometry (GC-MS) was employed following extraction with organic solvents.
Microplastic concentrations ranged from 520.1 to 4216 particles per cubic meter, with elevated levels observed during periods of intense vehicular traffic. The GC-MS method was successfully optimized, and several plasticizers - including di-n-butyl phthalate, butyl benzyl phthalate, and di-n-octyl phthalate - were detected in selected samples.
Although this study is based on a single sampling campaign, the optimized analytical protocol and potential integration of μ-FTIR or additional personnel for microplastic identification will enhance the efficiency and accuracy of future research.

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BIODEGRADABLE POLYMER BLENDS WITH LIGNIN AS UV STABILIZER FOR ECO-SUSTAINABLE FISHING NETS

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Plastic pollution in marine environments is an increasing global issue, with significant ecological consequences. One of the most hazardous forms of plastic pollution for marine ecosystems is represented by abandoned or lost fishing nets, known as "ghost fishing". These nets can trap marine organisms, degrade habitats, and contribute to the accumulation of plastics and microplastics in the ocean [1]. In this context, polymeric blends were developed using two biodegradable and compostable polymers polybutylene succinate (PBS) and polybutylene adipate terephthalate (PBAT) [2] as a sustainable solution to produce fishing nets. To improve the materials' stability under UV exposure, lignin, a natural UV-absorbing compound, was introduced into PBS/PBAT polymer blends. Thanks to its intrinsic ability to absorb a wide spectrum of UV light in the 250–400 nm range, lignin [3] is expected to enhance the photodegradability of the material when exposed to sunlight in marine environments, providing effective UV protection to the blends even at low concentrations. Multiple formulations were developed by varying the concentration of the filler phases, and their chemical-physical and rheological properties were characterized to assess processability. To evaluate the efficacy of lignin, polymeric films were produced and subsequently exposed to both natural and artificial UV radiation. Colorimetric measurements, morphological and thermal analysis were carried out at different times.

This study represents a step forward in the development of eco-sustainable fishing gear, contributing to the formulation of new biodegradable and compostable materials capable of mitigating the environmental impact associated with fishing equipment and its end-of-life management.

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TOWARDS SUSTAINABLE SOLUTIONS BASED ON BIOPLYMERIC BLENDS FOR CONTAINMENT NETS IN THE AQUACULTURE SECTOR

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In the field of Aquaculture, the ordinary maintenance of containment nets involves the use of plastic ties commonly designed for terrestrial applications. The project “ECOSEA” aims to redesign this component, developing ties specifically designed for use in the marine environment. The main challenge consists in designing fastening systems that can guarantee adequate mechanical performance during use, but at the same time at the end of use are able to biodegrade in the marine environment within times compatible with the protection of the ecosystem. In this context, it is essential to complement the design and development phases with the implementation of experimental set-ups in real marine environments, in order to accurately assess the performance and degradation behavior of the prototypes under operational conditions [1]. To verify the biodegradability of materials in environment, field tests permitt a complexity of environmental variables (temperature, salinity, hydrodynamics and biological communities) that cannot be fully replicated in laboratory conditions. The use of biomolecules from food and industrial by-products (such as proteins, lignocellulosic fibers and lipid polyesters) represents a promising approach towards mechanical properties suitable for the marine environment, while ensuring controlled biodegradation and greater environmental sustainability [2,3]. The development process, including formulation, 3D-printed laboratory prototypes, and field trials, is presented.

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MICROPLASTICS IN SEA SALTS FROM MEDITERRANEAN AND ATLANTIC OCEAN SALT PANS: A COMPARATIVE STUDY

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Microplastic (MP) contamination is an increasingly urgent environmental and public health concern [1], as these persistent particles spread rapidly through ecosystems, infiltrate the food chain, and ultimately pose risks to human health. Among the various pathways through which MPs can enter the human body, the ingestion of salt (sodium chloride, NaCl) is particularly relevant. Salt is not only one of the oldest and most widely used food additives for culinary and preservation purposes [2], but also extensively employed in the preparation of saline solutions for medical applications. In this study, we quantified and characterized MPs in both raw and commercially available salt samples collected from Mediterranean and Atlantic Ocean salt pans. Characterization included assessment of particle colour, size, shape, and chemical composition. Special emphasis was placed on optimizing the analytical protocol to enhance reliability and minimize external contaminations. The workflow involved dissolving a measured mass of each salt sample in pre-filtered Milli-Q water, followed by sequential filtration using a continuous system equipped with two stainless steel mesh filters (50 µm and 25 µm). The retained particles were subsequently dried and examined under an optical microscope for visual characterization. MPs were then chemically identified using advanced spectroscopic techniques, specifically micro-Fourier Transform Infrared (micro-FTIR) spectroscopy. Finally, the results were evaluated through multivariate statistical analyses to explore potential differences in MP contamination levels among the sampled salts. This study contributes to a better understanding of MP contamination in food-grade salt and highlights the importance of standardized, contamination-free analytical protocols in environmental and food safety research.

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BIODEGRADABLE FUNCTIONAL COMPOSITES CONTAINING AGRICULTURAL BYPRODUCTS: RESULTS FROM THE "NEW SKIN" PROJECT

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The environmental and health risks associated with the ever increasing use of synthetic plastics are of large concern, in particular regarding the generation and diffusion of microplastics as a consequence of their improper disposal and of the action of environmental agents.
One promising strategy to mitigate the impact of plastics is the replacement of conventional, oil-based polymers with bioplastics, that is, polymers that are biodegradable and/or bio-based. To enhance and modulate the performance of bioplastics, fillers of natural origin can be incorporated into the biopolymer matrix, providing mechanical reinforcement and specific functionalities.
In this study, poly(butylene succinate-co-butylene adipate) (PBSA) was used as the biopolymer matrix. As fillers, we explored a class of by-products sourced from agri-food industry waste, specifically the skins of edible seeds (almonds, pine nuts, hazelnuts, and coffee). This last material is commonly called coffee silverskin (CSS). All of these materials have shown interesting antioxidant properties, as assessed using the DPPH assay in combination with the QUENCHER method.
Composite materials based on milled CSS and PBSA were realized, assessing the thermomechanical properties, antioxidant ability, and biodegradation behavior in both soil burial and composting conditions. The results obtained highlighting the beneficial effect of the biobased filler on properties and, in particular, on the biodegradation process, particularly relevant in the frame of sustainability and environmental impact.

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RECENT DEVELOPMENTS ON MICROPLASTICS ANALYSIS IN MARINE SEDIMENTS AND AIR INVOLVING GCMS-PYROLISIS AND AGILENT LDIR SPECTROSCOPY

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Microplastics (MPs) emerge as pervasive pollutants with potential impacts on ecosystems and human health. Their detection and characterization remain analytically challenging due to their small size, chemical diversity, and ubiquitous presence. This work presents a multi-technique approach to MP analysis in marine sediments and airborne particulate matter, integrating quantitative pyrolysis-GC/MS and infrared chemical imaging via Agilent LDIR. Marine sediment samples from coastal and offshore areas, as well as air samples collected via passive filtration, were analyzed. A critical focus was placed on sample preparation: density separation in saturated salt solutions, oxidative digestion using hydrogen peroxide, and cryogenic milling of filters were essential to remove organic matrix interferences and homogenize the sample. All procedures were performed under ultra-clean conditions to prevent secondary contamination, highlighting the preparative phase as a key step for reproducible and reliable data. Quantification was carried out using micro-furnace pyrolysis-GC/MS in splitless mode, employing polymer-inorganic calibration standards and dedicated analytical software (F-Search MPs). This enabled sensitive and selective detection of major polymer types down to the nanogram range. Complementarily, the Agilent LDIR system allowed for high-throughput identification and imaging of microplastics on solid supports, providing spatial and morphological context that complements the molecular data from GC/MS. The integration of thermal and spectroscopic methods offers a comprehensive workflow for the characterization of MPs in complex environmental matrices, supporting environmental monitoring efforts and standardization of analytical protocols.

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SUSTAINABLE-TO-GO CUPS: ECO-FRIENDLY OR A HIDDEN PLASTIC HAZARD UNDER THERMAL STRESS?

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Micro- and nanoplastics (MNPs) in food present an emerging health concern, with ingestion via single-use items like disposable cups identified as a significant exposure route [1]. As conventional plastics such as polyethylene (PE) and polystyrene (PS) are increasingly replaced by “sustainable-to-go” alternatives like polylactic acid (PLA)-based compostable cups, questions arise regarding the reliability of these materials under realistic usage scenarios [2]. While PLA is widely presented as a greener alternative, its structural integrity and behavior under heat exposure are not well-characterized and may, in fact, compromise both its functionality and environmental promise. To address this knowledge gap, this study conducted a comparative analysis of MNP release and surface degradation from commercially available conventional and compostable cups using FTIR, SEM, flow cytometry with Nile Red staining, and X-ray photoelectron spectroscopy (XPS). All samples were subjected to EU-standard migration testing (95 °C for 15 minutes) [3]. Results showed distinct MNP profiles: PE and PS released ~1×10^5 particles/mL (spherical/angular fragments), while PLA generated ~1×10^6 particles/mL (amorphous aggregates). SEM and XPS analyses revealed notable surface degradation following thermal exposure. Previous studies reported much lower migration levels—e.g., ~1,293 particles/mL for PE ([4]; China) and just ~180 particles/mL for PLA ([5]; Ireland)—highlighting inconsistencies in test conditions and the need for standardized evaluation. Estimated MNP intake per single use reached ~250 million particles for PLA, compared to ~25 million for PE/PS. These findings urge a re-evaluation of compostable plastics in food contact applications. Far from being a harmless alternative, PLA may contribute more substantially to MNP exposure, raising critical questions about how we define—and measure—sustainability in consumer packaging.

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DESIGN OF HYPER-CROSS-LINKED CELLULOSE NANOFIBRILS AS RENEWABLE SORBENTS FOR CHLOROPHENOL REMOVAL FROM WATER

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Water pollution from industrial activities remains a major environmental challenge, with chlorophenols among the most persistent and toxic contaminants. To address this issue, we developed a novel bio-based adsorbent inspired by hyper-cross-linked polymers using cellulose nanofibrils (CNFs). The CNFs were functionalized with poly(vinylbenzyl chloride) and cross-linked via Friedel–Crafts alkylation, yielding a micro/mesoporous material with a specific surface area of 409 m²/g, a 50% microporous fraction, and a renewable content of about 70 wt%. The adsorbent efficiently removed 90% of 2,4-dichlorophenol (DCP) from a 62.5 mg/L solution at 298 K, reaching a maximum adsorption capacity of 284 mg/g at higher concentrations. Thermodynamic analysis indicated a spontaneous and exothermic multilayer adsorption process. The material retained over 98% efficiency after five reuse cycles and showed high stability against pH variations and organic matter interference. These results highlight the potential of CNF-based architectures for sustainable and efficient water purification [1].

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HEAVY METAL IONS SORBENTS BASED ON FLYASH/MWCNT

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Water contamination is a serious problem and increases the concern because of its effects on living organisms as well as the surrounding environment. Microorganisms, organics, and inorganics are the three primary types of pollutants found in water. Because of their toxicity to ecological and biological processes, heavy metal ions (HMI), which make up the majority of inorganic contaminants, have raised a lot of concern. As a result, scientists, water regulatory agencies, and government agencies are concerned about maintaining and improving water quality. Due to the problems created by the inclusion of HMs in wastewater, traditional wastewater treatment techniques such as adsorption, coagulation, flocculation, precipitation, reverse osmosis, biological process, gamma radiations, and photocatalysis were used to remove them.

The subject of this work was to obtain and to test the Fly ash/MWCNT composites aimed for HMI adsorption in polluted waters. Three different types of fly ash waste particles were used, two types supplied from EURONICKEL and one supplied from OSLOMEJ, Macedonia. The surface of the fly ash (FA) particles was modified by treating with nitric acid. Several types of composite sorbents were prepared using the FA and MWCNT. The characterization of the FA waste particles was performed by XRF, XRD, TGA, SEM and FTIR analysis, while the obtained composites were tested by TGA, SEM and FTIR analysis. FA/CMWCNT sorbents were tested as an adsorbent for Cu (II), and Pb (II) from aqueous solutions. The effects of contact time, solution pH, initial metal concentration were studied in batch experiments at room temperature. Maximum metal sorption was found to occur at pH 6.0. The equilibrium adsorption data for Cu (II) and Pb (II) ions were fitted to Langmuir isotherm model. The efficiency trend was Pb (II) > Cu (II). The results indicated that the removal efficiency for Cu (II) and Pb (II) ions was 91.1% and 99.7% respectively.

A COMPARATIVE STUDY ON ANTHROPOGENIC PARTICLES IN *ANEMONIA VIRIDIS* BETWEEN THE CAPO PELORO NATURAL RESERVE AND THE AEOLIAN ISLANDS

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Sea anemones, due to their proximity to the coast and their non-selective suspension feeding behavior, are likely exposed to microplastics, which pose both physical and chemical threats through ingestion and external adhesion. This study investigates the occurrence of anthropogenic particles (APs) in the snakelocks anemone *Anemonia viridis*, a widespread and edible species, within the Capo Peloro Natural Reserve and Vulcano Island (Sicily, Italy). A total of 288 APs was found, both on external surface and incorporated within the tissues of the organisms, with an average of 5.07 ± 0.88 items/specimen (corresponding to 0.58 ± 0.07 items/g) and frequency of occurrence of 87.9%. APs were found at all sampling sites, with a minimum of 0.39 ± 0.06 items/g at Vulcano Island (Aeolian Islands), 0.63 ± 0.12 at Faro Lake (Capo Peloro Natural Reserve) and a maximum of 0.74 ± 0.15 at Beach Rock (Cape Peloro Natural Reserve). The most common shape was fiber, followed by fragment and film. Polyester, polystyrene, polyethylene terephthalate, polypropylene, and cotton were the most abundant APs. These findings highlight the differences between the incorporated and the attached APs, supporting the potential use of sea anemones as bioindicators for monitoring plastic pollution. The results also underscore the pervasive nature of microplastic contamination, even within protected marine areas, and the vulnerability of benthic organisms like *Anemonia viridis* to anthropogenic pollution. Further research is needed to assess the ecological implications and potential risks to marine food webs and human health.

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MICROWAVE-ASSISTED HYDROGEN PEROXIDE DEGRADATION OF POLYSTYRENE MICROPLASTICS

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Commonly used in packaging and electronics, polystyrene has become a persistent environmental pollutant due to its high resistance to natural degradation. This study investigates the degradation of PS microplastics through a microwave-assisted oxidative process at 220 °C using a hydrogen peroxide and nitric acid solution. PS particles, sized at approximately 1 mm, were obtained through mechanical fragmentation of PS cups and subjected to controlled microwave exposure across multiple time intervals ranging from 0 to 105 minutes.
Microscopic characterization using scanning electron microscopy (SEM) and stereo microscopy revealed that the particles transformed from irregular white fragments into grayish to orange-brown clusters with porous morphology, indicating progressive degradation. Mass loss measurements showed distinct trends throughout the exposure period. Gel Permeation Chromatography confirmed molecular breakdown, as high-molecular-weight peaks diminished, and oligomer distributions shifted. FTIR analysis revealed carbonyl bands around 1710 cm^{-1}, suggesting oxidative modifications in the polymer structure. Preliminary kinetic analysis indicated a two-stage degradation pattern, which suggests a change in degradation mechanism over time. In the first 45 min, particle mass did not change much (20 %); however, rapid degradation occurred in 50−105 min, achieving 84 % mass loss. The first stage followed the Korsmeyer-Peppas model with the exponent n=1.66, suggesting bulk erosion as the main polymer degradation mechanism. The second stage followed pseudo-first-order kinetics, typical for microplastic chain scission behavior, with a rate constant of 0.0181 min^{-1}. A Total Organic Carbon (TOC) analysis will be conducted on the resulting aqueous phase to assess the concentration of dissolved organic compounds. This evaluation will offer valuable insight into the environmental relevance and sustainability of the degradation process. Further investigation is required to elucidate the specific kinetics involved and validate the mechanistic hypotheses. This study provides essential insights into PS microplastic degradation under microwave-assisted conditions and highlights the potential of this technique for developing sustainable plastic waste treatment strategies.

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MULTICOMPONENT PLATFORMS INTEGRATING FIBERS AND NANOPARTICLES FOR ENVIRONMENTAL REMEDIATION

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To develop and implement innovative and sustainable solutions for combating plastic pollution, it is essential to integrate various research strategies. This approach creates effective systems that align with sustainable-by-design principles, environmental and health safety standards, circularity, and functionality. In this context, an innovative approach is described for producing fibrous composite membranes for water remediation. The proposed approach aims to develop an innovative, nanotechnology-based manufacturing process for creating coated fibrous membrane filtration (MF) systems for wastewater treatment through the combination of two versatile fabrication techniques: flame synthesis/thermophoretic deposition and electrospinning. First, electrospun membranes are realized using different polymers, and then they are coated by direct thermophoretic deposition with nanostructured thin films of composite materials composed of TiO_2 and graphitic-like carbon nanoparticles (TNPs and CNPs, respectively). Thanks to their unique photoinduced and photocatalytic properties, the combination of TNPs and CNPs may be a promising strategy to reduce the band gap and shift photon absorption toward the visible spectrum. The resulting membranes exhibited tunable porosity and surface properties due to the presence of the particle layer.

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ZEBRAFISH TO STUDY MICROPLASTICS AND TROJAN HORSE EFFECT

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Microplastics (MPs) are small particles (< 5 mm) resulting from breakdown of plastic debris or from industrial sources. Their spread in the environment raises concern due to potential accumulation in organisms and alteration of ecosystems [1]. The hydrophobic surface of microplastics implies the “Trojan Horse effect”, allowing them to transport other pollutants present in the environment. Bisphenol A (BPA) is a synthetic compound used in the production of plastic, widely detected in the environment and demonstrated to be an endocrine distruptor. Zebrafish (*Danio rerio*) is a good model organism for toxicology studies for its genetic similarity to humans, transparent embryos, and rapid development [2]. In this study, the zebrafish development was followed for 72 h in presence of polystyrene microplastics (PS-MPs) of 1 µm in size (0.01, 0.1, 1.0, 10.0 mgL^{-1}) and bisphenol A (6.25, 12.5, 25.0 and 50 µM), individually as first step. Then a mixture of PS-MPs (1.0 mgL^{-1}) and BPA (25.0 µM), was used to test the effects of their interaction. Thus, toxicity parameters and respective genes involved in development (*cd63, zhe1, mgaa, gata4, gap43, ngn1*) were analyzed for 72h. The results showed that PS-MPs did not alter survival and hatching, but the higher concentration (1.0 and 10.0 mgL^{-1}) caused tachycardia at 72 hours of treatment [3]. Instead, BPA at 50 µM reduced survival and blocked the hatching process. The concentration of 25 µM did not alter survival but reduced the hatching process and caused bradycardia in the heart rate at 72 h. Finally, lower concentrations did not cause toxicity at 72 h. During co-exposure the two pollutants showed an antagonistic effect and PS-MPs mitigated the effects caused by BPA. In conclusion, the results highlight the importance of understanding how these toxic substances interact to evaluate risks on human health and to add information on water pollution.

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INVISIBLE THREADS, VISIBLE IMPACT: MICROFIBERS IN DOMESTIC APPLIANCES

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Synthetic fibers, particularly those made of polyethylene terephthalate (PET), are widely used in clothing and household textiles, and their release during domestic laundering is recognized as a significant source of microfiber (MF) pollution [1]. Even natural fibers may still act as vector for chemical additives and dyes [2], contributing to environmental contamination. In this context, while washing machines have been extensively studied as primary sources of MF emissions, the role of other common household appliances - such as tumble dryers and combined washer-dryers - remains underexplored [3].
This study aims to assess and compare MF release during the standard operation of washing machines, tumble dryers, and combined washer-dryers, using garments made of PET and cotton. Preliminary results indicate that the quantity of MFs released varies according to both the textile material and the type of appliance used. Moreover, the extent of fibre shedding is influenced not only by the type of fabric but also by the washing method—whether washing alone, washing followed by tumble drying, or combined washer-dryer cycles—highlighting the significant role of the appliance used.
Understanding how different machines and laundry practices influence microfibre release is key to identifying practical and effective mitigation options. These may involve the development of improved filtration systems, the optimization of washing and drying programs, or design solutions to minimize fibre loss. Exploring these strategies at the appliance level offers a concrete opportunity to limit microfibre emissions directly at the source, potentially reducing their entry into the environment.

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CHARACTERIZATION OF THE COMPOSITION AND TYPES OF MARINE MICROPLASTICS IN THE CANARY ISLANDS

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The Canary Islands, due to their geographical and strategic location in the Atlantic Ocean, as well as the influence of the North Atlantic gyre, become hotspots for microplastics. In this area, several studies on microplastics in beaches and in surface waters have estimated that polyethylene (PE) and polypropylene (PP) are the dominant polymers in the coastal areas of the Canary Islands [1], being the most abundant in the ocean surface due to their low density [2]. However, although there are studies focused on deep waters [3], due to the difficulty of sample collection and the complexity of microparticle determination, the information available on their presence, composition and transport is limited. In addition, microplastics are exposed to various processes in the ocean such as weathering processes, photodegradation, chemical oxidation, and physical abrasion, together with the high resistance and permanence of these microplastics, they undergo fragmentation and degradation, being transported long distances in the ocean [4, 5]. Consequently, the high adsorption capacity of microplastics promotes the release of plastic additives into the environment and causes them to accumulate and transport persistent chemical pollutants (POPs) [6]. For this reason, microplastics become a double entry vector of pollutants. Therefore, considering that marine currents bring tons of plastics to the coasts of the Canary Islands, the Subproject 2 “Promoviendo la salud de oceánica de las Islas Canarias” aims to study the marine microplastics that reach the region by evaluating their abundance, composition and the additives they contain in different areas of the islands. For this purpose, the type of microplastic and the composition of the samples collected will be determined using Fourier-transform infrared spectroscopy (FTIR). In addition, the concentration and types of additives, such as POPs, will be analyzed using Gas Chromatography-Mass Spectrometry (GC-MS).

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IMPACT OF BIODEGRADABLE PLASTICS ON FRESHWATER ENVIRONMENTS

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To reduce the ecological impacts of conventional plastic, the use of biodegradable plastics (BDP) is increasingly spreading as alternative material [1,2]. In the environment, BDP are degraded by abiotic and biotic factors, resulting in the release of degradation products (DP), including microplastics, potential toxic additives and polymers [1,2]. This study investigates the impact of BDP on freshwater environments, which are fragile ecosystems already affected by several anthropogenic pressures, including plastic pollution. To assess the chemical release from BDP, abiotic degradation experiments were performed by exposing both bio-based and petrol-based BDP to UV light, with a control sample kept in the dark. Experiments were carried out in both pure water and in water collected from different freshwater environments. The resulting BDP-DP were analysed using different chemical techniques to identify their chemical composition. In addition, leachates were used in toxicity test to investigate the potential effects on freshwater biota. Target organisms included both ecotoxicological model organisms and wild freshwater species from different trophic levels, like microalgae and zooplankton, which play a key role in aquatic food web. The use of these complementary approaches allows to compare potential effects of BDP-DP with other contaminants using standardized methods for model organism, while in the case of wild species, it provides a more realistic assessment of the ecological impact of BDP-DP.

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UNVEILING THE SIZE EFFECT ON HAZARD OF COMMERCIALLY DERIVED MICROPLASTICS

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Microplastics (MPs; particles < 5 mm) occur as contaminants of emergent (eco)toxicological concern for environmental and human health. A probable warning of smaller particles is associated with their cumulative toxicity and ability to penetrate deeply into tissues and organs. Indeed, small MP fragments (< 30 µm) have been associated with greater ingestion, higher mortality rates and more severe damages than those of larger fragments. To better understand the effects of MPs on aquatic organisms and humans, their effects should be evaluated according to characteristics as MP type, size and shape. Furthermore, although studies on MPs have deepened worldwide, environmental threshold values have not yet been defined.
In this study, we experimentally collected ecotoxicological data - as Effect Concentrations (ECs) - of commercially derived MPs of PolyLactic Acid (PLA) and PolyPropylene (PP) on bacteria, algae and crustaceans, by exploring the particle size effect (20-38 µm vs 38-212 µm). In addition, we derived thresholds for acceptable effects on organisms, calculating Predicted No Effect Concentrations (PNECs) from ECs applying assessment factors as uncertainty. Results contribute to deepen how MP size influences their toxic effect and their hazard assessment.

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IMPACT OF PET NANOPLASTICS ON IMMUNE HOMEOSTASIS AND CELLULAR FUNCTION IN *MYTILUS GALLOPROVINCIALIS*

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Plastics are widely used due to their chemical stability and durability, making them also responsible for their persistence in the environment. Among them, nanoplastics (NPs) pose an insidious threat to marine organisms due to their nanoscale size (<100 nm) and high bioavailability. Considering the above, mussel *Mytilus galloprovincialis* is particularly well-suited to assess NPs critical impacts on marine invertebrate immune function, as a non-conventional model organism with conserved genetic pathways related to metabolism and immunity. In a 7-day exposure experiment, mussels were treated with increasing concentrations of PET NPs (Control, 0.05 mg/L, 0.5 mg/L, 1 mg/L), resulting in significant alterations in immune and antioxidant biomarkers in both gills and digestive gland. Glutathione peroxidase activity increased early in the digestive gland at low concentrations, whereas in the gills a marked suppression at higher concentrations and longer exposures suggested oxidative damage and a breakdown of antioxidant defence. Lysozyme, key enzyme of innate immunity, showed initially elevated activity followed by a sharp decrease particularly in the digestive gland, indicating potential inhibition due to high exposure levels. A biphasic trend was also registered for Phenoloxidase activity, also involved in innate immunity, with early peaks in the gills followed later by a general decrease. HSC70 presence increased after 7 days of exposure pointing a possible adaptive response to prolonged stress, as it is constitutively expressed but responsive to environmental stress. The in vitro approach showed reduced mussels haemocytes viability at higher exposure concentrations, along with decreased in their motility and velocity, suggesting impaired immune function and potential onset of apoptosis or necrosis. These findings highlight the need for further investigation into the impact of plastic pollution on the immune responses of marine organisms, as the proper functioning of their immune system is fundamental to organism health and to the stability and biodiversity of marine ecosystems.

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ABUNDANCE AND CHARACTERISTICS OF MICROPLASTICS IN SURFACE WATERS OF TWO TRANSITIONAL ECOSYSTEMS: THE VENICE LAGOON AND THE PO DELTA

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Transitional ecosystems such as river deltas and coastal lagoons are increasingly recognised as hot spots for microplastic (MP) accumulation, acting as interfaces that intercept land-derived debris before it reaches the open sea [1].
This study reports MPs abundance, morphology and polymer composition in surface waters from two Northern Adriatic transitional systems: the Venice Lagoon and the Po Delta.
Sampling in in the lagoon site covered the period from February 2022 to August 2024, while monitoring the Po Delta was carried out seasonally between August 2024 and May 2025. Surface water samples were collected using a manta net equipped with a 330 µm mesh and processed following harmonised protocols.
Microplastics were then visually identified and categorised under a stereomicroscope, and concentrations were normalised to particles m-3 [2]. Subsets of particles will be subjected to ATR-FTIR spectroscopy for polymer identification.
Microplastics were detected in all samples and across both study areas. Concentrations ranged from 0.33 to 4.34 particles m^{-3} at the lagoon site of Sacca Fisola, and from 2.59 to 35.33 particles m^{-3} in the Po Delta. Fibres and fragments consistently represented the dominant morphotypes.
The comparison between these deltaic and lagoonal environments provides new insights into spatial variability and accumulation patterns of MPs in transitional waters. These findings offer valuable baseline data for ongoing monitoring efforts and will inform future assessments of targeted mitigation actions

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ADVANCING MICROPLASTIC MITIGATION THROUGH LIFE CYCLE ASSESSMENT: POLICY INTEGRATION CHALLENGES IN THE REPUBLIC OF SERBIA WITHIN THE EU ACCESSION CONTEXT

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Over the past decade, microplastics (MPs) have become a major global environmental and public health concern due to their persistence and accumulation across ecosystems. Inefficient recycling, excessive plastic use, and poorly managed landfills have led to their widespread distribution, causing significant environmental, social, and economic impacts [1,2]. Addressing this issue is particularly challenging for countries like the Republic of Serbia, which are still aligning national legislation with EU environmental standards [3]. Life Cycle Assessment (LCA) offers a comprehensive, science-based approach to evaluating environmental impacts across the entire life cycle of products or processes [4], making it a valuable tool for evidence-based policymaking [5]. However, its application to microplastic pollution is still methodologically evolving and requires further investigation. [3,6,7]. This paper explores key barriers and potential opportunities for integrating LCA into microplastic-related policy and decision-making in Serbia, in the broader context of global efforts to strengthen environmental governance, particularly among EU-associated countries.

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MICROPLASTIC INGESTION IN THREE DEEP-WATER FISH SPECIES: ECOLOGICAL INSIGHTS FROM STABLE ISOTOPE ANALYSIS

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Plastics represent a major environmental concern on a global scale. Particularly, microplastics (MPs) pose significant ecological risks due to their pervasive distribution and interactions with marine organisms, primarily through ingestion [1]. This study investigates the relationship between MP ingestion and the trophic ecology of three deep-sea fish species: the benthic feeder *Chlorophthalmus agassizi*, the benthopelagic predator *Hoplostethus mediterraneus*, and the demersal predator *Coelorhinchus caelorhincus*). Samples were collected off the Anzio coast, Tyrrhenian Sea (Western Mediterranean). Sampling occurred along the 500 m isobath during a single fishing trip, yielding 90 specimens (30 per each species).
Stable isotope analysis (SIA) on muscle tissue was used to define trophic positions (TP) and isotopic niches, and MP ingestion patterns were analysed in relation to the inferred feeding strategies. Individuals were measured and dissected. The gastrointestinal tract was digested with 10% KOH, filtered, and analysed under a stereomicroscope. Each particle was characterized according to its shapeand colour [2]. Images of each particle were used to compute surface area measurements [3], and μFT-IR analyses for polymer identification were performed on all collected particles. Isotopic analysis on the three species revealed distinct foraging patterns: C. agassizi exhibited the lowest TP (3.81 ± 0.3) and an isotopic niche clearly separated from the other two species. H. mediterraneus (TP = 4.41 ± 0.11) and C. caelorhincus (TP = 4.5 ± 0.18) showed partially overlapping niches. MP ingestion rates did not follow trophic level gradients; notably, C. agassizi individuals ingesting MPs had the highest mean number of particles (2 ± 1.60), followed by H. mediterraneus (1.75 ± 1.06) and C. caelorhincus (1.36 ± 0.67). In contrast, C. caelorhincus showed the ingestion of MPs of larger sizes, with average particle sizes of 0.11 ± 0.19 mm, compared to H. mediterraneus, 0.04 ± 0.07 mm, and C. agassizii, 0.08 ± 0.18 mm. This pattern suggests feeding mode rather than trophic level primarily influences MP exposure: scavenging and detritivory species showed a higher rate of particle ingestion, while predation seems to be linked to the ingestion of few but large-sized MPs [4,5]. More specifically, an increase in trophic level corresponds to greater diversity of ingested MPs but a decrease in the average number of particles per individual; concurrently, species occupying higher TP tend to ingest larger MPs particles, reflecting differences in feeding behavior and exposure pathways. These findings underscore the importance of integrating isotopic niche analysis with detailed MPs characterization to enhance our understanding of the ecological dynamics of MPs ingestion within marine food webs.

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GREENPLASMA: A MOBILE WASTE-TO-ENERGY SYSTEM FOR MARINE PLASTIC RECOVERY AND VALORISATION

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Plastic pollution in marine environments is a global issue, with thousands of tons of plastic waste entering the Mediterranean Sea annually. While recent policies, such as Italy's "SalvaMare" law (60/2022), promote the collection of plastic debris from the sea, the lack of recycling options for the recovered waste often leads to landfill disposal, undermining both environmental and economic sustainability. GreenPlasma provides an innovative and sustainable response through a mobile waste-to-energy (WtE) system designed to valorise non-recyclable plastic waste from marine and coastal environments. After pre-treatment to reduce waste size, the system employs high-temperature pyro-gasification to thermochemically decompose plastic into a hydrogen-rich syngas with high calorific power, which is then purified and converted into electricity that can be used immediately or stored. One of the key innovations lies in its mobility: GreenPlasma is fully integrated into a van, enabling application along coastlines, in remote areas, or on small islands, thus reducing waste transport and related emissions. The current prototype processes up to 10 kg/h of plastic, with approximate yields of 1 kWh per kg, and it is energy self-sufficient, consuming ~30% of the generated electricity. Ongoing research focuses on optimizing the process across various plastic waste streams—such as single or mixed polymers, and aged or degraded materials—to define robust, scenario-specific operational protocols. Processed materials include stranded plastics from beach clean-ups, ghost nets recovered at sea, and plastic waste from ports and sea-based activities. Its mobile nature reduces emissions and costs associated with waste transportation and disposal, supporting coastal resilience and environmental remediation, as well as circular flows where waste-derived energy powers the very activities that generate the waste. By converting unrecyclable plastics into clean energy, GreenPlasma offers a circular, scalable solution aligned with Sustainable Development Goals, enhancing coastal resilience and contributing to effective marine plastic pollution mitigation.

INTEGRATED ASSESSMENT OF AIRBORNE MICROPLASTICS IN PLASTIC-PROCESSING FACILITIES

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Airborne microplastics (AMPs) represent an emerging occupational hazard [1] due to their persistence, small size and potential ability to penetrate deep into the respiratory tract [2]. We are developing and validating an integrated method—active air sampling, fluorescence microscopy and pyrolysis-GC/MS—for quantitative and qualitative AMP characterization in five facilities that deal with virgin, recycled plastics and undifferentiated waste. Low-flow pumps (15 L/min) collect air on polycarbonate filters for particle counting (5–200 µm; up to 1.2×10^4 particles/m³) and on quartz filters for polymer mass analysis. Sampling covers high-stress zones (cutting, grinding, shredding), secondary processing areas, offices, operator-worn personal samplers and outdoor backgrounds. Following Fenton's digestion and Nile Red staining, microscopy enables automated morphometric profiling, while Py-GC/MS identifies polymers chemical composition [3]. Preliminary data reveal that the first investigated plant (Plexiglass processing facility) reaches peak concentrations of 36 µg/m³ for PMMA and 28 µg/m³ for PE in primary zones, whereas the second one (PVC-fixture facility) records PVC levels ranging from 1.3 to 12.7 µg/m³. Rigorous QA/QC—including procedural blanks, reagent pre-filtration and recovery rates of 89.6–96.7%—confirms the method's reliability. These preliminary results highlight significant workplace AMP exposures and underscore the need for targeted controls and evidence-based safety guidelines.

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FRONTIERS IN MICROPLASTICS AND NANOPLASTICS RESEARCH: PRINCIPAL GAPS AND FUTURE PERSPECTIVES

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Microplastic (MP) and nanoplastic (NP) pollution has become a critical environmental issue, with widespread detection across marine, freshwater, and terrestrial ecosystems. MPs and NPs are found in water, sediments, snow, and biota, and their effects have been studied using a wide range of biological indicators, including invertebrates, mollusks, amphibians, and plants. Field studies have confirmed their ubiquity, while laboratory experiments have shown that plastic particles can cause acute and sub-lethal effects in organisms across different trophic levels. These effects depend on particle characteristics and environmental conditions and are further complicated by the role of MPs as vectors for contaminants such as heavy metals, PAHs, PCBs, and surfactants. Despite advances, significant knowledge gaps remain. Nanoplastics, in particular, are poorly understood due to challenges in detection and quantification. Their small size suggests they can interact with cells and organelles, but their biological effects are largely unknown. The ecotoxicological consequences of co-exposure to plastics and other pollutants are also insufficiently characterized, especially under realistic environmental conditions. Moreover, secondary sources such as tire wear, synthetic fibers, and urban dust are under-quantified, and most research has focused on aquatic systems, leaving terrestrial and agricultural impacts largely unexplored. Little is known about how MPs and NPs affect soil microbiota, nutrient cycling, or plant health. Long-term and ecosystem-level effects, including trophic transfer and changes in community structure, are also understudied. To address these challenges, future research must adopt multidisciplinary approaches, advance analytical techniques, and standardize protocols. Greater focus on terrestrial environments, mixture toxicity, and human health impacts is essential. Only through integrated scientific efforts can we effectively assess and mitigate the risks posed by plastic pollution across ecosystems and scales.

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MICROPLASTICS IN THE DRAINAGE BASIN OF THE VENETIAN LAGOON: AN ASSESMENT OF AN EMERGEING POLLUTANT IN WATER SURFACE AND SEDIMENTS

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Microplastics are an emerging contaminant that has become ubiquitous worldwide, accumulating in all ecosystems, particularly aquatic ones [1]. Over the last decade, numerous studies have been conducted to determine and identify the potential sources, distribution pathways and effects of this contaminant [2]. Despite these efforts, in many areas of the world there is still limited or no information on the concentration and distribution of this emerging contaminant. Transitional environments are areas of considerable ecological and socio-economic importance, as they serve as biodiversity hotspots and provide valuable ecosystem services. However, these environments are exposed to numerous anthropogenic pressures, including microplastic pollution.
In this study, the presence of microplastics in the surface waters and sediments of the Venice Lagoon Drainage basin was investigated. Twelve sites were selected within the area and sampled on a seasonal basis from June 2023 to February 2024. A total of 48 floating microplastic samples and 48 surface sediment samples were obtained.
The analysis was conducted using a stereomicroscope, followed by FTIR and ATRFTIR spectroscopy to identify polymer types. The results indicated that the northern area exhibited a higher concentration of microplastics in surface waters compared to the central and southern areas, likely due to the greater anthropogenic influence. Moreover, microfibers emerged as the main form of microplastic, possibly due to urban and industrial discharges in the region. The microplastics identified were mainly composed of polyethylene in both the matrices.

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PRELIMINARY INVESTIGATION OF MICROPLASTIC AND MICROFIBER CONTAMINATION IN RAW MILK FROM ITALY: IMPLICATIONS FOR FOOD SAFETY

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In recent years, microplastics (MPs), defined as plastic particles smaller than 5 mm, have emerged as contaminants of growing concern. Among the potential human exposure routes, food consumption plays a significant role. While various food matrices have been widely studied, milk and related products remain poorly investigated. However, emerging evidence suggests their vulnerability to MP contamination [1]. This study aimed to assess the presence and characteristics of MPs in raw milk samples collected in the Molise region (Italy). To minimize contamination from equipment, milk was obtained by manual milking from three cows over a three-month period, with one sampling per month. Milk samples were digested using 30% (v/v) hydrogen peroxide (H_2O_2) and then filtered through cellulose membrane filters with a pore size of 8 µm. MPs were identified, classified, and measured through microscopic analysis, followed by chemical identification of a subsample of particles using Fourier Transform Infrared (FTIR) microspectroscopy. Results confirmed the presence of MPs and synthetic microfibers (MFs) at a mean concentration of 3.22 ± 2.23 particles/100 mL. Additionally, a significant amount of natural MFs was detected (4.5 MFs/100 mL). Among the MFs, dark (52%) and blue (15%) fibers were predominant, while sky blue fragments were the most common among MPs (34%). MPs and MFs exhibited mean lengths of 398.48 ± 523.53 µm and 1296.45 ± 958.16 µm, respectively. Although manual milking is now uncommon, it was applied in this study in order to investigate sources of contamination other than those associated with mechanical milking. The hypothesis of MP transfer from the cow (e.g., via the mammary gland) remains unconfirmed [2], and the occurrence of polymers, such as cellulose and polyester, found in raw milk may be traced back to various sources throughout the farm environment [3]. In particular, the cellulose fragments and MFs could be derived from the wipes used for cleaning the udder before milking. These findings underscore the need for further investigations into MP sources and mitigation strategies within the dairy supply chain.

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MESO- AND MICROPLASTICS IN BEACH SEDIMENTS WITH *POSIDONIA OCEANICA*: A PRELIMINARY ASSESSMENT FROM LIGURIAN SEA

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The pervasive presence of plastic debris in marine ecosystems is an increasingly recognized threat, with ecological, social, and economic implications at local and global levels. Coastal areas are particularly vulnerable to plastic accumulation, revealing that both mesoplastics (MEPs, >5 mm to 25 mm) and microplastics (MPs, <5 mm) can be retained in beach sediments. In this scenario, seagrass meadows, such as *Posidonia oceanica*, which seasonally shed leaves, play an important role as significant reservoirs for plastic debris.
In the framework of SUNRISE project, aimed at promoting Nature-Based Solutions for the restoration of degraded coastal environments, a survey was conducted on two beaches along the Ligurian coast, to assess, for the first time, the presence of meso- and microplastics in sediments. Samples were collected during spring and autumn using 0.5×0.5 m quadrats along a transect parallel to the shoreline. In the laboratory, sediments were sieved using a cascade from 5 to 0.5 mm mesh size and subjected to a basic grain size analysis. The sediment fraction >5 mm was visually examined to directly identify potential MEPs, whereas the <5 mm fraction was also treated with a hypersaline solution to extract MPs. All particles were characterized using FTIR spectroscopy. Preliminary results indicate that polyvinyl chloride (PVC) and polystyrene (PS) were among the most common polymers in both size classes, with fragments being the predominant shape. No significant differences in plastic abundance (items/kg) were found between the two beaches or between pre- and post-tourist season samplings. However, the quantity of *P. oceanica* detritus, included as a covariate, significantly influenced MEP but not MP abundance, supporting the hypothesis that *P. oceanica* may have a role in accumulation and transport of plastic debris in the beach ecosystem.

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PRELIMINARY RESULTS ON MICROPLASTIC POLLUTION IN THE TICINO RIVER AND ITS URBAN TRIBUTARIES IN PAVIA: INSIGHTS FROM THE MINOSSE PROJECT

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Plastic debris transport in rivers is a growing concern, yet our understanding of its dynamics and of pollution sources in freshwater systems remains limited. Within the framework of the EU-funded MINOSSE project (Managing Plastic Transport in Rivers and Coastal Areas - PRIN 2022 PNRR Prot. P2022S2WJZ - CUP B53D23033740001), we performed three microplastic monitoring campaigns on the Ticino River within the Pavia city area (Northern Italy), aimed at assessing the presence of microplastics (MPs) and identifying potential point and diffuse sources.
Sampling stations included the Ticino River upstream and downstream of the city, and the final sections of three urban tributaries: Naviglio Pavese, Colatore Navigliaccio, and Roggia Canobbio. The campaigns were carried out under different meteorological and hydrological conditions: (1) after a rainy period followed by dry weather, (2) immediately after a flood event, and (3) during prolonged drought and low river discharge. Water samples were collected using a 100 µm mesh net and analyzed via stereomicroscopy and FT-IR spectroscopy.
Preliminary results reveal significant spatial and temporal variation in MP concentrations. The Colatore Navigliaccio consistently showed the highest MP loads, particularly microbeads, suggesting a localized point source. The Roggia Canobbio exhibited high fiber content, likely linked to being the receiving water body of the Pavia wastewater treatment plant. After heavy rainfall, MP concentrations increased sharply across all sites, with the Ticino River itself showing higher values than during dry conditions. The most frequently identified polymers included polypropylene (PP), polyethylene (PE), and polystyrene (PS), and the most abundant size class was the smallest detectable range, raising concerns for ecological bioavailability.
These findings highlight the influence of tributary inputs, weather conditions, and hydrodynamics on MP distribution in urban river contexts and provide a foundation for calibrating numerical models of plastic transport under development within the MINOSSE project.

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