INTERNATIONAL CONFERENCE ON MICROPLASTIC POLLUTION IN THE MEDITERRANEAN SEA

µMED Conference – III edition
Naples, Italy
25 – 28 September 2022
Partenope Congress Centre

BOOK of ABSTRACTS

INTERNATIONAL CONFERENCE ON MICROPLASTIC POLLUTION IN THE MEDITERRANEAN SEA

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Consiglio Nazionale delle Ricerche
IPCB/DSCTM

Piazzale Aldo Moro, 7 - 00185 Roma
ISBN 978 88 8080 359 1 (electronic edition)

edizioni
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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 III edition of the µMED Conference, held in Naples (NA), Italy, from 25th to 28th September at the Partenope Congress Centre.

The µMED Conference is a key event on microplastic pollution. The Conference gathers experts from scientific and industrial communities, policy makers and environmental organizations. It is the occasion to update the state-of-the-art, to highlight the progresses, and to identify new and effective solutions to mitigate this environmental issue.

Conference topics

1. Microplastic and nanoplastic pollution in different environments: Freshwater, Marine, Air and Soil
2. Sources, fate and effects of micro and nanoplastics
3. Monitoring and detection of micro and nanoplastic pollutants
4. Innovative solutions to mitigate microplastic pollution
5. Recovery and recycling of marine plastics
6. Valorisation of plastics waste into chemicals and/or fuels
7. Green synthetic approaches for the preparation of environmentally friendly polymers
8. Degradation of plastics in marine environment
9. Technologies to improve degradation of micro and nano-plastics
10. Impact of microplastics on biota
11. Biodiversity & Plastic
12. Microplastics: from marine pollution to human food chain
13. Effect of micro and nanoplastics on human health
14. Micro and nanoparticles interaction with biomolecules, cellular uptake and biodisposition
15. Socio-economic and environmental impact assessment and risk analysis
16. Sampling, extraction, purification and identification approaches for micro and nanoplastics
17. Adsorption and transport of pollutants by micro and nanoplastics

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Programme

25 Sept	
25 Sept AFTERNOON SESSION	
5:00 PM 6:00 PM	**Registration - Welcome - Wine & Cheese - Opening**
6:00 PM 6:40 PM	**Maria Westerbos** Plastic Soup Foundation, NL *From utopia to waste*

26 Sept	
26 Sept MORNING SESSION	
8:30 AM 9:00 AM	**Registration**
9:00 AM 9:30 AM	**Welcome and Introduction** **Lidia Armelao** Director of the Department of Chemical Sciences and Materials Technologies (DSCTM) - National Research Council of Italy (CNR), IT **Luigi Ambrosio** Past Director Institute of Polymers Composites and Biomaterials (IPCB) - National Research Council of Italy (CNR), IT **Giorgio Zampetti** Legambiente, IT **Pier Paolo Celeste** Marevivo, IT **Maurizio Avella** Institute of Polymers Composites and Biomaterials (IPCB) - National Research Council of Italy (CNR), IT

26 Sept MORNING SESSION **Chairman:**	**Luigi Ambrosio** IPCB-CNR, IT
9:30 AM 10:00 AM	**Jes Vollertsen** University of Aalborg, DK *Limits of quantification – a discussion on our ability to quantify small microplastics in complex matrices*

10:00 AM 10:12 AM	**Claudio Marchesi** Department of Mechanical and Industrial Engineering - University of Brescia, IT *Portable spectroscopy and multivariate analysis for microplastics pollution*
10:12 AM 10:24 AM	**Valter Castelvetro** Department of Chemistry and Industrial Chemistry - University of Pisa, IT *Micro- and nanoplastics determination in complex environmental samples by the PISA (Polymer Identification and Specific Analysis) procedure*
10:24 AM 10:36 AM	**Luca Maurizi** The Build Department, Aalborg University – DK *A comparison between FTIR microscopy and Raman microscopy applied to microplastic analysis in drinking water*
10:36 AM 10:48 AM	**Matteo Giardino** Department of Applied Science and Technology (DISAT) - Politecnico di Torino, IT *A novel technique for automated detection, count and measurement of microplastics*
10:48 AM 11:00 AM	**Nuno Nunes** SubCtech GmbH, DE *Versatile sampling of microplastics for busy sailors in remote locations*
11:00 AM 11:30 AM	**Coffee Break**
26 Sept MORNING SESSION **Chairwoman:**	**Maria Westerbos** Plastic Soup Foundation, NL
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12:00 AM 12:12 AM	**Danielle Marchant** School of Biological and Behavioral Sciences, Queen Mary University of London – UK *Interactive effects of microplastic types, concentrations and nutrient load on freshwater ecosystem structure and function*

12:12 AM 12:24 AM	**Matteo Galli** Department of Physical, Earth and Environmental Sciences - University of Siena, IT *Microplastic ingestion and PAE levels as plastic tracers in the Mediterranean Velella velella: a candidate indicator of pelagic environment*
12:24 AM 12:36 AM	**Ana Martínez Rodríguez** School of Biological and Behavioural Sciences - Queen Mary University of London, UK *Contrasting the impact of oil-based and bio-based biodegradable microplastics on freshwater macroinvertebrate communities under seminatural conditions*
12:36 AM 12:48 AM	**Fabiana Corami** Institute of Polar Sciences - National Research Council of Italy, IT *Small Microplastics (<100 µm), Additives, and plasticizers in Mytilus galloprovincialis, a potential bioindicator for microplastics pollution*
12:48 AM 1:00 PM	**Dario Giani** Department of Physical Sciences, Earth and Environment - University of Siena, IT *Assessment of the impact and abundance of microplastics on twenty-two edible fish species from five different areas of the Mediterranean Sea*
1:00 PM 2:30 PM	**Lunch**
26 Sept AFTERNOON SESSION **Chairman:**	**Francesco Regoli** Polytechnic University of Marche, IT
2:30 PM 3:00 PM	**Maria Cristina Fossi** University of Siena, IT *The Plastic Busters MPAs methodological approach to detect the impact of microplastics and related plastic additives in the Mediterranean biodiversity*
3:00 PM 3:12 PM	**Matan Oren** Department of Molecular Biology - University of Ariel, IL *Plastisphere is not one ecosystem: the geographical and seasonal effect on microplastic microbiome*
3:12 PM 3:24 PM	**Roberto Fattorusso** Department of Environmental, Biological and Pharmaceutical Sciences and Technologies - University of Campania Luigi Vanvitelli, IT *Polystyrene nanoparticles effects on human ubiquitin structure and functions*

3:24 PM 3:36 PM	**Anita Grozdanov** Faculty of Technology and Metallurgy -University of Skopje Ss Cyril and Methodius, MK *Risks and health effects from exposure to engineered nanostructures: a critical review*
3:36 PM 3:48 PM	**Serena Ducoli** Department of Mechanical and Industrial Engineering - University of Brescia, IT *True-to-life nanoplastics for the investigation of the biological interface*
3:48 PM 4:00 PM	**Conception Martínez-Gómez** Instituto Español de Oceanografía (IEO) - CSIC Oceanographic Center of Murcia, ES *Quantification of polyethylene in mussel hemolymph and its limited additive effect on immune function induced by bezafibrate.*
4:00 PM 4:30 PM	**Coffee break**
26 Sept AFTERNOON SESSION **Chairwoman:**	**Maria Emanuela Errico** IPCB-CNR, IT
4:30 PM 4:42 PM	**Carola Murano** Department of Integrative Marine Ecology - Stazione Zoologica Anton Dohrn, IT *Plastic microbial colonization: seasonality and dynamics*
4:42 PM 4:54 PM	**Giacomo Limonta** Department of Physical, Earth and Environmental Sciences - University of Siena, IT *Applying molecular and biochemical biomarkers to detect the impact of microplastic ingestion and plastic additives in Mediterranean striped red mullet*
4:54 PM 5:06 PM	**Pascaline Francelle** School of Biological and Behavioural Sciences - Queen Mary University of London, UK *Interactions between microbial communities and plastics in freshwater and estuarine environments*
5:06 PM 5:18 PM	**Gábor Bordós** WESSLING Hungary Ltd – HU *Analysis of microplastics in wastewater treatment plants along the Hungarian stretch of the Danube River*

5:18 PM 5:30 PM	**Agnieszka Monika Dąbrowska** Laboratory of Spectroscopy and Intermolecular Interactions, Faculty of Chemistry -University of Warsaw, PL *The physical and chemical methods for the quantitative modelling of nanoplastics, microplastics and the plastisphere – selected case studies*
5:30 PM 5:42 PM	**Jeanette Lykkemark** University of Aalborg, DK *Step-by-step evaluation of matrix effect and sample recovery during pretreatment of wastewater samples for the quali-quantitation of microplastics by Py-GC-MS*
6:00 PM **7:00 PM**	**POSTER SESSION 1**

27 Sept	
27 Sept MORNING SESSION **Chairwoman:**	**Maria Cristina Fossi** University of Siena, IT
9:00 AM 9:30 AM	**Christos Ioakeimidis** UNEP-MAP, EL *Marine Litter Policy Advances in the Mediterranean*
9:30 AM 9:42 AM	**Roberta Minetti** Institute for the study of anthropogenic impacts and sustainability in the marine environment - National Research Council of Italy, IT *A citizen science project to validate a new sampling methods for microplastic monitoring in coastal marine environment*
9:42 AM 9:54 AM	**Esther Kentin** Leiden University, Steenschuur 25, 2311ES Leiden, NL *Challenges of rectricting microplastics in the EU: recommendations from scientists for the restriction proposal*
9:54 AM 10:06 AM	**Stefania Federici** Department of Mechanical and Industrial Engineering - University of Brescia, IT *COST Action CA20101 PRIORITY: Collaborative research network tackling the global challenges of plastic pollution*
10:06 AM 10:18 AM	**Federica Tommasi** Ecosystems and Health, Dept. Environment and Health - Italian National Institute of Health, IT *What kind of international legally binding instrument on plastic pollution do we need?*

10:18 AM 10:30 AM	**Davide Poletto** Venice Lagoon Plastic Free, Castello 2641, 30122 Venice, IT *Detection and characterisation of micro- and nano-plastic pollutants: A case study of the Adriatic Sea*
10:30 AM 10:42 AM	**Luca Fambri** Department of Industrial Engineering and INSTM Research Unit - University of Trento, IT *First collection and monitoring of plastics and microplastics in the freshwater of Garda Lake using seabin. Technical and educational aspects*
10:42 AM 10:54 AM	**Margherita Barchiesi** Department of Civil, Constructional and Environmental Engineering - Sapienza University of Rome, IT *MPs analysis with μ-Raman: potential and practical aspects*
11:00 AM 11:30 AM	**Coffee Break**
27 Sept MORNING SESSION **Chairwoman:**	**Veronica Ambrogi** University of Naples Federico II, IT
11:30 AM 12:00 AM	**Jean-Marie Raquez** University of Mons, BE *(Bio)plastics: hope or hype*
12:00 AM 12:12 AM	**Jacopo La Nasa** Dept. of Chemistry and Industrial Chemistry - University of Pisa, IT *Stability of microplastics: Detection of potentially harmful compounds produced by microplastics during accelerated aging studies*
12:12 AM 12:24 AM	**José Paulo Da Silva** Centre of Marine Sciences (CCMAR/CIMAR LA), University of Algarve, PT *Markers of plastics and microplastics in marine environments*
12:24 AM 12:36 AM	**Sonia Manzo** ENEA - CR Portici, IT *Photo-oxidation techniques for microplastics (MPs) accelerated weathering*
12:36 AM 12:48 AM	**Lara Nigro** Department of Biosciences, University of Milan – IT *Are water-soluble polymers a new environmental threat? The case of polyvinyl alcohol*
12:48 AM 1:00 PM	**Katerina Karkanorachaki** School of Chemical and Environmental Engineering - Technical University of Crete, EL *Fate of fossil-based and bioplastics in the marine environmnent*

1:00 PM 2:30 PM	**Lunch**
27 Sept AFTERNOON SESSION **Chairman:**	**Richard C. Thompson,** University of Plymouth, UK
2:30 PM 3:00 PM	**Monica Passananti** University of Turin, IT /University of Helsinki, FI *Reactivity and analysis of nanoplastics and small microplastics*
3:00 PM 3:12 PM	**Sabrina Gioria** European Commission, Joint Research Centre (JRC), Ispra, IT *In vitro high-throughput toxicological assessment of nanoplastics*
3:12 PM 3:24 PM	**Michael Süß** Competence Center CHASE GmbH, AT *Plastics recycling and microplastic emissions*
3:24 PM 3:36 PM	**Filomena Del Piano** Department of Veterinary Medicine and Animal Productions - University of Naples Federico II, IT *Subchronic oral toxicity of polystyrene microplastic on intestinal homeostasis and health status in gilthead seabreams (Sparus aurata)*
3:36 PM 3:48 PM	**Lucia Pittura** Università Politecnica delle Marche, IT *A matter of size: toward an effect-based approach for microplastics risk assessment*
3:48 PM 4:00 PM	**Francesca Lionetto** Department of Engineering for Innovation, University of Salento – IT *Model nanoplastics for environmental assessment*
4:00 PM 4:30 PM	**Coffee break**
27 Sept AFTERNOON SESSION **Chairman:**	**Cosimo Carfagna** University of Naples Federico II, IT
4:30 PM 4:42 PM	**Beatrice Rosso** Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari - University of Venice, IT *Additives, plasticizers and small microplastics (<100 µm) in wet and dry depositions from an urban area of Venice, Italy*
4:42 PM 4:54 PM	**Rossana Bellopede** Department of Environment, Land and Infrastructure Engineering - Politecnico di Torino, IT *Detection of microplastics in marine sediments: results from three Italian coasts*

4:54 PM 5:06 PM	**Andrea Binelli** Department of Biosciences - University of Milan, IT *The quali-quantitative evaluation of plastics in 7 watercourses of the metropolitan city of Milan (n. Italy) and their ecotoxicological consequences*
5:06 PM 5:18 PM	**Francesca Garaventa** Institute for the Study of Anthropic Impact and Sustainability in the Marine Environment, National research Council of Italy, IT *Microplastics are ubiquitous in the marine ecosystem: an integrated assessment in water, sediments and biota*
5:18 PM 5:30 PM	**Silvia Marchesan** Chemical & Pharmaceutical Sciences Sept. - University of Trieste, IT *Enzyme mimics for nanoplastics degradation*
5:30 PM 5:42 PM	**Joana Patrício Rodrigues** Department of Chemistry & CESAM - University of Aveiro, PT *Metals in plastic debris from spanish mediterranean beaches with different anthropogenic pressure: are these particles potential monitors for metal pollution?*
6:00 PM **7:00 PM**	**POSTER SESSION 2**

28 Sept	
28 Sept MORNING SESSION **Chairman:**	**Emanuele Fiore** IPCB-CNR, IT
9:00 AM 9:30 AM	**Richard Thompson** University of Plymouth, UK *Marine Litter: are there solutions to this global environmental challenge?*
9:30 AM 9:42 AM	**Valentina Balestra** Department of Environment, Land and Infrastructure Engineering - Politecnico di Torino, IT *Groundwater: an endangered invisible resource. Microplastic pollution in underground karst systems from surface watercourses to cave waters*
9:42 AM 9:54 AM	**Andrea Paluselli** Institute of Marine Sciences - National Research Council of Italy, IT *Vertical distribution and transport of textile microfibers (MFs) in the Mediterranean water column*

9:54 AM 10:06 AM	**Mariana Nogueira Miranda** LSRE-LCM, Faculty of Engineering - University of Porto, PT *Evaluation of the role of plastic aging on the sorption of pesticides and pharmaceutical substances on microplastics*
10:06 AM 10:18 AM	**Marine Pyl** Laboratoire de Biologie marine - Université Libre de Bruxelles, BE *Evidence of microplastic-mediated transfer of PCB-153 to sea urchin tissues using radiotracers*
10:18 AM 10:30 AM	**Gerasimos Gkoutselis** Department of Mycology - University of Bayreuth, DE *Selection of pathogenic fungi by microplastics is linked to their generic virulence*
10:30 AM 10:42 AM	**Kryss Waldschläger** Hydrology and Quantitative Water Management Group - Wageningen University & Research, NL *Microplastics: what can we learn from natural sediments?*
10:42 AM 10:54 AM	**Marika Valentino** Institute of Applied Sciences and Intelligent Systems - National Research Council of Italy, IT *Intelligent holographic flow cytometers for identifying label-free microplastics in heterogeneous water samples*
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28 Sept MORNING SESSION **Chairman:**	**Gaetano Leone** UNEP-MAP
11:30 AM 12:00 PM	**Heidi Savelli-Soderberg** Programme Officer, UNEP *Plastic pollution and marine litter monitoring for global policy and action*
12:00 AM 12:12 AM	**Annamaria Vujanović** Faculty of Chemistry and Chemical Engineering, University of Maribor, SI *Environmental impact of innovative microplastics filtration system for washing machines & marinas*
12:12 AM 12:24 AM	**Paul Servin** Xeros Technology Group plc, Unit 2 Evolution – UK *Innovating solutions to plastic pollution: The journey to new product lines reducing / capturing microplastics in both domestic and commercial washing machines*

12:24 AM 12:36 AM	**Erika Iveth Cedillo-González** Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia – IT *Towards a μ-plastic-free ocean: green photocatalysts for mitigation of micro- and nanoplastic marine pollution*
12:36 AM 12:48 AM	**Giovanna Laudisio** Naturbeads Ltd, UK *Cellulose microbeads, a sustainable alternative to microplastics for industrial and consumers applications*
12:48 AM 1:00 PM	**Awards and Conclusions**

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P1	**Martina Miloloža** Faculty of Chemical Engineering and Technology - University of Zagreb, HR *Determination of optimal conditions for biodegradation of polystyrene by bacteria*
P2	**Bence Prinkler** Hungarian University of Agriculture and Life Sciences, HU *A pilot to establish centralised microplastic laboratory: analysis of waterworks in the Western Balkan region*
P3	**Lorenzo Martellone** Department of Chemistry & Technology of Drugs - Sapienza University of Rome, IT *Microplastics in drinking water: Italian national working group and analytical methods*
P4	**Sara Accardo** ENEA CR PORTICI, IT *Ecotoxicological assessment of Alento river catchment a focus on microplastic impact*
P5	**Gurusamy Kutralam-Muniasamy** Department of Biotechnology and Bioengineering, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, MX *Human exposure to microplastics from various beverages in Mexico City*
P6	**Teresa Cacace** Institute of Applied Sciences and Intelligent Systems - National Research Council of Italy, IT *Compact holographic imaging and machine learning for microfibers quantification in laundry wastewater*

P7	**Eleonora Brancaleone** Acea Elabori SpA, IT *Microplastic in drinking water: are they really dangerous for human health?*
P8	**Alessandra Gallo** Department of Biology and Evolution of Marine Organisms - Stazione Zoologica Anton Dohrn, IT *Reproductive toxicity assessment of environmental microplastics in the mussel Mytilus galloprovincialis*
P9	**Sara Vencato** Institute of Anthropic Impact and Sustainability in Marine Environment - National Research Council of Italy, IT *Microplastics and associated plasticizers: presence and detection in cnidarians used as possible bioindicators for microplastic contamination in Marine environments*
P10	**Laura Ciaralli** Italian National Institute for Environmental Protection and Research ISPRA, IT *Random or not? Comparing microplastic ingestion and preys in Scomber colias and Trachurus trachurus*
P11	**Federica Laface** Department of Integrative Marine Ecology - Stazione Zoologica Anton Dohrn, IT *May mesopelagic fishes play an important role as vector of microplastics across the Mediterranean trophic web? A case of study in the Strait of Messina*
P12	**Serena Santonicola** Department of Medicine and Health Sciences V. Tiberio - University of Molise, IT *Microplastic fiber content in Mullus barbatus from the Tyrrhenian Sea: preliminary results*
P13	**Marco Cifoni** Stazione Zoologica Anthon Dohrn, IT *Temporal and spatial dynamic of Microplastic ingestion by Zooplankton species in the Gulf of Naples (Western Mediterranean Sea)*
P14	**Vincenzo Donnarumma** EMI Department - Stazione Zoologica Anton Dohrn, IT *Temporal variability of microplastics and their attached community along the Campania coast*

P15	**Kaori Nakamura** Graduate School of Engineering and Science - University of the Ryukyus, JP *Microplastics in spring and rainfall collected from subtropical regions in Okinawa, Japan*
P16	**Iulian Pojar** National Institute of Marine Geology and Geo-Ecology - GeoEcoMar, RO *Microplastic abundance, distribution and classification in the Siriu Reservoir - Buzau River, Romania*
P17	**Luisa Albarano** Department of Biology - University of Naples Federico II, IT *Plastic debris from face masks: release rates and effects*
P18	**Hadeel Al-Zawaidah** Hydrology & Quantitative Management Group - Wageningen University and Research, NL *Untangling water-column microplastics, a closer look into turbulence*
P19	**Shruti Venkata Chari** Instituto de Geología - Universidad Nacional Autónoma de México (UNAM), MX *Detection of atmospheric microplastics in particulate matter (PM10 & PM2.5) of Mexico City*
P20	**Yusuke Iwaki** Graduate School of Engineering and Science Faculty of Science - University of the Ryukyus, JP *Microplastics in the sea cucumber Holothuria (Halodeima) atra and sediment around Okinawa Island*
P21	**Sara Accardo** ENEA - CR PORTICI, IT *Ecotoxic effect of plastic bags long term leaching in seawater*
P22	**Jana Hildebrandt** Bundesanstalt für Materialforschung und -prüfung (BAM), DE *Aqueous dispersions of polypropylene: towards reference materials for nanoplastics characterization*
P23	**Arianna Peruzzo** Microbial Ecology and Genomics Laboratory - Istituto Zooprofilattico Sperimentale delle Venezie, IT *Microplastics bacterial community: a potential hazard for food-safety?*

27 Sept POSTER SESSION 2
6:00 – 7:00 PM

P24	**Jena Jamsek** National Institute of Biology, Marine Biology Station Piran, SI *Microplastics in sediments and selected marine organisms of the gulf of trieste*
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P26	**Raffaella Mossotti** Institute of Intelligent Industrial Technologies and System for advanced Manufacturing - National Research Council of Italy, IT *High-quality carbon materials from synthetic industrial fibre waste*
P27	**Stefano Magni** Department of Biosciences, - University of Milan, IT *Ecotoxicological effects of water-soluble polymers on freshwater species*
P28	**Elisa Costa** Institute for the Study of Anthropic Impact and Sustainability in the Marine Environment - National Research Council of Italy, IT *Uptake and ecotoxicological effects of microplastics and nanoplastics on gelatinous zooplankton*
P29	**Thomas Viel** Institute of Polymers, Composites and Biomaterials - National Research Council of Italy, IT *Degradation behaviour and rate of biodegradable polymers in marine environment*
P30	**Elisa Costa** Institute for the Study of Anthropic Impact and Sustainability in the Marine Environment - National Research Council of Italy, IT *New insights into plastic degradation: ecotoxicological effects of plastic leachates in marine invertebrates*
P31	**Cristina De Monte** Institute for Physico-Chemical Processes - National Research Council of Italy, IT *Resin pellets aging and degradation investigation from long term in situ experiment: first results*
P32	**Marius Sandru** SINTEF AS, Dep. Of Biotechnology and Nanomedicine, NO *Removal of nano- and microplastics from maritime environment by use of biodegradable flocculants*

P33	**Paola Amato** Department of Chemical, Material and Industrial Production Engineering - University of Naples Federico II, IT *Photodegradation of LLDPE and PLA thin films induced by hybrid humic acids/ZnO nanoparticles with advanced ROS-generating properties*
P34	**Margherita Concato** Department of Physical, Earth and Environmental Sciences - University of Siena, IT *Assessment of microplastic ingestion and quantification of eleven phthalate acid esters in Mediterranean edible fish species*
P35	**Conception Martínez-Gómez** Instituto Español de Oceanografía (IEO) - CSIC Oceanographic Center of Murcia, ES *High density polyethylene and polystyrene microplastics as vectors of Triclosan towards marine invertebrates: signals of reduced bioreactivity*
P36	**Rachid Amara** Laboratoire d'Océanologie et de Géosciences- Universitè Littoral Côte d'Opale, CNRS, FR *The Manta Robot: a new sampling device for microplastics in different water bodies*
P37	**Daniela Thomas** Institute for Agricultural Technology - Johann Heinrich von Thuenen Institute, DE *Density separation of conventional and biodegradable microplastics from solid sample matrices*
P38	**Tjaša Kolar** Faculty of Mechanical Engineering - University of Maribor, SI *Filtration/separation efficacy of micro-to-nano plastic particles using nanocellulose-based membrane*
P39	**Xhoen Gjashta** Dresden University of Applied Sciences, DE *Does calibration with pristine pet allow the identification and quantification of aged PET microplastic particels by DSC*?
P40	**Elena Battaglini** Department of Civil, Chemical, Environmental and Materials Engineering - University of Bologna, IT *Identification of microplastics in chocolate using microspectroscopy techniques*
P41	**Federico Sacco** SRA Instruments, IT *Morphology and mass quantification combined approach for microplastics characterization with Agilent ldir and frontier lab pyrolizer*

P42	**Immacolata Liotta** Institute of Polymers, Composites and Biomaterials - National Research Council of Italy, IT *Mechanical recycling of polyethylene-rich plastic fraction recovered from marine environment to mitigate plastic and microplastic pollution*
P43	**Lucia Sansone** Institute of Polymers, Composites and Biomaterials - National Research Council of Italy, IT *A process to turn cigarette waste into sunglasses*
P44	**Maria Kaliva** Institute of Electronic Structure and Laser, Foundation for Research and Technology Hellas, GR *Functional and sustainable materials*
P45	**Nello Russo** Institute of Polymers, Composites and Biomaterials - National Research Council of Italy, IT *Mitigation effect of detergent on microfiber release*

Abstracts

FROM UTOPIA TO WASTE

Maria WESTERBOS*

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We go back to the 1939 World's Fair in New York, where 45 million visitors were first introduced to such inventions as television, air conditioning and color film. Here, American chemical giant Dupont unveiled the discovery of polymers at a presentation christened the "Wonder World of Chemistry. With these polymers, unprecedented possibilities lay ahead, visitors were told; the synthetic materials surpassed the properties of natural raw materials. In advertisements, people and even the earth were wrapped entirely in cellophane.

Three quarters of a century later, there are plastic particles in our blood, we speak of Homo Plasticus and we live in the Plastiglomerate.

The wonder material that saw the light of day in 1939 is now found as waste all over the world: from the bottom of the ocean to the highest mountains. There is plastic in our food and beverages, but we even breathe it in.

How did it come to this and, more importantly, can we do anything about it?

LIMITS OF QUANTIFICATION – A DISCUSSION ON OUR ABILITY TO QUANTIFY SMALL MICROPLASTICS IN COMPLEX MATRICES

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Understanding the occurrence, fate, and impacts of microplastics (MPs) requires reliable quantification methods. While this seems quite self-evident, it covers aspects commonly overlooked when analysing and reporting MPs. One aspect relates to limits of detection and quantification (LOD/LOQ). Others are that no single analytical method can detect all plastic types [1], that assessment of recovery rates from complex matrices is difficult, and that contamination during sampling and analysis occurs. Hence when stating we found # MPs or µg of MP per unit of matrix, it is often unclear how to interpret these numbers.

Take the LOD/LOQ aspect as an example: It matters for the reported concentration whether we could quantify down to, say, 500 or 10 µm. Concentrations differ by orders of magnitude. While also this seems quite self-evident, what is less so is which size limit we can reliably quantify down to and how to define these limits. Here we need to differentiate between the lower size limit given by sample preparation, e.g., pore size of the filter used, and the one given by the analytical approach itself. Another issue is reporting the smallest MP which was found as the size quantification limit; however, finding one small MP does not mean we found them all. One could argue for two limits: The lower size detection limit, defined by the lowest particle size which occasionally can be detected, and the quantification limit, defined as the lower size at which MP concentration can reliably be quantified [2].

A further issue is recovery during sample preparation. When particles get smaller, they get more prone to being lost in the sample preparation. The reasons can be manifold: the first is that smaller particles have a much larger surface area-to-volume ratio than bigger ones, leaving the particles more prone to chemical degradation which can make them more difficult to reliably detect or even shrink their size. Another is the fragmentation of brittle weathered MPs, forming many small particles from few larger ones.

Which is the quantification limit when analysing for MPs is hence not simple to define; however, the topic must be addressed and discussed. Without a consensus on LOD/LOQ, it seems impossible to arrive at the golden target – harmonized analysis of MPs.

References:

[1] S. Primpke, M. Fischer, C. Lorenz, G. Gerdts, B. M. Scholz-Böttcher. Analytical and Bioanalytical Chemistry, 412, 8283–8298, 2020

[2] I. V. Kirstein, A. Gomiero, J. Vollertsen. Current Opinion in Toxicology, 28, 70-75, 2021

PORTABLE SPECTROSCOPY AND MULTIVARIATE ANALYSIS FOR MICROPLASTICS POLLUTION

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The amount of plastic produced every year has increased dramatically, reaching 368 million metric tons annually by 2020 [1]. Due to its indiscriminate disposal in the environment, plastic has shown several ecological and toxicological issues, despite its many advantages. When plastic gets into the environment is subjected to fragmentation processes, resulting in the production of fragments at the microscale. Microplastics (MPs) are defined as " solid particle insoluble in water in the dimension between 1 µm and 1 000 µm" [2]. The evidence of MP contamination of seafood has been proven, and the potential effects of the presence of MPs on human food security, food safety, and health have been shown [3-4]. The purpose of this research was to examine the capabilities of a Miniaturized Near-Infrared (MicroNIR) spectrometer coupled with chemometric instruments for qualitative and quantitative characterization of MPs. First, 250 plastic samples were collected from a recycling facility based on the Resin Identification Code to create a library of plastic waste. MicroNIR spectra were analysed using multivariate modelling: Principal Component Analysis (PCA) and Partial Least Squares Discriminant Analysis (PLS-DA). The second phase was initiated at the laboratory-scale, with the production of MPs by mechanically fragmenting daily used plastic products to obtain "true-to-life" MPs. MPs were then mixed at different percentage ranging from 0 to 100 percent. Using PCA and PLS-regression, chemometrics was applied for the qualitative and quantitative characterization of three- and four-components MP mixtures. First, for ternary combinations, polypropylene (PP), polyethylene (PE), and polystyrene (PS) were selected to represent the most prevalent portion of plastic waste in the environment. Subsequently, polyethylene terephthalate (PET) was added to the quaternary mixtures. Finally, the models were applied to field MP samples to evaluate the performances with weathered samples. The findings will enable quick, reliable, in-situ microplastics identification and quantification.

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MICRO- AND NANOPLASTICS DETERMINATION IN COMPLEX ENVIRONMENTAL SAMPLES BY THE PISA (POLYMER IDENTIFICATION AND SPECIFIC ANALYSIS) PROCEDURE

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Microplastics (MPs) quantification in soils and sediments is typically performed by time-consuming, waste-generating, moderately accurate density (flotation) separation followed by micro-spectroscopy (FTIR, Raman) detection, identification, and counting.
Packaging and single use plastics made of polystyrene (PS) and polyolefins (polyethylene, PE, polypropylene, PP, and their copolymers) are considered as the main sources of plastics pollution; besides, their susceptibility to photo-oxidative ageing and fragmentation makes them the likely main source of microplastics pollutants in the environment. Additional polymeric microparticle pollutants are textile microfibers released in the wastewaters of laundry machines; among them, polyester (PET) and polyamides such as nylon 6 (polycaprolactam) and nylon 6,6 (polyadipammide).
These four polymers and polymer classes are indeed those targeted by the newly developed PISA (Polymer Identification and Specific Analysis) procedure [1], allowing their individual detection and quantification. Polyolefins and PS are quantified by pyrolysis-gas chromatography-mass spectrometry (Pyr-GC/MS) performed upon hot solvent sequential extraction with dichloromethane and xylene, respectiverly. Nylon 6 and nylon 6,6 are quantified from their respective monomeric amine 6-aminohexanoic acid (AHA) and hexamethylenediamine (HMDA) after depolymerization by acid hydrolysis and tagging with a fluorophore all aminated species in the hydrolysate, followed by reversed-phase HPLC) (RP-HPLC) analysis. Polyethylene terephthalate (PET) is finally quantified from its terephthalic acid comonomer recovered after depolymerization by alkaline hydrolysis of the residue from acid hydrolysis followed the appropriate purification steps (depending on the complexity of the environmental sample) and then by RP-HPLC analysis.
The PISA procedure has been used to systematically analyse oceanic benthic sediments within the HOTMIC (Horizontal and vertical oceanic distribution, transport, and impact of microplastics) project [2], a JPI Oceans “Ecological Aspects of Microplastics” joint action. Among the project scopes, also the intercomparison of (more established) particle-targeting vs. total mass targeting (PISA) analytical procedures.

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A COMPARISON BETWEEN FTIR MICROSCOPY AND RAMAN MICROSCOPY APPLIED TO MICROPLASTIC ANALYSIS IN DRINKING WATER

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Raman microscopy (μRaman) and Fourier Transform IR microscopy (μFTIR) are the most widely employed methods for micro- and nanoplastics analysis in drinking water [1]. Nonetheless, a quantitative comparison between the two techniques is lacking. The present work aims to fill this gap by quantifying the microplastic abundance in Danish drinking water samples with both techniques and comparing the performances in terms of the size distribution for the particles above 1 μm and types of polymers identified.
Forty samples were taken in a Danish drinking waterwork by filtering about 1 m3 of drinking water each through sintered steel 1 μm filters. Both inlet and outlet of the plant were sampled. The filters were then treated according to a cleaning protocol employing 5% SDS (Sodium Dodecylsulphate), leading to particle-enriched mixtures in ethanol. Before the analysis, a known amount of each sample was deposed onto Si (Silicon) substrates for the μRaman analysis and ZnSe (Zinc Selenide) windows for the μFTIR analysis. Both methods were validated by calculating the LOD and the LOQ from the field blanks contamination. During the sample preparation, only particle-free chemicals were used (they were pre-filtered with 0.7 μm glass-fiber filters) and 100% cotton laboratory coats were worn. Moreover, the glassware was previously muffled at 500°C for 4 hours.
Microplastic abundance was calculated as the number of particles per liter and the mass of plastic per liter. The latter was estimated by modeling the particles as ellipsoids and assigning them their pristine polymer density. Furthermore, the microplastic removal efficiency of the plant was calculated. Early results show the μRaman to be more effective in both qualifying and quantifying particles below 10 μm. Consequently, more than 80% of the particles analysed with the μFTIR had a size above 50 μm, while the same size fraction constituted less than 1% for the μRaman measurements.

Acknowledgement: The authors wish to thank the European Union's H2020 MSCA programme ITN MONPLAS 860775 for funding.

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A NOVEL TECHNIQUE FOR AUTOMATED DETECTION, COUNT AND MEASUREMENT OF MICROPLASTICS

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Microplastics are *solid plastic particles* composed of different polymers whose dimensions are less or equal to 5 mm. They originate either from primary production or, more frequently, by degradation of plastic materials. Given their interaction with the ecosystems, and their long-lived persistence in the environment, they pose a significant threat to the world biota including human life. For that, their detection and continuous monitoring are of paramount importance. Unfortunately, detection and quantification of their abundance require a long work of visual observation and count, which makes the process of a high number of samples a very time-demanding task.
Softwares like ImageJ and MP-VAT has been employed with certain success to automate the detection and counting task, although the recognition is not always robust, and a fully automated process is still far. In this context, we report a novel approach in image analysis for detecting, counting, and measuring microplastics on filter membrane substrates with UV-excited fluorescence. The technique relies on a multichannel variant of the Canny edge detection algorithm, which allows an effective microplastic particle segmentation, even in the presence of a strong fluorescence halo.
The developed method has been validated against manual count on real sediment samples from Borgio Verezzi (Italy) show cave and water from Po River (Italy). After collection, the samples were treated with 30% hydrogen peroxide to remove fluorescent organic compounds and filtered on glass filter membranes. The filters were imaged with a high-resolution camera under 365 nm UV illumination to stimulate microplastic fluorescence emission.
In addition, the staining of microplastic with NileRed dye has also been tested to verify if it can provide improvements in terms of count reliability.

VERSATILE SAMPLING OF MICROPLASTICS FOR BUSY SAILORS IN REMOTE LOCATIONS

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In order to assess the true global extent of pollution by microplastics, sampling in remote areas of the world ocean is essential. Sampling for microplastics in the open ocean often involves slowing or stopping the vessel, deploying a large net and filtering the trapped contents. Apart from the large amount of ship time required for these operations, rough seas and weather conditions can also impose limits on the sampling.
Within its “Sailing meets Science” programme, SubCtech has developed a microplastics sampler, with largely autonomous operation. The system has been successfully used by solo sailors, recently on a world record 92-day solo circumnavigation of Antarctica. Filtering is done under way continuously, and no speed reduction or complicated manoeuvres are required. The filter sets can be quickly swapped according to the sampling schedule, and automatic geolocation of the samples is provided. Mesh filters for different particle sizes are available, depending on the research focus. The compact, standalone system can be installed in vessels of almost any size. Larger versions are available for integration into complete underway measuring systems in research vessels and other ships of opportunity.
In this presentation we provide further details of the system’s operation, and also preliminary microplastics data from regions in the Southern Ocean that had previously not been sampled. A glimpse into technologies currently being developed for automated and deep water sampling is presented.

TOWARDS A RISK-BASED ASSESSMENT OF MICROPLASTIC POLLUTION IN MARINE ECOSYSTEMS

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There are several differences between chemical and microplastic pollution, but also some analogies and common principles that should be considered for a risk-based assessment of these particles in the marine environment. Among these, the importance of multidisciplinary approaches and the integration of several typologies of investigations is certainly fundamental to better describe and evaluate such a complex environmental issue. Within the RESPONSE project, expertise on oceanography and environmental chemistry are combined with ecotoxicology, experimental ecology, field and laboratory studies on a wide panel of biological models to answer key research questions on fate and effects of microplastics (MPs) in marine ecosystems. One of the more general aims of the project is to develop a quantitative Weight Of Evidence (WOE) model designed to integrate and differentially weight data from a suite of lines of evidence, including the distribution of MPs along water column and sediments, their bioavailability and bioaccumulation in key indicator species, onset of sublethal and chronic adverse effects at the cellular level, organism, and ecological functioning. Field and laboratory studies are validating weighting factors and ecological thresholds for specific characteristics of MPs that can modulate the ingestion and toxicity of these particles to marine organisms, including the role of size, shape and other polymer characteristics, both alone and in combination with other environmental stressors. The development of a dedicated and software-assisted tool will represent a sound support for monitoring guidelines and policy makers ensuring both scientific reliability and synthetic indices for stakeholders.

Acknowledgement: We thank Italian Ministry of University (MUR) for supporting the EMME project (PRIN 2017) and RESPONSE within JPI call (2020-23)

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INTERACTIVE EFFECTS OF MICROPLASTIC TYPES, CONCENTRATIONS AND NUTRIENT LOAD ON FRESHWATER ECOSYSTEM STRUCTURE AND FUNCTION

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Microplastics are now ubiquitous in freshwater environments. As most previous research has focused on species-specific effects under controlled laboratory conditions, little is known about their impacts at higher levels of ecological organization, such as freshwater communities and their associated ecosystem functions. To fill this knowledge gap, we experimentally manipulated (i) microplastic type: traditional oil-based high-density polyethylene (HDPE) versus bio-based biodegradable polylactic acid (PLA), (ii) concentration of microplastic particles and (iii) nutrient enrichment, in 40 outdoor pond mesocosms (1.57 m^3 each), sampling on various occasions over a period of three months. The concentrations of microplastic we used were equivalent to a) measured naturally occurring concentrations and b) concentrations known to cause effects under laboratory conditions. We added 1 mg L^{-1} N and 50 µg L^{-1} P to the nutrient enriched mesocosms. We tested the independent and interactive effects of these treatments on community structure (phytoplankton and zooplankton community composition) and ecosystem functioning (periphyton productivity and leaf litter decomposition). There were trends towards higher phytoplankton biomass in both plastic treatments compared with the control, which were unrelated to nutrient treatments. There were no significant treatment effects on periphyton productivity, total or microbial leaf litter decomposition after exposure to the treatments. These results contribute to the increasing evidence that microplastics should be considered as a suite of contaminants and that more robust evidence is needed to generate a proper risk assessment of microplastics in freshwater ecosystems.

Acknowledgement: This research was funded by the EU INTERREG France (Channel) England project “Preventing Plastic Pollution” co-financed by the European Regional Development Fund. We thank Gabriela Zemelka, James L. Pretty, John F. Murphy and Dave Cooling for help with the experimental setup and continued maintenance of the experimental plot. We also thank Gabriela Zemelka and Carl Sutton for help with sample collection and Ian Sanders for help with analytical equipment.

MICROPLASTIC INGESTION AND PAE LEVELS AS PLASTIC TRACERS IN THE MEDITERRANEAN *VELELLA VELELLA: A CANDIDATE INDICATOR OF PELAGIC ENVIRONMENT*

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Scientific awareness of marine litter pollution and its toxicity to organisms has increased over the past decade. Over 90 Mediterranean marine species have been observed interacting with plastic, ranging from megafauna to invertebrates. The use of bioindicator species may allow the gathering of important information on plastic distribution and availability for marine biodiversity stressing the urgency to address their fate in the environment and the associated ecological risk. To achieve that, the cosmopolitan holoplanktonic hydrozoan *Velella velella* was collected in the SPAMI Pelagos Sanctuary in 2019 (Plastic Busters MPAs Project). Specimens were isolated from manta trawl samples and stored in 62 pools. Each pool (8 ind.) has been digested using a KOH 10% solution, filtered, and inspected to isolate and characterize synthetic particles. A new Phthalate Acid Esters (PAEs) extraction method has been developed and applied to evaluate the presence of these toxic substances as plastic tracers through the gas chromatography-mass spectrometry technique. Here we report the first assessment in the Mediterranean Sea and worldwide of plastic ingestion in this species. More than 200 microplastics were isolated for a total occurrence of 81%. As neustonic organisms, they may passively accumulate, transported by wind and current, in areas heavy affected by floating microplastics, suggesting the potential ingestion of particles mistaken for prey. A total of 313 ng/g w.w. was detected with DBP, DIBP and DEHP resulting in the three most abundant plasticizers (95% of the total PAEs detected). Their concentrations resulted to be slightly positively related to the number of ingested particles, suggesting their direct release from plastic. Due to its wide spatial distribution, the relevant role in the marine trophic chain and the high number of ingested plastics, *Velella velella* may be considered a potential indicator of microplastic pollution in the pelagic waters of the Pelagos Sanctuary and the Mediterranean Sea.

Acknowledgement: This study was funded by the Interreg MED project: Plastic Busters MPAs: preserving biodiversity from plastics in Mediterranean Marine Protected Areas, co-funded by the European Regional Development Fund (grant agreement No 4MED17_3.2_M123_027).

CONTRASTING THE IMPACT OF OIL-BASED AND BIO-BASED BIODEGRADABLE MICROPLASTICS ON FRESHWATER MACROINVERTEBRATE COMMUNITIES UNDER SEMINATURAL CONDITIONS

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Plastic pollution is a pervasive threat to aquatic ecosystems, with recent concerns being raised about microplastics (plastics particles smaller than 5mm) due to their unique and detrimental effects on freshwater communities. An increasing number of industries are offering bio-based plastics as an alternative to traditional (oil-based) microplastics. However, there is little empirical evidence about the impacts of bio-based microplastics on food webs and ecosystems, with most research focusing on individual taxa investigated under laboratory conditions. Here, we experimentally compared the effects of oil-based (high density polyethylene – HDPE) and bio-based (polylactic acid – PLA) microplastics on freshwater macroinvertebrate communities in 40 seminatural pond mesocosms. We used three concentrations of each microplastic, equivalent to i) measured environmental concentrations, ii) concentrations known to cause effects under laboratory conditions, and iii) control no microplastics. Furthermore, we crossed these with two levels of nutrient loading, equivalent to i) nutrient enriched ecosystems, and ii) control no nutrient addition, to determine if nutrient enrichment would ameliorate the negative effects of microplastics exposure. The experiment lasted twelve weeks. We found that populations were significantly more evenly distributed (i.e., had similar abundances among the different taxa) and had higher Simpson's dominance in ponds with PLA than in ponds with HDPE ($F_{2,37} = 3.929$, $P = 0.028$; $F_{2,37} = 3.349$, $P = 0.046$, respectively). Total abundance, beta diversity and community composition showed no statistically significant difference among the treatments ($P > 0.05$). Overall, we found no clear negative effect of neither HDPE nor PLA on macroinvertebrate communities. Nevertheless, this does not mean that these microparticles could not have sublethal effects on individual taxa. We suggest the possibility that macroinvertebrates could ingest and assimilate PLA microplastics using them as a carbon source. More research under environmentally relevant conditions and at community and ecosystem level for both traditional and bio-based microplastics is needed.

SMALL MICROPLASTICS (<100 µM), ADDITIVES, AND PLASTICIZERS IN MYTILUS GALLOPROVINCIALIS, A POTENTIAL BIOINDICATOR FOR MICROPLASTICS POLLUTION

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As the definition reported by ECHA [1], microplastics (MPs) can hold within additives and plasticizers; they are part of microlitter together with natural and non-plastic synthetic fibers [2]. MPs were reported to be ingested by different organisms, from invertebrates to mammals [3,4,5]. Organisms ingest these particles according to their mouthparts' size; invertebrates ingest MPs, additives, plasticizers, and other microlitter components less than 100 µm in size (i.e., SMPs and APFs). Through the invertebrates at the base of the trophic web, SMPs and APFs can reach other organisms, especially those at higher levels of the trophic web, with the chance of giving rise to bioaccumulation and biomagnification. Also, once entering the trophic web, these particles can pose a significant risk to human health. Coastal environments and transitional environments are areas of high-ecological diversity and substantial productivity. Since these areas may be a sink and source for MPs and other pollutants, they are among the critical habitats for monitoring, for which a sentinel organism, commonly found in large areas with biological traits that make it suitable for the purpose, can be employed. Mussels are usually considered optimal sentinels for this kind of study, being common in temperate coastal seas all around the globe, sessile, which can provide location-specific information, and a link to the human food chain since they are very popular as seafood. This study's focuses were to investigate the occurrence of SMPs and APFs in *Mytilus galloprovincialis,* assess the spatial microplastic pollution all over the Lagoon, evaluate APFs as good proxies of the presence of SMPs in mussels and the potential impact on humans. Specimens of *Mytilus galloprovincialis* were collected from about 20 sites in the Venice Lagoon, characterized by different inputs and pathways of pollutants. SMPs and APFs were quantified via microscopic counting and identified using Micro-FTIR.

Acknowledgment: The authors thank Elga Lab water, High Wycombe UK, which supplied the pure water system used in this study.

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ASSESSMENT OF THE IMPACT AND ABUNDANCE OF MICROPLASTICS ON TWENTY-TWO EDIBLE FISH SPECIES FROM FIVE DIFFERENT AREAS OF THE MEDITERRANEAN SEA

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Marine litter, including microplastics and microfibers, is ubiquitous in marine environments. Plastic ingestion by fish species was first described 50 years ago and has been a topic of growing interest over the past decade. According to our knowledge, this study presents the largest sample size analyzed in the Mediterranean Sea, to date. In total, the gastrointestinal tracts (GI) of 1983 specimens belonging to 22 fish species were collected from 5 different areas of the Mediterranean Sea (Tyrrhenian Sea, Ligurian Sea, North Adriatic Sea, Central Adriatic Sea and Southern Adriatic Sea).

For this study, the choice of fish species was based on a careful evaluation of several criteria such as habitat, trophic level, feeding habits and exposure to litter ingestion based on the existent literature, assuming that these parameters might influence the occurrence and abundance of plastic particles.

Plastic ingestion was found in 21 out of 22 species analysed accounting for the 31% of the total individuals analysed. The number of particles found in GI tract ranged between 1 and 11. A total of 1021 particles were isolated, 46% of these were textile microfibers and transparent was the most common colour. The occurrence of plastic ingestion shows high variability between the same species sampled in a different area.

Pelagic and mesopelagic species ingested more microplastic than demersal species. Planktivorous species with lower trophic levels revealed a higher amount of microplastics per individual than selective predator species with higher trophic levels.

This study provided a comprehensive characterization of the ingestion of different typologies of microplastics in several fish species from 5 different areas of the Mediterranean Sea, moreover, these results suggest that habitat and feeding habits could play a significant role in the ingestion of plastic particles in marine fish species.

Acknowledgments:

This study was partially funded by: Interreg MED project “Plastic Busters MPAs: preserving biodiversity from plastics in Mediterranean Marine Protected Areas”, co-financed by the European Regional Development Fund (grant agreement No 4MED17_3.2_M123_027), by PRIN project “EMME - Exploring the fate of Mediterranean microplastics: from distribution pathways to biological effects” (grant agreement no. 2017WERYZP) and by ENI CBC project “COMMON COastal Management and MOnitoring Network for tackling marine litter in Mediterranean sea”.

THE PLASTIC BUSTERS MPAS METHODOLOGICAL APPROACH TO DETECT THE IMPACT OF MICROPLASTICS AND RELATED PLASTIC ADDITIVES IN THE MEDITERRANEAN BIODIVERSITY

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Plastic Busters MPAs (PBMPAs) is a 4-year-long Interreg EU Med-project aiming to contribute to maintaining biodiversity, and preserving natural ecosystems, against marine litter, in Mediterranean marine protected areas (MPAs). The overarching aim of this presentation is to describe the implementation of the PBMPAs monitoring approach to detect the impact of microplastics (MPs) on Mediterranean biodiversity, focusing mainly on cetacean species inhabiting the SPAMI Pelagos Sanctuary, and the Tuscan Archipelago National Park-PNAT. In 2019, researchers of 8 European institutions, monitored 2230 nautical miles, collecting 140 samples of superficial MPs in both study areas and carrying out a simultaneous monitoring of surface macrolitter and biota survey. High MPs concentrations were detected, with higher values in PNAT (0.36±0.61 items/m2) compared to Pelagos (0.18 ± 0.58 items/m2). During the sampling campaign, in order to assess the multiple-ecotoxicological impact on biodiversity several candidate bioindicator species were monitored and sampled ranging from invertebrate (e.g. Velella velella) to cetacean species. MPs ingestion, plastic additives concentration, and biological end-points were detected in several species, exploring also the relationship with MPs environmental concentrations. In detail 17 skin biopsies samples of fin whale (Balaenoptera physalus) and 24 samples of striped dolphin (Stenella coeruleoalba) were collected and analyzed for plastic additives (phthalates). In parallel, we carried out 1H-NMR and MS metabolomics studies on extracts of skin biopsies. This is the first time metabolomics are used in cetaceans to attempt discriminate between different groups. Successful results open the road for further toxicological interpretation of the pathways modulated by xenobiotic exposure. Metabolomics could be an extremely relevant tool for discriminating the potential impact of microplastics and related chemicals on several bioindicator species inhabiting this fragile and highly anthropized ecosystem.

Acknowledgement: Plastic Busters MPAs Interreg EU Med-project

PLASTISPHERE IS NOT ONE ECOSYSTEM: THE GEOGRAPHICAL AND SEASONAL EFFECT ON MICROPLASTIC MICROBIOME

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Floating microplastic debris (<5 mm) have been found in almost all marine environments around the world. Due to their high durability at sea, plastic polymers such as polyethylene, polypropylene and polystyrene serve as stable substrates for the colonization of diverse communities of marine organisms.
In this study we aimed to characterize and compare the marine microplastic and its bacterial microbiome in contrasting seasons (Winter and Summer) between two separate marine environments – along the Israeli coast of the Mediterranean Sea (IL), and the Portuguese coast of the Atlantic Ocean (PT). At both locations microplastics and surrounding water were sampled in triplicates. State-of-the art DNA metabarcoding methodology was used for the characterization of the microplastic microbiome. Additionally, the physical environmental parameters, including the microplastic itself were analyzed and compared using the same methods for both locations.
In similar to previous studies, our results suggest that the geographical location is the strongest source of microplastic microbiome variation followed by the season. While few reoccurring bacteria have been identified in the samples from the two marine environments, most genera were significantly enriched in either one of them. The overall plastisphere microbial composition of the samples from the two environments was different and showed different seasonal effects. These results suggest that the plastisphere is composed of multiple different ecosystems that are defined by multiple environmental factors of their specific geographical location.

POLYSTYRENE NANOPARTICLE EFFECTS ON HUMAN UBIQUITIN STRUCTURE AND FUNCTIONS

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Nowadays, the concerns about nano-plastics (NPs) pollution have been increasing constantly. Plastic micromaterials easily fragment in smaller particles that we can find in the air, water, food [1] and even in blood cells [2]. Since the causes and effects are scanty, it is very important to understand their behavior towards biological systems and (bio)macromolecules present in them.

Here, we show that polystyrene nano-plastics (23 nm) are prone to interact with the human Ubiquitin, one of the best-known proteins. Therefore, we explored structure and dynamics of the protein by performing TEM (Trasmission Electron Microscopy), CD (Circular Dichroism) and high-resolution NMR (Nuclear Magnetic Resonance) analyses. Moreover, we tested the influence of these nanoparticles on ubiquitin functions by investigating in vitro and in cell ubiquitination. Overall, our results confirm that NPs can interact with important biomolecules, influencing their biological functions and therefore possibly causing relevant toxicological consequences.

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RISKS AND HEALTH EFFECTS FROM EXPOSURE TO ENGINEERED NANOSTRUCTURES: A CRITICAL REVIEW

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Nanotechnology and engineered nanostructures (ENSs) as well as nanoplastics are becoming part of the everyday life, starting from industrial application, even in food products, to gene therapy. Thus, tons and tons of nanoparticles and nanoplastics (NPs) enter in the environment (water systems) and indirectly or directly into the biological systems, including the human body. There are many controversial papers that describe interactions of the ENSs with the biological systems and rice concern that intentional or unintentional human exposure to certain types of ENSs may lead to significant health i.e. toxicological effects. Because of our insufficient and contradictory knowledge about the health effects associated with the NPs exposure, the aim of this paper is to summarize and systemize the already confirmed data and the latest found facts about NPs and their health effects and to discuss about the future perspectives and tasks in the field of nanotoxicology. Also, some of our research results concerning the health effects of SiC NP will be presented.

TRUE-TO-LIFE NANOPLASTICS FOR THE INVESTIGATION OF THE BIOLOGICAL INTERFACE

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Environmental nanoplastic pollution is a great issue affecting our Planet, especially marine ecosystems. The need to understand the possible implications of microplastics and nanoplastics pollution on the environment and living organisms is becoming increasingly pressing. Given the complexity of separating nanoplastics from environmental samples, studies have been so far conducted using synthetic polystyrene nanobeads (NBs). There is an urgent need to create nanomaterials that better reflect the real characteristics of nanoplastics naturally formed, viz. true-to-life nanoplastics (T2LNPs), to close the gap between the laboratory parameters and the rules of nature, and to provide more realistic understandings of the characteristics of nanoplastics.
Here, we present a study on the production and characterization of T2LNPs and the investigation of bio-interfaces through the study of protein corona formation on T2LNPs with respect to synthetic NBs. T2LNPs samples were produced from daily life plastic items subjected to a mechanical fragmentation through an ultracentrifugal mill operating in cryogenic conditions. The produced T2LNPs were characterized by Fourier transform Infrared (FT-IR) spectroscopy to investigate their chemical nature and check the absence of induced chemical modifications. Morphology and size distribution analyses were performed through Atomic Force Microscope (AFM). Finally, the protein corona formation from human plasma on T2LNPs and nanobeads was examined by electrophoresis (SDS-PAGE) [1].
The differences detected in the protein corona profiles of T2LNPs and NBs confirm the gap between controlled models and the complexity in real-life scenarios, supporting the need to develop true-to-life materials as reasonable models for environmental nanoplastics. The broad heterogeneity in size and shape shown by fragmented T2LNPs gives the nanomaterial a peculiar and different behavior compared to the defined pristine nature of NBs, nominating T2LNPs as a more faithful material for naturally-occurring nanoplastics and opening the possibility to new and unexpected results in biological interactions.

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QUANTIFICATION OF POLYETHYLENE IN MUSSEL HEMOLYMPH AND ITS LIMITED ADDITIVE EFFECT ON IMMUNE FUNCTION INDUCED BY BEZAFIBRATE

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Bioaccumulation of waterborne pharmaceutical residuals can be influenced by the presence of microplastics in the surrounding water and therefore, this study investigated whether *in vivo* co-exposure to weathered polyethylene microplastics (PE) (1 mg/L) and bezafibrate (BZ) (500 ng/L) caused add-on effects on immune function in comparison to exposure to BZ alone, as it has been observed for other emerging contaminants.
Mytilus galloprovincialis was used as model organism and the co-exposure study was carried out for 3 weeks. Size exclusion liquid chromatography coupled to high resolution mass spectrometry equipped with an Atmospheric pressure photoionization source (SEC-APPI-HRMS) working in negative conditions was used to quantify PE concentration in hemolymph. Lysosomal membrane stability (LMS) and phagocytosis efficiency of hemocytes, extracellular lysozyme activity and oxyradical production were determined as endpoints of immune function. PE concentration in hemolymph of mussels treated with PE and PE+BZ were similar and had a high variability but the values were an order of magnitude higher than those of mussels treated with BZ alone, representing the first quantitative estimate of the microplastic concentration that can be achieved in this tissue under *in vivo* exposure conditions. However, it remains to be determined what fraction of plastic particles was present in the plasma and which fraction is carried by hemocytes.
Mussels exposed to BZ and co-exposed to BZ+PE had significantly higher phagocytic rate than control mussels after 10 days, but this induction was transitory and not observed after 20 days. Lysosomal destabilization was only found after 20 days of exposure to BZ and BZ+PE, but not after exposure to PE. Overall, the results of this *in vivo* study showed that the coexposure to BZ+PE had no additive immunotoxic impact on mussels and that the effects of BZ on immune function outweighed the effects induced by the PE microparticles themselves.

PLASTIC MICROBIAL COLONIZATION: SEASONALITY AND DYNAMICS

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Plastic items in the marine environment harbor many organisms thriving and interacting, forming a real ecosystem. As soon as plastic items enter the sea, their surface is immediately colonized by microbes (both autotrophs and heterotrophs) and also macroorganisms, which together form the so-called “Plastisphere” [1]. However, the processes underlying biofouling formation and how this affects the behavior of plastics and consequently their fate in the marine environment, are still poorly understood, especially for items < 5 mm (MicroPlastics, MP). Here, we present the preliminary results of an in situ incubation study performed in the Gulf of Naples as part of the JPI-Oceans Project “MicroplastiX - Integrated approach on the fate of microplastics towards healthy marine ecosystems”. 1 cm x 1 cm pieces of nine different polymers have been incubated at a coastal site in the Gulf of Naples (Italy) every 4 months and sampled after 7, 15, 30, 60 and 90 days for measurements of density, sinking rates and biofilm formation. The pieces were visualized by Scanning Electron Microscopy (SEM) to characterize the microbial components (prokaryotic and eukaryotic) and to estimate coverage in terms of individuals per mm^2. High Throughput Sequencing of 16S and 18S rRNA genes was also performed to characterize diversity of prokaryotes and eukaryotes, respectively. Preliminary results indicate that biofilm formation is very abundant during the summer season and that biofilm growth is not linear over residency time for most polymers. In addition, biofilm formation alters the density and sinking rate of some polymers (e.g. polypropylene) after 30 days of incubation during winter and spring. Overall, these observations provide information on the dynamics of biofilm colonization and its role in changing the behavior of plastics at sea.

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APPLYING MOLECULAR AND BIOCHEMICAL BIOMARKERS TO DETECT THE IMPACT OF MICROPLASTIC INGESTION AND PLASTIC ADDITIVES IN MEDITERRANEAN STRIPED RED MULLET

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The effects of microplastics on marine biota have been extensively studied in the recent years, especially through controlled exposure scenarios in laboratory settings. However, the detection and the quantification of the biological effects of microplastics in nature still represent a research challenge, due to the numerous variables at play and possibly the lack of suitable biomarkers sensitive to microplastics contamination. In this study, carried out within the Plastic Buster MPAs project, we estimated the presence and potential impact of microplastics on wild specimens of *Mullus surmuletus* collected in two marine areas belonging to the Tuscan Archipelago National Park, through the isolation of microplastics from the fish gastrointestinal tract and the investigation of biological endpoints. The biological effects of microplastics, combined with other potential environmental stressors, were investigated measuring the expression of 11 candidate genes in the fish livers and the quantification of 8 biochemical biomarkers in brain, liver, and muscle tissues. Moreover, the concentration of 11 phthalates compounds was quantified in the fish muscle, these chemicals were selected as potential tracers of microplastic exposure. The data obtained though this multi-biomarker approach was integrated and analyzed to discover potentially significant correlations with the microplastic load in the environment and occurrence in the collected fish specimens. The results obtained contribute to the establishment of sensitive tools to detect the biological effects of microplastic pollution in wild fish species inhabiting Mediterranean MPAs.

Acknowledgement: This study was partially funded by: Interreg MED project “Plastic Busters MPAs: preserving biodiversity from plastics in Mediterranean Marine Protected Areas”, co-financed by the European Regional Development Fund (grant agreement No 4MED17_3.2_M123_027)

INTERACTIONS BETWEEN MICROBIAL COMMUNITIES AND PLASTICS IN FRESHWATER AND ESTUARINE ENVIRONMENTS

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Plastics in rivers and estuaries are rapidly colonised by diverse microorganisms. However, knowledge of the diversity and function of plastic-associated microbial communities, and the ecological and biogeochemical alterations they might cause, is limited.
We carried out a field-based survey to investigate the diversity of microbial communities that colonised various plastic polymers and sediments from six rivers and three estuaries in the UK. We sequenced the 16S rRNA gene to identify the sediment and plastic-associated microbial communities and characterised the plastic polymers using Fourier-Transform-Infrared spectroscopy.
Our results show significant differences between plastic-associated and sediment-dwelling microbial communities in both riverine and estuarine environments. In estuaries, the plastic-associated microbial composition was significantly enriched in Desulfosarcinaceae, Desulfatiglandaceae, and Sulfurimonadaceae compared to the sediment's communities. Those families are known to play an important part in metabolising sulphur into other forms and reducing sulphate into hydrogen sulphide and various sulphuric compounds. Furthermore, the plastic communities had a significantly lower abundance of Chloroflexi in the saline sites of the estuaries. In the freshwater part of the estuary, plastic-associated communities contained a higher relative abundance of Methylomonadaceae, known to be methane-oxidising bacteria. Nonetheless, sediments and plastics appeared to have similar alpha-diversities. On the contrary, plastic-colonising microorganisms in rivers had a significantly lower alpha-diversity than sediments. Plastic-associated bacteria had twice less observed species and a lower evenness. The river sites' beta-diversity showed that instead of grouping by site, the communities grouped by sample type hence, having markedly distinct communities between plastics and sediments. Plastics in rivers were significantly enriched in Methylomonadaceae and Methylophilaceae.
Overall, our results suggest that plastics found in riverine and estuarine sediments are colonised by distinct microorganisms enriched with certain functional groups such as sulfate-reducers, sulfur-oxidisers and methanotrophs. Therefore, plastic pollution in rivers and estuaries likely causes alteration to sulfur and carbon cycles.

ANALYSIS OF MICROPLASTICS IN WASTEWATER TREATMENT PLANTS ALONG THE HUNGARIAN STRETCH OF THE DANUBE RIVER

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The current tasks of the EU Strategy for the Danube Region (EUSDR) "Water Quality" Priority Area (PA4) include "Encouraging the monitoring, prevention and reduction of water pollution caused by hazardous and emerging substances". This group of materials includes microplastics (MPs) as well, therefore we assessed the effectiveness of the removal of microplastics at wastewater treatment plants (WWTPs) in Hungary. Samples were taken from the raw wastewater received by the plants, the treated wastewater discharged into the Danube River and, in some cases, the sewage sludge as well in 5 WWTPs (2 large, 2 medium and 1 small municipal facility). All plants were sampled twice. To obtain data on the relation of MP concentration in wastewater and surface water, the Danube River was also sampled. MP content (polymer type and particle numbers) have been characterized by FTIR microscopy (imaging). All together four samples were collected from the Danube River, in average 1725 L/sample (range 994-2118 L). Treated wastewaters (effluents) have a more stable suspended solid content, so thus the average sample volume was 2016 L (range 1781-2105 L). Raw wastewaters (influents) are very dense samples, so the average sample volume was 87 L (range 26-150). The analysis of 10 WWTP influent samples showed and average concentration of MPs of 1800 particles/m^3, ranging from 800 to 4400 particles/m^3 in the individual samples. Regarding the wastewater effluent samples, average concentration of microplastics of 52.2 particles/m3, ranging from 11.7 to 84.6 particles/m^3 in the individual samples. Based on the current study, the surface water samples contain less microplastics than the wastewater samples (downstream in average 23.5 particles/m^3; upstream in average 16.35 particles/ m^3). It is clearly shown, that MPs are most commonly made of polyethylene (PE) and polypropylene (PP). We found that WWTPs are able to reduce the MP content of the raw wastewater, but the treated effluent is still containing more microplastics, than the receiver river water. This could indicate an accumulation in the sludge that we have not detected, so in the future potential MP retention capability of WWTPs should be further investigated. The study also revealed some methodological issues that need to be overcome on the international level.

Acknowledgement: The analysis has been carried out by WESSLING Hungary Ltd., in the frame of the EU SDR PA4 „Water Quality" activities in the commission of the Ministry of Foreign Affairs and Trade of Hungary (contract number: KKM/18565/2021/Adm).

THE PHYSICAL AND CHEMICAL METHODS FOR THE QUANTITATIVE MODELLING OF NANOPLASTICS, MICROPLASTICS AND THE PLASTISPHERE – SELECTED CASE STUDIES

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The interdisciplinary problem of microplastics and nanoplastics in the environment can be tackled from different perspectives. Usually, one divides it into sampling strategies, identification methods, ecotoxicological impact and mitigation strategies. The starting point of this contribution is based on the hypothesis that the physical and chemical properties of the debris surface will far more determine its behaviour than the polymer type itself. Thus, the methods of quantitative, not only qualitative microplastics descriptions are developed: numerical modelling of spectra and the scanning electron microscope (SEM) picture analysis. Furthermore, the different proposals for the morphology description and ageing monitoring via Raman spectra parameters will be presented. Moreover, the leakage analysis by electrochemical methods is proposed. All concepts are to be discussed using examples from concluded and ongoing projects, for instance: monitoring in Santuario Pelagos, plastic tide studies for Portoferraio, Porto Ercole and Saint-Tropez, freshwater sampling, characterization of primary microplastics, PE weathering, the ecotoxicological effect of nanoplastics on bivalves, soil microplastics and their interaction with Eisenia fetida.
Finally, an emerging and hitherto neglected direct source of primary microplastics will be discussed shortly.

Acknowledgement: This work was partially supported by the University of Warsaw POB I grant (BOB-IDUB-622-168/2021/PSP: 501-D112-20-1004310). The author is grateful to prof. Barbara Pałys for the inspiring work atmosphere in Her research group and all collaborators who contributed to this research.

STEP-BY-STEP EVALUATION OF MATRIX EFFECT AND SAMPLE RECOVERY DURING PRETREATMENT OF WASTEWATER SAMPLES FOR THE QUALI-QUANTITATION OF MICROPLASTICS BY PY-GC-MS

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Sample pretreatment strategies for quali-quantitative analysis of microplastics (MPs) in environmental samples usually entail several separation, digestion, and purification steps, in which plastics particles are isolated from both the inorganic and organic components of the matrix. The aim of such pretreatments is to increase the method sensitivity and reduce the interference of the matrix on the analysis. However, limited information is available on the recovery of plastics during such pretreatments, and on the entity of matrix effects generated by matrix components. A more in-depth knowledge of these aspects could provide valuable insights to further optimize pretreatment strategies. We describe a systematic investigation of the effects of a sequence of widely used pretreatment steps for quantitative MPs analysis in wastewater samples by analytical pyrolysis-gas chromatography-mass spectrometry (Py-GC-MS). The goal was to evaluate the effect of sample pretreatment in the Py-GC-MS quantification of MPs. A set of replicate samples from a wastewater treatment plant were subjected to an increasing number of modular different pretreatment steps, and the cumulative effects of these steps on Py-GC-MS recovery and sensibility were evaluated on deuterated polystyrene (PS-d8), which was used as internal standard. Samples preparation consisted of six-steps including (1) washing with surfactants, (2) enzymatic digestion of proteins, (3) enzymatic digestion of cellulose, (4) Fenton oxidation, and (5, 6) single and double density separation. After each step, a fraction of the samples was analysed by Py-GC-MS, while the others were brought forward to the next step. Aliquots of the samples were spiked with different amounts of PS-d8, allowing us to build in-matrix calibration curves at each step of the pretreatment. This allowed us to estimate polymer recoveries and matrix effects throughout the sample treatment process. The results showed a loss in polymer amount as the number of pretreatment steps increased. Recoveries as low as 40% were determined for the samples which underwent all pretreatment steps. All in-matrix calibration curves provided good r2 values. Sensitivity and response linearity at each pretreatment step were only marginally affected by the presence of the environmental matrix, suggesting that minimal matrix effect was present. Multi-step pretreatment strategies can lead to loss in polymer amount, with the risk of analytes falling below the instrumental detection limits. In-matrix calibration could be a promising strategy when dealing with samples with very low polymer amounts, in which an extensive sample pretreatment could cause significant sample loss. Future studies should be aimed at investigating polymer recovery and the effectiveness of in-matrix calibration when dealing with other environmental matrices, such as soil, seawater, and biota.

Acknowledgements: The research was carried out in the context of the North Atlantic Microplastic Centre NAMC coordinated by the NORCE Norwegian Research Centre and implemented after a donation of the Agenda Vestlandet (Bergen, Norway)

MARINE LITTER POLICY ADVANCES IN THE MEDITERRANEAN

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The updated Regional Plan on Marine Litter Management in the Mediterranean was adopted in December 2021 during COP22 (Antalya, Turkey, 7-10 December 2021). The Regional Plan includes new elements, including new definitions, updated scope of measures expanded under four key areas (economic instruments, circular economy principles, land-based and sea-based sources of marine litter) and amended targets for plastic waste and microplastics. Moreover, additional principles are included, such as phasing out single-use plastic items and promote reuse options; setting targets for plastic recycling and other waste items; introducing economic instruments such as environmental taxes, banning and design requirements; EPR (land and sea-based sources); promoting new technologies and measures for the removal of marine litter; supporting the application of prevention measures to achieve a circular economy for plastics; reducing packaging; promoting voluntary agreements with industry; taking measures to integrate the informal sector into regulated waste collection and recycling schemes; strengthening measures related to SCP programmes; phasing-out chemical additives used in plastic products; introducing concrete measures on microplastics reduction; implementing measures to prevent and reduce marine litter in MPAs; minimizing the amount of marine litter associated with fishing and aquaculture; establishing marine litter monitoring programmes as part of IMAP EO10; enhancing public awareness and education; and including measures in the SPAMIs to combat marine litter. The added value of the updated Regional Plan is pertinent to reflecting and addressing recent directions by UNEA resolutions including of UNEA 5.2, global conventions and regional initiatives, encompassing substantive elements and lessons learnt over the 2013 version of Regional Plan on Marine Litter Management in the Mediterranean, as well as mobilizing significant resources to enable its effective implementation including from the Mediterranean Trust Fund (MTF) and the European Union.

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A CITIZEN SCIENCE PROJECT TO VALIDATE A NEW SAMPLING METHODS FOR MICROPLASTIC MONITORING IN COASTAL MARINE ENVIRONMENT

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Microplastic (MP) presence in the marine environment has been widely documented globally in all the offshore areas of the oceans, while the nearshore marine zones remain poorly investigated despite being the regions where the largest plastic mass flux occurs. Manta net are the most used devices for MP sampling in surface water, however the coastal monitoring is limited by the high variability of the coast morphology and the difficulty to sail in shallow depth environments for research vessels and boats. For this purpose, the “MicroPlastic Hunter”, a pilot citizen science project lead by the CNR-IAS of Genoa, with Auxiliary Coast Guard, Outdoor Portofino, Marevivo Onlus and Italian Naval League in collaboration with Marine Protected Area of Portofino, 4 Elements and supported by different scientific projects, aims to validate a Mini-manta net to collect samples in the nearshore pulled by different type of recreational sports floating gear like kayaks and stand-up paddle. Four sampling field activities, starting on March 2021 were performed in the Portofino Marine Protected Area. Surface water samples were collected along three coastal transects by using both Minimanta net pulled by kayakers and traditional Manta net towed from boats by researchers to compare the different methods. The results showed that MP abundances in the nearshore sampled by Minimanta net were on average higher than those collected offshore by using the traditional Manta net. However, no differences in term of shape, size, and composition between the two methods used, were observed, suggesting the validation of the Minimanta net. These results suggest the importance of the monitoring nearshore as a source of plastic that need to be further investigated. In addition, this project represents a paradigm shift in MP research, demonstrating how citizen science for monitoring floating microplastic can be an effective tool in helping science in collecting data.

Acknowledgement: The authors thanks for the financially support by Kia Motors, EXO Kayak to lend us the kayaks for the monitoring activities. Special thanks to the support received from OutBe community. We also want to thank Erika Renda and Blu Frame of Marzio Cardellini for the technical support and media production. This work was supported by the JPI Ocean project Response and the PRIN project EMME.

CHALLENGES OF RECTRICTING MICROPLASTICS IN THE EU: RECOMMENDATIONS FROM SCIENTISTS FOR THE RESTRICTION PROPOSAL

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During this interactive presentation I would like to challenge participants to reflect on the developments concerning the restriction dossier on microplastics. When the European Commission requested ECHA to compile a restriction dossier on microplastics in 2017 [1], the procedure foresaw an adoption of the restriction in 2020. Unfortunately, the European Commission has not completed a proposal yet.

As part of the process, the restriction proposal has been adjusted after several consultation rounds, and the Committee for Risk Assessment (RAC) and the Committee for Socio-economic Analysis (SEAC) have provided their opinions and suggestions. Also, the enforcement authorities of the EU Member States have given input via the Forum for Exchange of Information on Enforcement.

The latest document proposes several changes in relation to the first proposal from ECHA of which I will discuss two revisions in particular: the definition of microplastics and the exemption for biodegradable microplastics [2]. The revised definition of microplastics with a lower size limit of 100 nm is defended by SEAC on the basis of practical and technical considerations, such as analytical difficulties, while RAC concludes that the revised definition may lead to circumvention of the restriction via substitution by nanoplastics.

The second issue is the derogation for biodegradable polymers. RAC considers the 'all compartments' testing method as most appropriate but points out that none of the proposed testing methods would fully address all uncertainties. 'Biodegradable microplastics' may be less degradable in a certain environment and therefore continue to be a source of microplastic pollution.

Can present scientific evidence justify the lower size limit and the exemption for biodegradable microplastics? In the coming year, the Commission, the European Parliament, and the Member States will decide on the restriction and also in this stage revisions can be made. What message can we send?

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COST ACTION CA20101 PRIORITY: COLLABORATIVE RESEARCH NETWORK TACKLING THE GLOBAL CHALLENGES OF PLASTIC POLLUTION

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The COST Action CA20101 "Plastics Monitoring Detection Remediation Recovery" (https://ca-priority.eu/ and https://www.cost.eu/actions/CA20101/) – acronym PRIORITY – is a science and technology research network focused on developing, implementing, and consolidating strategies to tackle the global challenges of micro- and nanoplastics in the environment.
COST (European Cooperation in Science and Technology) funds the four years PRIORITY (start 19/10/2021 - end 18/10/2025) to enable scientists to grow their ideas by sharing them with peers, boosting research, career, and innovation.
Environmental plastic pollution is nowadays a great concern. The extremely wide usage of plastic in almost every human activity has led to a progressive accumulation of plastic waste in the environment. Once plastic gets into the environment it undergoes degradation processes, resulting in fragmentation into smaller pieces, generating micro- and nanoscale particles. PRIORITY supports the harmonization of European regulation associated with micro- and nanoplastics, assisting the European Commission in critical aspects of environmental and ecosystems protection, food safety, and life science [1].
This COST Action combines expertise in chemistry, physics, life science, engineering, economy, and law on issues related to micro- and nanoplastics, with specific targets of health and environmental concerns. The network is meant as a robust infrastructure for scientific communication, exchange, and collaboration to foster new research activities and citizen science. The topics of interest include, but are not limited to, hazard assessment, analytical procedures, metrology, regulatory science, remediation, recovery and mitigation strategies.

Acknowledgement: This contribution is based upon work from COST Action CA20101 Plastics monitoring detection Remediation recovery - PRIORITY, supported by COST (European Cooperation in Science and Technology). www.cost.eu.

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WHAT KIND OF INTERNATIONAL LEGALLY BINDING INSTRUMENT ON PLASTIC POLLUTION DO WE NEED?

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For the international challenge on the Plastic theme this will perhaps be remembered as the hottest spring and the turning point.
Last March the UNEP Assembly finally decided on a historic legally binding intervention on plastic. We finally have the perception that the challenge is not only global, but that the solution is approaching. In 2021, the amendments to the Basel Convention on plastics became effective. The very recent COPs of the Stockholm, Basel and Rotterdam Conventions (as we write), has also put plastic at the center again, as an emerging pollutant and with impacts everywhere, not only starting from aquatic environments. After years in which the growing alarm about MPs Pollution has produced an ever-growing literature on environmental sectors and human health, finally all international bodies seem to converge to tackle the problem (EU, G7, OECD, UNEP, WEF, WHO, FAO). But what will they be premises, foundations, indispensable elements but above all the method, that is the elements that cannot be missing, in order to be able to say that the effort made becomes a success?
Surely we need a simple, clear, gradual, and shared agreement that on a global level starts from the existing regulatory framework, confirming what already binds the international community, expanding its audience. More than big unattainable resolutions, this phase of initiating the work of the delegate group requires clear input and method.
Such a far-reaching agreement must be shared, understandable also for the societies and stakeholders who must accept it, because it has great implications, not only economic, but also sociological and cultural. Will we be able to take up this challenge, inevitably linked to the others we have faced recently, such as the pandemic and climate challenges?
We have only one possible destiny: success with the reversal of the trend in consumption and lifestyles linked to the abuse of plastic. Defeat is actually our present that we need to change.

Acknowledgement: to my sons the only engines of my life

DETECTION AND CHARACTERISATION OF MICRO- AND NANO-PLASTIC POLLUTANTS: A CASE STUDY OF THE ADRIATIC SEA

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In the EU, 150,000 to 500,000 tons of plastic waste enter the oceans every year with 75,000 and 300,000 tons of microplastics released into the environment. The negative impact this has on the environment is widely recognized as being unacceptable at the biological, ecological and the socio-economic levels [1]. Consequently, aquatic ecosystems have been threatened by an exponential increase of plastics debris whose impact is not entirely understood within an overall systemic crisis of our oceans driven by habitat degradation, loss of biodiversity, climatic transformation and major sea streams alteration and disruption [2].
This study investigates the occurrence and characterization of micro-plastic contamination in the Adriatic Sea, where different plastic waste generating activities from neighboring countries are considered as a pollution source. According to the applied protocol, water samples of 5L have been collected and filtrated from three locations around the Venice Lagoon in Italy and five locations around the island of Krk in Croatia. Microplastics, perceptually categorized as fibers, films, and fragments, were quantified; their morphological features (dimensions, color) were studied using the optical microscopy. The size mean, undersize (D10, D50 and D90) and concentration of nano-plastics were also estimated using Dynamic Light Scattering. Furthermore, heavy metals have been quantified in the water bodies by Flame Atomization Atomic Absorption Spectrometry after the digestion step.
The results of this scouting scientific investigation show significant presence of microplastic particles in all samples independent of sampling location. The highest concentrations were observed in the Canal Grande at the city center nearby the Rialto bridge, which is one of the most iconic and massively visited location of Venice.

Acknowledgement: M.R., P.F. and D.P. would like to acknowledge financial support from the IN NO PLASTIC (Innovative approaches towards prevention, removal, and reuse of marine plastic litter) under the call CE-FNR-09-2020, and A.V. from Slovenian Research Agency (project No. J7-3149 and core research funding No. P2-0412).

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FIRST COLLECTION AND MONITORING OF PLASTICS AND MICROPLASTICS IN THE FRESHWATER OF GARDA LAKE USING SEABIN. TECHNICAL AND EDUCATIONAL ASPECTS.

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Object of this study is the collection and characterization of plastics (P) and microplastics (MP) floating in the north side of Garda lake, and simultaneously the evaluation of the functionality of the Seabin [1,2]. Seabin is a basket capable of capturing various debris floating in surface water to clean and remove plastic waste from environment [3], and today more than 900 units have been installed worldwide. The chosen site for Garda Lake (June 17th, 2021) is the northern Fraglia Vela harbour in Riva del Garda, at a strategic confluence of winds and water corrents, that favour the local concentration of floating residues [4]. Several collection campaigns were carried out between June 2021 and May 2022. The collected materials were removed from the basket and examined in lab at different levels, number, weight, size, type of polymer (by FTIR, pycnometry, calorimetry, and SEM analysis). Local classes of two high schools, namely Liceo Maffei and Gardascuola, have been involved in Plastic Environment Project for specific monthly collection and sampling for 12 or 6 months respectively, identifying the type of plastics by density (bouyancy method or immersion in selected density solution). The collection profile showed a seasons dependence. In summer-autumn more than 4000 pieces of plastics were identified (72% PE; 15% PP; 12% EPS; a minor content of PET, CA, nylon, PMMA). The peak of EPS recorded in July-August 2021,. Important data selected are the ratio of plastics to total, and for P and MP, pieces per hour/day, weight per hours/day, type of plastics, and also the seasonal comparison.
In conclusion, the installed Seabin appears to be an efficient system to monitor the level of plastic contamination. Limitations of maximum continuous use time were highlighted. Local activities have become a valuable tool for educational and awareness-raising.

Acknowledgements: The authors acknowledge COOP Italia and LifeGate for their promotion and support activities.

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MPS ANALYSIS WITH µ-RAMAN: POTENTIAL AND PRACTICAL ASPECTS

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Microplastics (MPs) are defined as plastic particles with size lower than 5 mm. They have been recognized as pervasive and persistent pollutants and have been found in high amounts in each environmental compartment. Many are still the unknown aspects about presence, fate and effect of MPs into the environment. To achieve a better understanding, the complete description in terms of shape, size and chemical composition is strictly required. Coupling the spectroscopic Raman technique with the potential of a microscope, allows for a complete description of the aforementioned parameters, reaching sizes of the order of 1 µm. Undoubtfully, it represents one of the best techniques nowadays available for achieving such a level of detail.
However, the practice of MPs analysis with µ-Raman is impaired by many issues that need to be addressed beforehand. Main steps of µ-Raman MPs analysis are: sampling, sample pretreatments, filtration, image acquisition and analysis, spectra acquisition and spectra library search. Each step presents indeed various challenges that must be fully addressed for a reliable and reproducible analysis. Additionally, a method quality assessment must always be included in the analysis protocol development.
This work presents therefore the experience of the research group within the context of MPs µ-Raman analysis: each step of the analysis protocol is reviewed in depth, highlighting issues, difficulties, solutions, cost-benefit and potential of the µ-Raman for MPs analysis. Moreover, preliminary results regarding the application of the µ-Raman technique to samples from a drinking water treatment plant are presented, along with findings on operative volume, optimal pretreatments and best practice for a meaningful MPs µ-Raman analysis.

BIOBASED POLYMERS: HYPE OR HOPE?

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Plastic materials are part of our everyday lives in various applications ranging from packaging to electronics. However, plastic materials are persistent in the environment and from petroleum, posing many ecological problems such as CO_2 emissions and microplastics in marine environments. The purpose of the keynote is to identify the challenges and issues related to the plastic materials and present the different solutions envisioned in the field, specifically on biobased polymers through industrial examples.

STABILITY OF MICROPLASTICS: DETECTION OF POTENTIALLY HARMFUL COMPOUNDS PRODUCED BY MICROPLASTICS DURING ACCELERATED AGING STUDIES

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Microplastics (MPs) have now been detected in all the main environmental compartments, and the associated environmental and health hazards have been the focus of intense social, scientific, and media attention. Plastic debris should be considered by no means as chemically stable persistent pollutants, but rather as reactive materials. Indeed, synthetic polymers exposed to the environment undergo chemical and physical degradation processes leading not only to mechanical but also molecular fragmentation. In this work we tested different analytical approaches based on pyrolysis, gas chromatography, and mass spectrometry to evaluate the potentially harmful molecular fragments generated by microplastics during accelerated ageing. Samples of micronized reference polymers (high-density and low-density polyethylene, polypropylene, and polystyrene) were photoaged in SolarBox and treated with specifically optimized extraction protocols to characterize the degraded soluble fractions produced during irradiation. The analyses were performed both on the solvent-soluble fraction of the polymers [1,2] and the volatile organic compounds produced and released by the reference microplastics [3]. Accelerated photo-oxidative aging of the same four reference MPs was also performed directly in artificial seawater to evaluate the production of water-soluble chemical species [4].
The combination of artificial ageing and extraction procedures, together with the multi-analytical approach, provided an initial but comprehensive picture of the chemical nature of degradation products released by different polymers present as microplastics in the environment, significant contributing to our understanding of the fate of this kind of pollutants.

Acknowledgement: The research is part of the JPI-Oceans HOTMIC project “Horizontal and vertical oceanic distribution, transport, and impact of microplastics”

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MARKERS OF PLASTICS AND MICROPLASTICS IN MARINE ENVIRONMENTS

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Plastics and microplastics are known to be stable in environmental conditions. Half-lives can be over than one thousand years for pipes in marine environments [1]. However, even at low rate, these materials undergo biotic and abiotic transformation in natural conditions, releasing particles and compounds. Plastics usually possess additives and are known to adsorb and spread organic contaminants. Polystyrene, for example, adsorbs polycyclic aromatic hydrocarbons such as pyrene [2]. However, little is known about the transformation reactions and final product distributions of plastics materials, their additives and/or adsorbed contaminants. We have been studying the chemical and photochemical transformation of microplastics, plastic materials and their additives and contaminants on natural surfaces. We will present and discuss new findings on the main reaction processes and products using a metabolomics approach. Data were obtained by GC-MS and LC-MS. Volatile and non-volatile compounds released after microplastics chemical and photochemical reactions were identified. Photoproducts are strongly dependent on oxygen and include ketones and carboxylic acids. The presence of adsorbed contaminants changes the main photoreaction pathways of microplastics. The main chemical and photochemical markers of polyethylene, polystyrene and polyvinyl chloride were identified on model and natural sand surfaces. Plastics and microplastics release volatile and non-volatile degradation products in marine and atmospheric environments, contributing to their generalized contamination.

Acknowledgement: We thank Fundação Azul for funding, grant “Size Matters - Looking for invisible plastics,” reference FA_05_2017_024. This study received Portuguese national funds from FCT - Foundation for Science and Technology through projects UIDB/04326/2020 and EXPL/CTA-AMB/1613/2021, and from the operational programmes CRESC Algarve 2020 and COMPETE 2020 through project EMBRC.PT ALG-01-0145-FEDER-022121.

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PHOTO-OXIDATION TECHNIQUES FOR MICROPLASTICS (MPS) ACCELERATED WEATHERING

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MPs weathering under natural conditions consists in a slow but continued exposition to various environmental stresses that need from months to years to produce effective plastic degradation. Different techniques can be applied to obtain a laboratory weathering process simulation and to accelerate it as a convenient way to overcome limitations of field monitoring study of weathered MPs. In this preliminary weathering experiment, Low Density Polyethylene (BAM 210) was used as starting test material. Three different configurations for MP light irradiation have been selected:
1. Irradiation with 500 W Xenon lamp (Light Irradiance 100 mW/cm^2) to simulate the entire solar radiation, with the intensity of sunlight in summer (~1000 W/m^2) [1].
2. Irradiation with 300 W UVa/UVb (Light irradiance 1, 6 mW/cm^2) to simulate the UV-only exposure (T 35°C humidity 35%)
3. Irradiation with Low pressure mercury arc lamp (Light irradiance 0, 4 mW/cm^2) in a UV_C/O_3 cleaner machine, to simulate “urban conditions” [2]
In this first phase, the maximum time exposure was 72 h with solar simulator and UV chamber and 40 minutes with UV_C/O_3 configuration. This difference is because the shorter wavelength of UV_C light should achieve a rapid aging of MPs in a shorter time. The aging process and PE degradation under the three conditions was monitored by SEM characterization and by ATR-FTIR analysis. The Carbonyl Index (calculated as the ratio of the carbonyl peak relative to a reference peak [3], was used as a metric for the oxidation of polymers, and therefore for the comparison of different treatment and time exposure efficacy. Our preliminary results highlighted that the treatment with UV_C/O_3 was more efficient than the two other milder conditions, and should be selected for further studies on the accelerated MPs weathering.

Acknowledgement: This research is carried out within the project:” Understanding exposure and toxicity of Micro- and Nano-Plastic contaminants in humans, POLYRISK” - Horizon 2020, Call: H2020-SC1-BHC-2018-2020” (Better Health and care, economic growth and sustainable health systems).

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ARE WATER-SOLUBLE POLYMERS A NEW ENVIRONMENTAL THREAT? THE CASE OF POLYVINYL ALCOHOL

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Plastic pollution represents a well-known emerging global issue, bringing many countries to adopt legislative restrictions to limit their use and production. Nevertheless, the impact on ecosystems of another emerging category of synthetic polymers, the water-soluble polymers (WSPs) also called “liquid plastics”, is currently overlooked by scientific community. Due to their versatile chemical/physical properties, WSPs are produced in large quantities and used in many industrial products, such as food and detergent packaging, consumer objects, pharmaceuticals and personal care products, with a consequent continuous release in the environment.
For this reason, the aim of this study was the investigation of toxicity induced by the polyvinyl alcohol (PVA), one of the main used WSPs, and a PVA commercial bag used for carp-fishing. This study is surely the first to investigate the potential ecotoxicological effect of one of the most widely used WSPs using two different biological models.
Firstly, the hydrolysis degree as well as the eventual presence of additives in the PVA bag has been characterized through the Fourier Transform Infrared Spectroscopy (FT-IR) and nuclear magnetic resonance (NMR), respectively. The potential adverse effects induced by PVA materials were investigated on two freshwater model organisms, namely the crustacean *Daphnia magna* and the teleost *Danio rerio* (zebrafish). Three different concentrations (1 µg/L, 0.5 mg/L and 1 mg/L) of both solubilized standard PVA powder and PVA-based commercial bags were administered for 14 days to *D. magna* daphnids (age < 24 h) and for 5 days to zebrafish embryos (up to 120 hours post fertilization - hpf).
As acute effects we evaluated the immobilization/mortality of specimens, while for chronic toxicity we selected several endpoints with a high ecological relevance, as the organism viability, the behavioural alteration on both horizontal swimming performance and vertical migration and the activity of monoamine oxidase (MAO), a neuro-enzyme with a potential implication in the organism movement. Locomotion analyses were carried out by the DanioVision™ video tracking system, alternating cycles of dark periods with periods of different light intensities (from 300 lux to 4,000 lux).
The results showed a hydrolysis degree of 98% for the PVA powder and 85% in the PVA bag, which was also characterized by the presence of three different additives, namely the triethylene glycol (TEG), tetraethylene glycol (TetraEG) and pentaethylene glycol, probably used as plasticizer in the PVA-based bag production. Regarding the effects, no significant swimming alterations induced by the selected materials were obtained in both model organisms at all tested concentrations. Moreover, after the exposure tests, non-significant increase in the biological trend of MAO activity was observed in both *D. magna* and zebrafish embryos.
However, considering the wide plethora of available WSPs, other investigations are necessary to provide the initial knowledge of risk assessment for these compounds and to clarify and characterize their ecotoxicological impact.

FATE OF FOSSIL-BASED AND BIOPLASTICS IN THE MARINE ENVIRONMNENT

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The recently highlighted ubiquity of plastics in the marine environment has been a cause for rising concern, due to their size-dependent negative effects on marine and human life. Environmental factors, such as solar radiation, temperature, mechanical stress or microbial degradation, lead to the *in-situ* fragmentation of plastics into secondary particles, namely microplastics, with a nominal diameter smaller than 5 mm, or even nanoplastics (< 1 μm). In this work, the fate of 3 fossil-based plastic (polypropylene (PP), high-density polyethylene (HDPE) and polystyrene (PS)) and 4 bioplastic pellets (polylactic acid (PLA), thermoplastic starch (TPS), bio-polyethylene (bio-PE) and recycled thermoplastic starch (rTPS)) was monitored in marine mesocosms for 5 months. The surface chemical alterations and deterioration of pellets along with the biofilm development were studied. At the same time, the micro/nanoplastic generation was determined using microscope, dynamic light scattering (DLS) and Nanoparticle Tracking Analysis (NTA) in order to estimate the concentration and size distribution. Biofilm developed on the surface of all pellets since the first month and the concentration of biofilm cells displayed an increasing trend. An increase in the concentration of secondary bioplastic particles was also detected along experimental period. The surface area of all fossil-based pellets decreased over time and changes in the chemical structure of the surface of all polymer types were detected but at a different extent. It seems that a complex, polymer dependent degradation process occurs and the fate of the so-called biodegradable polymers should be more carefully investigated in the marine environment.

Acknowledgement: This research was co-financed by Greece and the European Union (European Social Fund-ESF) through the Operational Program «Human Resources Development, Education and Lifelong Learning» in the context of the project “Strengthening Human Resources Research Potential via Doctorate Research” (MIS-5000432), implemented by the State Scholarships Foundation (IKY). The financial support by the Erasmus+ Programme is greatly appreciated.

REACTIVITY AND ANALYSIS OF NANOPLASTICS AND SMALL MICROPLASTICS

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Plastic debris undergo a slow process of transformation in the environment, which will lead to transformation and fragmentation of plastic polymers. Lower the size of plastic debris, higher is their mobility through the environmental compartments [1]; moreover, oxidation and photo-oxidation become important chemical degradation pathways when the size of plastic particles decreases, because reactivity is proportional to the surface to volume ratio. Therefore, nanoplastics (NPs) and small microplastics (MPs) may have a significant impact on the ecosystem.
In this work we studied the reactivity of NPs and small MPs under laboratory conditions, and we tested a new method to analyze them. We investigated the reactivity of plastic debris toward light and chemical oxidants. Aqueous suspensions of polymers in nano and micro-size range were exposed to light and/or oxidants and the degradation kinetics were measured. Degradation products released in liquid phase were identified by high-resolution mass spectrometry; the chemical changes on plastic particles were investigated with scanning transmission X-ray microscopy coupled to near-edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS).
We found that plastic particles can degrade under our experimental conditions, leading to a change in the C/O ration in the particles and to the release of organic matter to water. To analyze plastic particles, we developed a method using the flow cytometry to detect plastic particles in the size range between 0.6 to 10 µm. The method was applied to several polymers and has potential for the analysis and quantification of plastic debris.

Acknowledgement: We acknowledge funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 948666 NaPuE), the University of Helsinki (Three-Year Research Grants), and the Fondazione CRT (Project n. 2020.1874).

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IN VITRO HIGH-THROUGHPUT TOXICOLOGICAL ASSESSMENT OF NANOPLASTICS

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Sub-micrometer particles derived from the fragmentation of plastics in the environment can enter the food chain and reach humans, posing significant health risks. To date, there is a lack of adequate toxicological assessment of the effects of nanoplastics (NPs) in mammalian systems, particularly in humans. In this work, we evaluated the potential toxic effects of three different NPs *in vitro*: two NPs obtained by laser ablation (polycarbonate and polyethylene terephthalate) and one (polyethylene terephthalate) produced by nanoprecipitation. The physico-chemical characterization of the NPs showed a smaller size, a larger size distribution, and a higher degree of surface oxidation for the particles produced by laser ablation in respect to the colloidal synthetized ones. Toxicological evaluation performed on human cell line models (HePG2 and Caco-2) showed a higher toxic effect for the particles synthesized by laser ablation, with polycarbonate more toxic than polyethylene terephthalate. Interestingly, on differentiated Caco-2 cells, a conventional intestinal barrier model, none of the NPs produced toxic effects. This work wants to contribute to increase knowledge on the potential risks posed by NPs.

PLASTICS RECYCLING AND MICROPLASTIC EMISSIONS

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Anthropogenic microplastic (MP) pollution has attracted increasingly attention in the last decades due to its potential adverse effect on human health. Several sources were identified as well as potential reducing strategies discussed and suggested. Plastics recycling, as one of the important measures to reduce the utilization of virgin material and decrease the CO_2 footprint, is a potential source for MP. However, it is scarcely investigated. In this ongoing study microplastic emissions during the pre-treatment of recycled polypropylene (PP) flakes were examined. To mimic an industrial scale washing process PP flakes were treated in a front-loading washer and the effluent water was analyzed. Microplastic particles were gravimetrically quantified and spectroscopically classified. In a preliminary study PP MP were found and ranged from 2.2 – 5.7 mg/L. Our results are shedding new light on the recycling process and provides insights on the necessity of the implementation of countermeasures to prevent MP production in plastics recycling.

SUBCHRONIC ORAL TOXICITY OF POLYSTYRENE MICROPLASTIC ON INTESTINAL HOMEOSTASIS AND HEALTH STATUS IN GILTHEAD SEABREAMS (*SPARUS AURATA*)

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Plastics debris are among the most widely distributed pollutants in the environment, particularly in aquatic ecosystems. Microplastics (MPs) (100nm-5mm) and nanoplastics (NPs) (1-100nm) undergo bioaccumulation processes along the trophic chain [1] and induce health consequences in living organisms not yet fully understood. Ingestion is one of the main exposure routes to MPs in aquatic organisms [2]. We investigated the effects of polystyrene (PS) polymer ingestion on gut function and integrity in gilthead seabreams (*Sparus aurata*). Fish were distributed in three experimental groups and fed for 21 days with different diets, containing 0, 25 or 250 mg kg^{-1} b.w./die of PS (1-20 μm), respectively. At the end of experimental time, the biometric parameters from each fish were determined. The cranial and caudal portions of intestine were then collected for molecular and biochemical analysis. Firstly, PS exposure caused a reduction of Fulton's condition factor indicating an adverse effect on the physiological fish growth and health status. PS increased mRNA expression of pro-inflammatory cytokines (i.e., $p<0.05$ for COX-2 and IL-1β) and decreased that of anti-inflammatory ones (i.e., $p<0.01$ for IL-10). PS stimulated local innate immune response and the induction of cytokines through the activation of Toll-like receptors and MAPK pathways. PS also caused an increase in nitrosylated proteins expression and ROS production. Finally, PS reduced mRNA expression of tight junction proteins (i.e., zonula occludens-1, occludin and tricellulin) in caudal intestine. These results suggest that PS causes intestine injury with inflammation, oxidative and nitrosative stress and the impairment of gut barrier integrity in seabreams compromising fish health.

Acknowledgement: Financial support by Italian Ministry of Health is acknowledged (IZS ME 06/19, CUP no. C75J19000170001).

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A MATTER OF SIZE: TOWARD AN EFFECT-BASED APPROACH FOR MICROPLASTICS RISK ASSESSMENT

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Microplastics (MPs) are ubiquitously distributed, representing a worldwide threat for marine ecosystems. However, from the generic definition of MPs, it is now necessary to move toward a more detailed differentiation, understanding the influence that the great variety of sizes, shapes and polymers might have on biological effects and risk induced by these particles on marine organisms.

To this aim, molecular pathways and cellular processes were investigated in Mediterranean mussels, *Mytilus galloprovincialis,* exposed to polyethylene-MPs of five different size classes: (XS, 20-50 µm; S, 50-100µm; M, 100-250 µm; L, 250-500 µm; XL, 500-1000 µm). After 10 days of treatment at 1000 particles/L, a wide panel of biological alterations were assessed in hemolymph, gills and digestive gland, including immunocytes subpopulations composition and functionality (phagocytosis and lysosomal alterations), cholinergic system, onset of DNA damages, antioxidant defenses, oxidative damages and lipid metabolism.

Obtained results were elaborated with a Weight of Evidence (WOE) approach, which allowed to synthesize the overall hazard associated to MPs of each investigated size-class based on toxicological relevance of biological endpoints and magnitude of observed variations.

Several biological traits were shown to be affected through intricated mechanisms, with particles smaller than 250 µm triggering the most numerous and pronounced variations in terms of redox homeostasis and neuro-immune responses.

The overall results confirm the utility of integrative indices to strengthen our knowledge on MPs, and the importance of a risk-based approach accounting for different characteristics of MPs when evaluating their impact in marine ecosystems.

MODEL NANOPLASTICS FOR ENVIRONMENTAL ASSESSMENT

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The environmental relevance of nanoplastics (NPs) used in laboratory experiments has been recognised to be very important for obtaining reliable results and a better understanding of their impact on living systems. In this work, a top-down approach has been developed to produce model polyethylene terephthalate (PET) nanoplastics with polydisperse size and irregular shape and surface [1]. The obtained PET NPs are also characterized by the absence of dispersant agents or chemical solvents. Their size distribution and morphology have been characterized by laser diffraction and atomic force microscopy.
Moreover, the autofluorescence of PET nanoplastics, which is a key property for the evaluation of their interaction with biota, has been studied by spectrofluorimetry and optical fluorescence imaging. The emission spectra of label free nanoplastics have been found to be comparable with those of nanoplastics labelled with Nile Red, a wellrecognized fluorescent dye for polymers [2]. Finally, the suitability of label free nanoplastics for biological studies has been assessed by in vitro exposure experiments with *Mytilus galloprovincialis* hemolymphatic cells. The obtained results underline that the autofluorescence of the model PET nanoplastics produced in the laboratory is adequate for biological studies having the potential to overcome the disadvantages commonly associated to several fluorescent dyes such as the tendency to stain also other organic materials different from plastics, to form aggregates due to intermolecular interactions at high concentrations with a consequent decrease in fluorescence intensity and to dye desorption from nanoparticles.

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WET AND DRY DEPOSITIONS FROM AN URBAN AREA OF VENICE, ITALY

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The atmosphere is considered one of the most important pathways for the transport of microplastics (MPs) from urban areas to far and remote places [1,2]. Atmospheric depositions consist of dry and wet depositions, and it may be a positive driver in atmospheric pathways of MPs, especially for the smallest particles (SMPs < 100 µm), since they are considering the current scavenging mechanisms for aerosol particles. However, there is a lack of knowledge on the amount and relative pathways of these emerging pollutants in atmospheric depositions, including sampling, pretreatments, and analytical techniques for their quantification and chemical identification. Further, additives and plasticizers can be leached from MPs and SMPs in depositions and they can be transported through different environmental compartments contributing to potential toxic effects on different organisms [3]. In this study, SMPs, additives, plasticizers, natural and non-plastic synthetic fibers (APFs), and of other components of micro-litter were investigated in wet and dry depositions from an urban area of Mestre (Venice-Italy). A wet and dry deposimeter was used for the sampling procedure with glass decontaminated buckets. A pretreatment method was developed for the quantification and chemical identification of both SMPs and APFs using a MicroFTIR to avoid further degradation/denaturation of these compounds. From the results, the removal efficiency of wet deposition in terms of the total SMPs and APs from the atmosphere is higher than in dry periods due to the scavenging effect. The consequence of this atmospheric removal by precipitation is the main sink for SMPs and APs on the ground with consequences in aquatic and terrestrial compartments. Different sources from the urban area could affect the abundance and distribution of SMPs and APs. Different APs investigated could be a good proxy of SMPs presence in the environment, for instance, road dust resuspension.

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DETECTION OF MICROPLASTICS IN MARINE SEDIMENTS: RESULTS FROM THREE ITALIAN COASTS

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The presence and dangerousness of microplastics (MPs) in aquatic environments is universally recognized. The MPs criticalities are tied to their small size (less than 5mm), which make most of the treatment processes used for other waste ineffective, to their persistence and poor degradability and to their presence in large and ever-increasing quantities.
This research deals with the separation and identification of MP particles present within sediments of sea sand sampled in three different Italian coasts: Imperia (Liguria), Metaponto (Basilicata) and Villa San Giovanni, (Calabria). Comparison between sediment sampled from less frequented beaches and tourist ones were made too, to verify the relation with tourism or any other sources of MP pollution. The complexity of collecting and analyzing real sample, the proper counting and recognition of all MPs in the sample were deeply discussed.
The importance of grain size classification and separation was highlighted [1]. The density separation method with saline solution (NaCl) was used to analyze the samples. In addition, a $CaCl_2$ solution was tested to separate MP particles with higher density. Electrostatic separation method was tested too, separating the conductive fraction to the non-conductive (containing MPs) one. An increasing of MP content/g of sediment was obtained comparing the non-conductive fraction with samples subjected to densimetric separation with NaCl solution (reaching also a 82% of variation). This method could be used to reduce the volume of samples, optimizing the MP identification and counting; however, other tests could be carried out in the future taking into account that a loss of material due to the apparatus should be considered. Visual identification under microscope with a UV lamp was used to identify and count fluorescent MPs particles [2][3], subsequently verified with spectroscopy analyses using FTIR.

Acknowledgement: The authors wish to thanks all people helped them during the various stages.

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THE QUALI-QUANTITATIVE EVALUATION OF PLASTICS IN 7 WATERCOURSES OF THE METROPOLITAN CITY OF MILAN (N. ITALY) AND THEIR ECOTOXICOLOGICAL CONSEQUENCES

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The evaluation of the ecotoxicological effects of the so-called emerging contaminants, which are currently also considered microplastics (MPs) and nanoplastics (NPs), can not disregard, at least initially, the experiments carried out at laboratory conditions that are able to highlight their possible capability to enter organisms, the ability to be transported to different body districts, any possible negative effects and the mechanism of action, without the interference made by the changing environmental conditions. However, the experiments in the laboratory performed with different biological models exposed to MPs and NPs often lack the ecological realism, as they are conducted with a single polymer of a single shape and size and at concentrations even greater than a few orders of magnitude than those measured in aquatic ecosystems [1]. In this context, the aim of this study was to collect different plastic mixtures in 9 sites located in 7 watercourses within the metropolitan city of Milan (N. Italy), one of the most anthropized and industrialized European areas, to evaluate both their qualitative and quantitative characteristics and, at the same time, to assess their ecotoxicological effects.
Plastics were collected by two twin plankton nets (100 μm of mesh) in each sampling station. The two samples were used both for the qualitative and quantitative evaluation of the plastic mixtures by a Fourier-Transform Infrared spectrometer coupled with an optical microscope (μFT-IR) and for the evaluation of their potential toxicity by exposing in laboratory for 7 days some specimens of the freshwater bivalve *Dreissena polymorpha* to the plastic mixtures collected in each sampling site.
The main results of monitoring highlighted that the contamination of plastics of the two watercourses of natural origin (R. Olona and Lambro) was much higher than levels detected in many European rivers. Furthermore, we observed that plastics derived mainly from a secondary origin, produced by the fragmentation of plastic objects ended in watercourses, as only in three sampling stations we found a prevalence of plastic debris of primary origin.
The suite of cellular and molecular biomarkers used to assess the toxicity of the 7 plastic mixtures showed only a low toxicity and a mild effect on oxidative stress and on the variation of some antioxidant enzymes, despite the high levels of plastics measured with the monitoring campaign.

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MICROPLASTICS ARE UBIQUITOUS IN THE MARINE ECOSYSTEM: AN INTEGRATED ASSESSMENT IN WATER, SEDIMENTS AND BIOTA.

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This study aims to assess levels and typologies of MPs occurring in the North Tyrrhenian Sea (Mediterranean Sea), an area particularly affected by MPs pollution, integrating analysis of surface water, water column, sediments and biota. Samples were collected during a sampling campaign promoted by Greenpeace Italia, in summer 2020 from sites characterized by different level of anthropogenic pressure (ports, river mouths, MPAs). Traditional devices were adopted to collect sea surface water samples (i.e. Manta net, 330µm mesh size) and sediments samples at depth ranging between 10 and 20 meters (i.e. Van veen grab). In addition, a sequential filtering device (300-100-20 µm mesh size) was used to filter water at different depths (from 5 to 10 meters). Wild-caught and farmed organisms were collected in collaboration with local fishermen, selecting species from different habitats and trophic habits. MPs characterization has been supported by (micro) ATR-FTIR analyses. Results highlighted significant differences in MPs concentration along the water column, varying from 0.05 to 4.15 items/m^3 in surface water, from 4 to 253 items/m^3 in the 5-10 m layer, and from 7.75 to 53.59 items/Kg in sediment. The majority of particles were in the range 1-3 mm in all samples with an increase proportional to depth; microfibers were the most abundant shape in water column and sediment (98%-55%), compared to surface water (10%).
As regards ingestion, an average of 2 MPs/specimen was reported for 40% of analyzed organisms. Most MPs extracted from tissues were in the size range of 500-100 µm and microfibers were confirmed also in the biotic compartment as the most frequently typology accounting for 88% of total MPs.
This study confirms the vulnerability of the Mediterranean Sea to plastic pollution and suggests the need to perform surveys including different marine compartments to achieve a reliable monitoring strategy for MPs in marine environment.

Acknowledgement: This work was supported by the JPI Ocean Project RESPONSE - Towards a Risk-Based Assessment of Microplastic Pollution in Marine Ecosystems and the PRIN Project EMME - Exploring the fate of Mediterranean microplastics: from distribution pathways to biological effects

ENZYME MIMICS FOR NANOPLASTICS DEGRADATION

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The issue of environmental pollution by microplastics and nanoplastics requires urgent action, however, often the approaches used for the former are unsuitable for the latter. As an example, filtration methods typically are not efficient at capturing nanoplastics. In our group, we are developing supramolecular systems based on the self-assembly of minimalistic peptides that exploit both L- and D-amino acids at specific positions to guide self-assembly and fine-tune the biodegradation rate and hence the lifetime of the assemblies and of their constituents.
In particular, we have identified a tripeptide sequence that is capable of forming nanofibers in water that, at higher concentrations, entangle into a hydrogel matrix, yielding a soft material that is thermoreversible[1]. This tripeptide, only in its assembled state as a nanostructure, is able to mimic a hydrolytic enzyme and catalyze the degradation of an ester[1]. Further studies revealed that the amidation at the C-terminus is a favourable modification, whilst N-acetylation has detrimental effects on the catalytic activity[2]. Furthermore, the presence of a primary amine at the N-terminus can undergo undesired reactions[3], and the simple addition of another amino acid from an enzyme catalytic triad is not always sufficient *per se* to improve the catalytic activity[4].
These studies are the beginning of our journey towards the development of hydrolytic enzyme mimics through the self-assembly of simple biomolecules into smart materials that do not persist in the environment, and future studies will be devoted to their improvement and fine-tuning towards the degradation of nanoplastic polymers.

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METALS IN PLASTIC DEBRIS FROM SPANISH MEDITERRANEAN BEACHES WITH DIFFERENT ANTHROPOGENIC PRESSURE: ARE THESE PARTICLES POTENTIAL MONITORS FOR METAL POLLUTION?

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Metal concentrations have been quantified in plastic pieces collected from four beaches located in the Mediterranean coast of Spain with different characteristics (i.e. anthropogenic pressures). Several sections of the beach were sampled (i.e. coastline, middle beach and upper dunes). After an acidic extraction, metal levels in the samples were measured for by ICP-MS. In addition to the metal content, plastics have been classified according to their characteristics such as polymer type, color or state of degradation. These characteristics have shown to influence the adsorption capacity of metals by plastics. Some preliminary results have shown that aged and dark colored plastics accumulate higher metal levels probably associated to plastic surface modification. In addition, significative differences in metal accumulation has been observed for each polymer. Finally, the most anthropized beaches (i.e. mining or industry) showed, in general, higher levels of metals such as As, Cd, Pb or Zn. This work shows that metal content in plastics can give an idea about the pollution degree of the area where these plastic pieces have been collected. Therefore, this study is a contribution to the potential use of plastics as pollution monitors.

Acknowledgement: The authors thank to CESAM for the financial support (UIDP/50017/2020 + UIDB/50017/2020 + LA/P/0094/2020), through national funds of FCT/MCTES. Thanks are also due to financial support from the Portuguese Science Foundation (FCT) through one doctoral scholarship (PD/BD/143086/2018 attributed to Joana Patrício Rodrigues) under POCH funds, co-financed by the European Social Fund and Portuguese National Funds from MEC. This work was carried out within the SEEME project (PID2019-109355RA-I00, MICIU/AEI/FEDER, EU) supported by the Spanish State Research Agency (AEI) and the Ministry of Science, Innovation and Universities (MICIU).

MARINE LITTER: ARE THERE SOLUTIONS TO THIS GLOBAL ENVIRONMENTAL CHALLENGE?

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Plastic debris is widely distributed at the sea surface, on the sea bed and on shorelines. Nearly 700 species are known to encounter marine litter, with many reports of physical harm resulting from entanglement in and ingestion of plastic. At the same time it is very clear that plastic items bring many societal benefits. Can these benefits be achieved without emissions of waste to the environment? Progress requires systemic changes in the way we produce, use and dispose of plastic. A key solution to two major environmental problems, our non-sustainable use of fossil carbon (to produce plastics) and the accumulation waste, lies in recycling end-of-life plastics into new products.

GROUNDWATER: AN ENDANGERED INVISIBLE RESOURCE. MICROPLASTIC POLLUTION IN UNDERGROUND KARST SYSTEMS FROM SURFACE WATERCOURSES TO CAVE WATERS

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Microplastic pollution is a global problem, however, in karst systems is still poorly known [1], especially in underground environments and aquifers, despite groundwater in karst aquifers constitutes about a quarter of the global drinking water sources. We investigated different water samples from a karst area of NW Italy, considering connected surface and underground waters. Spot sampling were carried out in one superficial tributary, in the underground collector of the Bossea cave, and in the riverbed of the Corsaglia stream, where the waters of the collector emerge. Microplastics were extracted from water by filtration and subjected to organic matter removal [2]. Filters were observed with and without UV light under a microscope and microplastics were characterized according to shape, colour, and size, with visual identification. Finally, spectroscopic analysis were carried out on 10% of the microplastics observed on each filter. The observed concentration of microplastics in the water of the tributary is of 23 items/L, in cave water varied from 12 to 54 items/L, while in the Corsaglia stream is of 29 items/L. Fibres represented the most abundant shape (95.1%) and most of microplastics were smaller than 1 mm (82.9%). The highest microplastic abundance was fluorescent under UV light (77.4%). Most fluorescent particles were transparent (46%), whereas black microplastics (68%) were more common for the nonfluorescent ones. Polyacetylene (51.7%) and PolyVinyl Alcohol (37.9%) are the main types of microplastics found. Our results highlight the presence of microplastics in karst water systems, from superficial waters to underground one, and provide useful information for evaluating the environmental risks posed by microplastics in karst waters. It must be considered that karst aquifers are open systems, even susceptible to contamination by surface pollutants, and therefore, the superficial areas must be monitored too. Karst areas conservation should become a priority for the management of water resources.

Acknowledgement: The authors are grateful to all people gave them advice, suggestions, supported them during monitoring and to Raw Materials Lab team of the Politecnico di Torino. This work was realised within the research project SHOWCAVE [PRIN 2017, Prot. 2017HTXT2R].

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VERTICAL DISTRIBUTION AND TRANSPORT OF TEXTILE MICROFIBERS (MFS) IN THE MEDITERRANEAN WATER COLUMN

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Microfibers (MFs) are ubiquitous in natural environments and are considered as an anthropogenic litter that has become a global concern. Approximately 2 million tons of MFs are released into the ocean every year and once in the marine environment, it can be hypothesized that their accumulation and transport are largely controlled by oceanographic processes. We collected water column samples for MFs separation and polymeric characterization at 38 stations located in the Central-Western Mediterranean Sea (down to 3465m). The aim of our study was to investigate MFs distribution in different water masses and the transport through different Mediterranean basins. MFs were detected in all samples with a median concentration of 3.8MFs/L (IQR: 3.1MFs/L) and a median fiber length and diameter of 1023µm (IQR: 1007µm) and 15µm (IQR: 3µm) respectively. Polymeric analysis highlighted cellulosic-based fibers as the dominant polymer (85%) over synthetic fibers (5%) and processed cellulose (8%), while animal fibers were detected occasionally. MF concentration was locally characterized by vertical variations according to water masses, and by changes in size, with surface and deep fibers being longer and larger than mid-water fibers. Mediterranean surface waters showed homogeneous MF content (range 3.0-4.9MFs/L), while intermediate and deep waters were characterized by two opposite trends. Intermediate-waters showed decreasing MFs concentration moving from the Eastern to the Western Mediterranean basin (9.6-1.6MFs/L) while MF content increased in deep waters at the same stations (3.7-9.1MFs/L). Along the Sardinia Channel, we estimated a negative MF flux of 6 X 1013MF/day entering the Tyrrhenian Sea at intermediate depths, and a positive flux of 12 X 1013MF/day in the deep-water mass. We also estimate a 10-fold flux of synthetic fibers leaving the Tyrrhenian Sea, compared with the daily inflow. Our findings suggest that: i)there is a predominant MFs input on surface waters by atmospheric deposition; ii)MFs vertical distribution is size-dependent; iii)MFs transport between Mediterranean basins is mediated by Levantine waters; iv)a potential export of MFs to deep waters occurs in the Tyrrhenian Sea.

EVALUATION OF THE ROLE OF PLASTIC AGING ON THE SORPTION OF PESTICIDES AND PHARMACEUTICAL SUBSTANCES ON MICROPLASTICS

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Microplastics' sorption capability has been studied over the last decade to better understand the potential impacts that they have on the ecosystems and human health. However, the role of plastic aging, in which the polymer's physical and chemical properties are changed due to exposure to environmental agents, such as weathering, has been overlooked. Consequently, there is a need to explore the role of the aging processes in the interaction of microplastics with other pollutants, and the potential risk of an enhanced capacity of microplastics carrying co-occurring pollutants between environmental compartments and ecosystems. Thus, the main goal of this study was to evaluate the changes in the sorption capacity after aging microplastics of LDPE – low-density polyethylene, PET – poly(ethylene terephthalate), and uPVC – unplasticized poly(vinyl chloride). Through sorption experiments, virgin and aged (by ozone exposure or 3 months of rooftop weathering) microplastic particles of the three polymers were exposed to ten organic contaminants (pesticides or pharmaceutical substances) at trace concentrations, including both priority substances and contaminants of emerging concern. The results show increased sorption of these contaminants on the microplastic particles, which is dependent on the affinity between each polymer and organic contaminant, and the effectiveness of the aging treatment. A better understanding of the interaction between these different pollutants was reached due to the analysis of the sorption experiments results when accounting for modifications of the chemical structure, surface morphology and/or crystallinity of the microplastic particles identified after the aging processes. This study supports the hypothesis that microplastics can be transport vectors for other pollutants and demonstrates the major role of the aging degree in the sorption process. Thus, it provides further evidence of the pressing need to study microplastics in more realistic conditions, in which they undergo aging and interact with other pollutants.

Acknowledgement: This work was financially supported by: LA/P/0045/2020 (ALiCE), UIDB/50020/2020 and UIDP/50020/2020 (LSRE-LCM), funded by national funds through FCT/MCTES (PIDDAC). M.N.M. acknowledges the PhD research grant from *Fundação para a Ciência e a Tecnologia* (FCT) (Ref. PD/BD/137730/2018, extended by COVID/BD/152633/2022), funded by national funds and by the European Union (EU) through the European Social Fund (ESF).

TRANSFER OF ^{14}C-PCB-153 FROM MPS TO ADULT P.LIVIDUS

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This work reports reports for the first time a microplastic-mediated transfer of the most abundant PCB congener in marine biota (i.e., PCB-153) into adult specimens of the sea urchin *P.lividus* using radiotracer techniques. Three experiments were conducted to determine whether ^{14}C-labeled PCB-153 adsorbed onto negatively buoyant MPs (500-600 μm) is bioavailable to the sea urchin over 15-day experimental period. The experiments were as follows: (1) exposure to a low concentration of ^{14}C-PCB-153 sorbed onto a high number of virgin MPs; (2) exposure to a high concentration of ^{14}C-PCB-153 sorbed onto a relatively low number of virgin MPs; and (3) exposure to a low concentration of ^{14}C-PCB-153 sorbed onto a relatively low number of aged MP. Results showed that the transfer of ^{14}C-PCB-153 from MPs to *P. lividus* occurred in each of the three experiments, suggesting that MPs effectively act as vectors of PCB-153 to benthic species even during relatively short-term exposure events.

Acknowledgement: The authors would like to acknowledge financial support for the conduct of the study from the governments of the USA, Sweden and the UK under the IAEA's Peaceful Uses Initiative (PUI). The IAEA is grateful for the support provided to its Environment Laboratories by the Government of the Principality of Monaco. This study was supported by the IAEA, the Marine Biology Laboratory of the Université Libre de Bruxelles and by the Fonds National de la Recherche Scientifique, Belgium (FNRS grant n°40004399).

SELECTION OF PATHOGENIC FUNGI BY MICROPLASTICS IS LINKED TO THEIR GENERIC VIRULENCE

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Microplastics (MPs) are emerging as selective microhabitats for soil fungi with yet elusive implications for humans and nature. To tackle the role of microplastic in the ecological and epidemiological dynamics of fungi in terrestrial systems, it is necessary to disentangle the architecture and assembly mechanisms of soil (micro)plastisphere mycobiomes. Therefore, neutral community model and co-occurrence network analysis were applied to ITS sequence data derived from metabarcoding of epiplastic and soil fungal communities from municipal hotspots of plastic pollution from Siaya, Kenya. The community model revealed an interplay of deterministic and stochastic processes that structured a diverse plastisphere metacommunity, while estimated networks indicated biotic interactions and key players (keystone taxa) prevalent in the plastisphere mycobiome. By linking a newly implemented, model-derived index of selection to annotated trait data, including generic virulence scores of contained fungal taxa, we could infer correlations and postulate adaptations toward a plastiphilic lifestyle for different phylogenetic and ecological groups of fungi. Ultimately, we provide insights into the role of MPs as ecological niche of pathogens and evolutionary training ground for virulence and discuss the scope of these environmental phenomena in an increasingly MP-polluted world.

MICROPLASTICS: WHAT CAN WE LEARN FROM NATURAL SEDIMENTS?

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While detailed understanding of the fate of microplastics in the aquatic environment remains scarce, extensive research on mineral sediments can provide valuable insights for future microplastics research. Therefore, we have analysed the comparability of microplastics with natural sediments regarding their particle properties, transport processes, sampling techniques and ecotoxicology in an interdisciplinary review paper [1]. Based on the literature review, we identify seven research goals that should be focused on in the future to enhance our knowledge on microplastics in the aquatic environment.

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INTELLIGENT HOLOGRAPHIC FLOW CYTOMETERS FOR IDENTIFYING LABEL-FREE MICROPLASTICS IN HETEROGENEOUS WATER SAMPLES

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Marine environment is severely flooded with an immense amount of microplastics particles (MPs), causing serious consequences on nature and humans. Although MPs identification is a fairly common goal, conventional protocols for easy detection are still lacking. Here, we present how we rely on Digital Holography (DH) [1] empowered by artificial intelligence for MPs recognition. The interferometric nature of DH microscopy allows to obtain quantitative features, morphological measurements and flexible refocusing, pivotal for distinguishing them in a microfluidic approach. We classify MPs and marine algae, i.e. different diatoms species, thanks to the discriminative power of holographic features, extracted from DH images [2], performing a SVM multi-classification. We demonstrate to manage diatoms heterogeneity, with respect to MPs types, by applying fractal geometry analysis to the holographic maps, thus improving our capabilities of describing phase-contrast patterns of both MPs and diatoms [3]. The robustness of fractal features allows the SVM to binary classify MPs and diatoms with high accuracy. Furthermore, we implemented a polarization-resolved DH flow cytometer to retrieve birefringence information of MPs samples, in order to reach material-specificity. The polarization state of light that impacts MPs samples can vary according to their anisotropic properties, allowing the application of the Jones formalism [4-5]. Developing a DH compact system on a Lab-on-Chip (LoC) assembly, strengthened by Machine Learning could be a complementary procedure to counteract plastic pollution.

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PLASTIC POLLUTION AND MARINE LITTER MONITORING FOR GLOBAL POLICY AND ACTION

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The Global Partnership on Marine Litter (GPML) is a multi-stakeholder partnership that brings together all actors working to address plastic pollution and marine litter. By providing a unique global platform to share knowledge and experience, partners can work together to create and advance solutions to this pressing global issue. The GPML Digital Platform on Plastic Pollution and Marine Litter drives transformation and supports the work of the GPML Action Tracks. The Digital Platform is multi-stakeholder and partly open source, compiling and crowdsourcing different resources, integrating data and connecting stakeholders to guide action on addressing the global problem of plastic pollution and marine litter.

Monitoring global plastic pollution and marine litter and understanding its transport are key pillars for setting realistic reduction targets. Integrating plastic pollution and marine litter monitoring at the global level is thus central to contributing to the Digital Platform and supporting the implementation, adjustment, and evaluation of plastic pollution reduction policies.

The goal of the Data Hub of the Digital Platform is to offer a coordinated point of access for data and information across the full plastic lifecycle, from source to fate, to enable discovery, access, and effective decision-making by stakeholders, on global, regional, national, and local scales. Key objectives include curating existing information, investing in standards and consistent methodologies, adding value through analysis and decision support tools, and supporting and networking communities including through Communities of Practice.

ENVIRONMENTAL IMPACT OF INNOVATIVE MICROPLASTICS FILTRATION SYSTEM FOR WASHING MACHINES & MARINAS

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The Mediterranean coastal zones are densely populated with 427 million inhabitants, attracts 25% international annual tourist trade, where 30% of global shipping traffic passes through the Mediterranean Sea [1]. The high activity in the region, its topography, and a lack of efficient waste management in many countries, have led to the accumulation of plastic debris in the Mediterranean Sea. Published studies report that plastic dominates in the marine litter [2], where 83% of plastic items in samples collected are microplastics [3].
Studies show that 36% of global microplastic pollution comes from washing clothes [4], >9% comes from ship-based losses [5]. The greywater released from cruise ships bears the highest microplastic concentrations. Clera.One's chemicals-free water recycling system enables the reuse of greywater and stops the discharge of microplastics. Its innovative membrane allows a high-water permeation and flow while maintaining low pressure, with membrane pores only 0.01 microns in size. The purified effluent water is organoleptically cleaner than tap water and can be reused in all washing processes for industrial purposes. Instead of common linearly aligned filters with higher energy and spatial footprints, the proposed system provides a synergistic, automated innovation that enables the removal of microparticles –5mm to 0.10 microns, using 70% less energy. The water recycling system can be retrofitted to reuse wastewater in all laundry systems, vessels washers, and cruise systems. Clera.One's device shows to retain 90% of microplastic and enables 70% wastewater reuse.
In this work, environmental impact assessment is performed using OpenLCA software with integrated databases. The obtained results comparatively show how the technology is less burdensome to the environment.

Acknowledgement: The authors would like to acknowledge financial support from the Slovenian Research Agency (project No. J7-3149 and core research funding No. P2-0412).

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INNOVATING SOLUTIONS TO PLASTIC POLLUTION: THE JOURNEY TO NEW PRODUCT LINES REDUCING / CAPTURING MICROPLASTICS IN BOTH DOMESTIC AND COMMERCIAL WASHING MACHINES

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In 2016 public and media pressure spread rapidly in response to microbeads being added to toothpastes, creams, and lotions[1]. The repercussions were swift, and bans were brought into place with a definition of microplastics being <5mm in size, to also cover nurdle pollution of our oceans[2]. In this wave of microbeads awareness, the topic of microplastics was also brought up as an impending global issue. Several hundred thousand microplastics were shown to be released from fleece (polyester) garments during each wash in washing machines[3]. Due to the slow degradation of polyester in the environment[4] and rapidly increasing quantities of polyester fibres used in the textile industry[5], the concentration of microplastics in our oceans is only increasing.

Xeros Technology Group was founded on the use of XOrbs™ (polymer spheres) in commercial washing machines to reduce the use of water, energy and chemicals, alongside improving wash performance and extending linen lifetime when compared to a conventional machine. As awareness grew of microfibers, we asked ourselves if our innovative XOrb technology could be contributing to this pervasive pollution? Our research found that the XOrbs gentle action on fabric was decreasing microfiber release, but for Xeros that was not sufficient. We needed to develop a filtration device that could capture a significant volume of the microfibers being shed from garments during the wash process. Through collaboration and innovation in our engineering and scientific teams our filtration technology XFilter was born.

Washing machines with our XOrb™ technology installed reduce the level of microfibres released during the wash and our filtration devices have a high capturing rate of microplastics and microfibres in general.

Acknowledgement: To all current and previous employees of Xeros.

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TOWARDS A µ-PLASTIC-FREE OCEAN: GREEN PHOTOCATALYSTS FOR MITIGATION OF MICRO- AND NANOPLASTIC MARINE POLLUTION

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The presence of microplastics (MPs, ⌀ = 1 µm – 5 mm) or nanoplastics (NPs, ⌀ < 1 µm) in the ocean is one of the most pressing environmental issues that our society faces. MPs and NPs cause health issues to the biota that consumes them and are transferred throughout the tropic chain up to humans. Formerly, it was assumed that ocean behave as MPs' reservoir. Now, it is known that MPs are released back into the atmosphere, cycling through the earth similar to global biogeochemical cycles. Since all the MPs and NPs present in the ocean were first produced in upstream processes, reduction of MPs inputs through management before they introduction to aquatic ecosystems is the best option to protect the ocean. Photocatalysis is a water treatment process that can be used to reduce MPs pollution. By photocatalysis, MPs and NPs can be transformed to CO_2 and H_2O or organic substances that act as C sources for living organisms. If the photocatalyst is prepared using renewable feedstocks, the overall process becomes a green technology. In this research, the Vis light photocatalysis of polyethylene (PE), polystyrene (PS) and polyethylene terephthalate (PET) MPs and NPs was investigated using N-TiO_2, C,N-TiO_2 and C,N-TiO_2/SiO_2. The photocatalysts were using proteins from *Mytilus edulis* mussels as renewable dopant agents. Photocatalysis was performed in aqueous medium and the influence of pH, temperature, MPs' size and shape and the semiconductor's form (powders or films) on the removal process was tested. The removal was monitored by gravimetry, FTIR, SEM-EDS and TG/DSC. It was found that MPs removal can reach values of up to 70% in 50 h of reaction. All the variables influenced degradation. This information can guide the design of photocatalytic systems that reduce MPs pollution.

Acknowledgement: E.I.C.G. thanks CONACYT's grant PN2017-5167 for the support for this research.

CELLULOSE MICROBEADS, A SUSTAINABLE ALTERNATIVE TO MICROPLASTICS FOR INDUSTRIAL AND CONSUMERS APPLICATIONS

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Microplastics are intentionally added to many industrial and consumer products because they fulfill multiple functions: sensory agents and film formers in cosmetics, structuring and matting agents in paints, additives for fluids in the oil and gas industry, fillers in composites, microcarriers for enzyme in biocatalysis and more.
These microplastics at the end of their working life end up in wastewater treatment plants or landfills and from there in the oceans and in the soil where they persist for centuries because plastic is not biodegradable. The impact of microplastics on the environment and human health is just starting to be evaluated with studies reporting of microplastics being found in human blood and lungs.
For this reason, environmental groups have lobbied governments to ban plastic microbeads starting from rinse-off products, e.g. shampoo, toothpaste. Partial bans are currently active in US, UK, Canada, China and few other countries, but plastic microbeads are still used in hundreds of products. The European Chemical Agency is considering banning plastic microbeads in all applications, including cosmetics, paints, coating, oil and gas, agriculture and horticulture.
Naturbeads, a spin-off of the University of Bath, is commercializing biodegradable, plant-based microbeads as an easy drop-in replacement for plastic microbeads. Our microbeads are made 100% of cellulose, a natural biopolymer, engineered by nature to be chemically, thermally and mechanically resistant and yet 100% biodegradable. Naturbeads technology is based on the process developed at the University of Bath [1] to transform cellulose from its natural fiber form into spherical cellulose beads without the addition of plasticizers.

Acknowledgement: The Authors would like to acknowledge the University of Bath for the use of the laboratory and facilities and Innovate UK for financial support.

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Abstracts
Poster sessions

DETERMINATION OF OPTIMAL CONDITIONS FOR BIODEGRADATION OF POLYSTYRENE BY BACTERIA

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Microplastic particles at size lower than 5 mm represent global environmental problem according to their long lasting in the environment and impact on aquatic organisms through bioaccumulation and biomagnifications [1]. Due to this, further researches are focused at finding adequate solutions for its removal from the environment. Potential solutions are biological processes, e.g. bioremediation, as an economical, efficient and environmentally friendly process, which involves the use of microorganisms in the purpose of removing pollutants from the environment [2]. In this study, biodegradation of polystyrene (PS) by two bacteria *Bacillus cereus* and *Pseudomonas alcaligenes* was investigated. Firstly, crucial factors that influence on biodegradation of PS were performed according to Taguchi design. During 30 days of experiments, 7 factors at 2 levels were investigated. According to the first set of experiments, optimal biodegradation conditions were determinate by Full Factorial design. In order to analyze influence of the examined factors, RSM methodology was applied. The number of living bacterial cells was used as response parameters. However, the aim of this study was to examine the possibility of biodegradation of microplastics by bacteria isolated from microplastic-enriched environmental samples. The use of environmental bacteria for biodegradation of microplastics, the determination of significant factors influencing the biodegradation process and the determination of optimal conditions for biodegradation are innovations of this research. This paper scientifically contributes to the expansion of existing knowledge about microplastics, since the removal of microplastics from surface systems by bacteria has been studied.

Acknowledgement: The authors would like to acknowledge the financial support of the Croatian Science Foundation through project entitled Advanced Water Treatment Technologies for Microplastics Removal (AdWaTMiR) (IP-2019-04-9661).

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A PILOT TO ESTABLISH CENTRALISED MICROPLASTIC LABORATORY: ANALYSIS OF WATERWORKS IN THE WESTERN BALKAN REGION

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Microplastics (plastic waste <5mm) are more commonly detected in drinking water. However only few studies have been conducted on this topic in the Central Eastern European region and even less in the Balkans. One of the reasons of the lacking information is that microplastic analytical laboratories have high capital expenditure and operational costs. Therefore, it is not effective to build up several smaller laboratories. Based on our concept, a laboratory with its state-of-the-art instrumentation and well-trained experts can act as a regional laboratory for microplastic analysis in the Western Balkans. For this reason, our primary goal was to share sampling experience and to train local engineers for sampling as it is very time consuming and inefficient financially, not to mention environmentally, if sampling is conducted by WESSLING staff from Hungary. This approach is facilitated by the fact that the samples can be stored and do not need special preservation. The study area consisted of three Western Balkan countries (Bosnia and Herzegovina, Montenegro, Serbia). The water utilities involved in the project process water from different sources. We aimed to collect samples at least on two technological steps of the plants to compare microplastic concentrations in raw water and treated water. Samplings have been conducted three times on each designated point, every time 2000 L water was concentrated on 25 µm pore size filters. All together 33 samples have been collected during 4 months. Microplastic particles in the samples have been identified with FTIR imaging technique. Based on the results, it can be concluded that the presence of microplastics was detected in each sample, typically in the range of 1-7 particles/m^3. The most commonly identified material types were polyethylene (PE) and polypropylene (PP). Their higher appearance coincides with their share in plastic production worldwide, as these are the most widely used materials. In addition, the appearance of other materials such as polystyrene (PS), polytetrafluorethylene (PTFE), polyamide (PA) and polyester was also detected to a lesser extent. The water treatment technologies used in the study sites typically seems to reduce the microplastics content of the raw waters. With this pilot study, the concept of the centralized laboratory and sampling by local staff after knowledge transfer is proved to be a viable solution.

Acknowledgement: The project was implemented with the support of the Hungarian Ministry of Foreign Affairs and Trade within the framework of the Water Sector Tender Program. The contents of this document do not constitute the official position of the Ministry of Foreign Affairs and Trade.

MICROPLASTICS IN DRINKING WATER: ITALIAN NATIONAL WORKING GROUP AND ANALYTICAL METHODS

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Microplastics are “emerging” heterogeneous contaminants with a complex toxicological profile. Extremely widespread in water bodies, microplastics have been studied for some time due to the possible effects on human and animal health. Drinking waters could be a potential source of microplastics due to the contamination of surface and ground waters [1]. According to Directive (EU) 2020/2184 [2] on the quality of water intended for human consumption, the European Commission will adopt a methodology to measure microplastics with the aim of including them on the watch-list, a new mechanism created to respond to growing concerns in a dynamic and flexible way. On this basis, the Joint Research Center (JRC) launched a scientific project in order to harmonize experience and knowledge about microplastic analysis in drinking water, requiring support from the national technical-scientific representatives. So, the Italian National Institute of Health (ISS), with the coordination of the Italian Ministry of Health, has defined [3] a national working group which include experts from the National Research Council (CNR), national and local environmental Authorities (SNPA: ISPRA and ARPA), Universities and Water Suppliers (Utilitalia). This group will work on: (i) JRC and EC support on national expertise about microplastic monitoring in drinking water (ii) development of national analytical method for microplastic in drinking water to be presented to the JRC.

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ECOTOXICOLOGICAL ASSESSMENT OF ALENTO RIVER CATCHMENT A FOCUS ON MICROPLASTIC IMPACT

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Human activities often generate contaminants compromising the function of ecosystems. In particular, the worldwide use of plastics and poor waste management have led a global concern due to their wide dispersion in water environments and unclear potential ecotoxicological effects. The effects of these physic-chemical cocktails is still largely unexplored especially for freshwater environments.
This work evaluates the ecotoxicological status of the Alento River, focussing on microplastic (MPs) assessment and evaluating the associated risk.
The Alento River catchment (Southern Italy) represents an interesting case study partly because of the presence of an integrated system of storage dams, the largest being the Piano della Rocca multipurpose earthen dam constructed to regulate water for irrigation, hydropower generation, flood control, and drinking purposes.
A stagional sampling campaign was performed in the main representative sites along the Alento River catchment. A battery of ecotoxicological test with organisms belonging to different trophic levels (bacteria, algae and crustacean) have been used. Besides, MPs occurrence were evaluated in sediments, the initial sink of MPs, and in fish gut samples. After processing, MPs visual characterization has been carried out. Each particle visually identified, was counted, photographed and categorized according to size, colour and morphology. MPs were characterized using the Fourier Transform Infrared Spectroscopy (FT-IR) and Raman. Fibers were the dominant MPs particles from the core samples.
The safety threshold of MPs for protecting the freshwater organism was determined and used to assess the potential ecological risk posed by MPs in riverine ecosystem of Alento.
This work provides an initial assessment of the river contamination impact and the role played by MPs occurrence.

Acknowledgement: This research is carried out within the project FEAMP: MISURA 1.44 - Pesca nelle acque interne e fauna e flora nelle acque interne - art. 44 del Reg. (UE) n. 508/2014. Moreover, this work is also part of the PhD research project of Sara Accardo funded by the University of Naples “Parthenope” and Municipality of Vallo della Lucania and Novi Velia.

HUMAN EXPOSURE TO MICROPLASTICS FROM VARIOUS BEVERAGES IN MEXICO CITY

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Microplastics have now been found not only in various ecosystems but also in food products for human consumption all over the world. In recent years, risks of potential human health have attracted more attention since microplastics have been found in various human foods such as drinking water, table salt and sugar [1-3]. In this study, we investigated the most often consumed beverages by people, such as milk, soft drinks, beer, tea, and metro station free drinking water fountains. The results revealed the significant abundance of microplastics ranging from not detected to 28 ± 5.29 particles/L in softdrinks, beer and tea, respectively, 3 ± 2 to 11 ± 3.54 particles/L in milk and 5 ± 2 to 91 ± 14 particles/L in drinking water fountains. Micro-Raman spectroscopy identified particles as polyamide, poly(ester-amide), acrylonitrile-butadiene-styrene and poly(ethylene-terephthalate) indicating microplastics contamination of synthetic textiles and packaging origin in the beverage products. However in milk samples, thermoplastic sulfone polymers (polyethersulfone and polysulfone) were common types of microplastics, which are highly used membrane materials in dairy processes. The identified microplastics were of various forms (fibers and fragments), sizes (0.1–3 mm) and colors (blue, red, brown, black and green). Combined, it is the first study to investigate microplastics contamination in milk, soft drinks, energy drinks, cold tea and drinking water fountains to document the material composition of microplastics from diverse beverage products in Mexico. While further research is underway, this study data provided a picture of microplastic contamination in various beverages from Mexico and added valuable information in current research area. In addition, the incidences of microplastics in food products for human consumption urge prevention measures to control both primary and secondary releases across the supply chain.

Acknowledgement: Authors thank Joel Alba Flores (DBB, CINVESTAV-IPN) for his help in the experiments. We gratefully acknowledge Luis Alberto Moreno Ruiz and Hugo Martínez Gutiérrez from Centro de Nanociencias y Micro y Nanotecnologías, IPN for their assistance in ATR-FTIR and SEM-EDX characterization of this work.

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COMPACT HOLOGRAPHIC IMAGING AND MACHINE LEARNING FOR MICROFIBERS QUANTIFICATION IN LAUNDRY WASTEWATER

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Microfiber shedding caused by the washing of synthetic textiles is now widely recognized as a major source of primary microplastics in the environment. Recent studies are concentratingon the quantification of microplastics released during a wash, also evaluating the influence of different washing treatments or textile characteristics. Multiple methodologies have been employed to this end. However, it is common to include a step of visual inspection by optical microscope of filtered fibers. This procedure is intrinsically time-consuming and not applicable to continuous monitoring. Therefore, there is a need to advance the instruments and techniques necessary for fast and automated microparticle identification and counting.
In this framework, we present a compact and low-cost holographic microscope, able to analyze microplastic samples dispersed in water and flowing through a commercial microchannel. The use of a microfluidic platform provides the basis for high-throughput and automatic acquisitions. We employ our device to analyze an aliquot of wastewater from a washing test of polyester textiles in a commercial washing machine. We exploit the unique features of Digital Holography to achieve label-free imaging, quantitative phase mapping and the flexible numerical refocusing of flowing samples.
Moreover, we propose an ad-hoc data processing procedure to estimate the microplastic concentration, based on image processing and machine learning techniques. The pipeline consists of an object detector dedicated to the identification of the mobile objects in video sequences, a deep learning module devoted to projecting the detected objects in a low dimensional space and finally a classification step responsible for the classification in one of the two categories “microplastic”/”non-microplastic” that enables the microplastic density estimation in a given water sample. Behind the scenes, the development of the mentioned approach required specific data annotation and training phases. Despite the data unbalancing we obtained an object classification accuracy of 77%.

MICROPLASTIC IN DRINKING WATER: ARE THEY REALLY DANGEROUS FOR HUMAN HEALTH?

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In recent years, microplastic pollution is a serious current topic: these compounds have been used in various production contexts such as healthcare, food or technology thanks to their chemical-physical properties and their "shelf-life", which makes them almost indispensable products in daily life. On the other hand, they have a negative impact on the environment and, consequently, on the health of the biota and humans.
According to the European Directive 2020/2184, it is essential to develop monitoring and prevention strategies focused on site-specific risk analysis according to the provisions of the Water Safety Plans to ensure the monitoring of water resources, and, therefore, to prevent this state of emergency originating from parameters not currently provided by law. [1] Therefore, the prospect of being able to develop a monitoring strategy for these contaminants is important to reduce potential exposure and prevent any health effects.
To this end, the European Community has prepared the need to regulate by 2024 the monitoring of these emerging contaminants to reduce the potential exposure to these substances through water and prevent any health effects, to include them in the "Watch List". In order to optimize an analytical method for the analysis of these pollutants in drinking water, it is essential to evaluate and carry out a correct sampling, estimating the sample volume necessary to guarantee its representativeness but, at the same time, that it respects the operational requirements of sampling and analysis with a view to a future routine. To this end, the actual presence of microplastics in drinking water will be statistically evaluated, through the analysis of real samples, to be able to estimate a possible exposure through the consumption of drinking water and on which to focus a future site-specific risk analysis for protection of health.

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REPRODUCTIVE TOXICITY ASSESSMENT OF ENVIRONMENTAL MICROPLASTICS IN THE MUSSEL *MYTILUS GALLOPROVINCIALIS*

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Plastic debris is currently the most abundant type of marine litter detected in all marine and coastal environments, where they tend to fragment into smaller particles leading to debris with a size smaller than 5 mm diameter, defined as environmental microplastics (EMPs). EMPs have been widely demonstrated to pose a threat to marine biota due to their persistence, ubiquity, small and irregular sizes, types and forms, which renders MPs accessible to a wide range of organisms [1-2]. This study aimed to assess the impact of the EMPs on the reproductive health of the marine invertebrate *Mytilus galloprovincialis*, focusing on the potential effects on male and female gamete quality. Indeed, despite the evaluation of gamete quality in marine species is now an important issue in the ecotoxicological studies looking at the impacts of contaminants on the reproductive health of marine organisms [3]; up to date, it is rarely included in the ecotoxicological assessment of EMPs. Plastics were collected along the Mediterranean beaches, shredded, mixed with an electric crusher, and then grinded to obtain a homogenized mix. Afterward, they were filtered through a 100 µm sieve retaining only particles < 100 µm, which have been tested in the in vitro exposure experiments. Preliminary results indicated that sperm exposure to MPs affected different physiological parameters such as mitochondrial activity and oxidative status, which may influence the sperm fertilizing capability, the reproductive success and, hence, species fitness and survival. Investigating the effects of EMPs on M. galloprovincialis reproduction, this project will provide valuable insights into the environmental risk of marine MPs and their mechanism of reproductive toxicity.

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MICROPLASTICS AND ASSOCIATED PLASTICIZERS: PRESENCE AND DETECTION IN CNIDARIANS USED AS POSSIBLE BIOINDICATORS FOR MICROPLASTIC CONTAMINATION IN MARINE ENVIRONMENTS

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Plastic pollution is a worldwide problem which requires new methods suitable for monitoring such phenomenon. Microplastics (MPs) can threaten marine life in different ways, such as acting as vectors of plastic additives and contaminants adsorbed from the environment. Phthalates (PAEs) are common plastic additives blended with plastic polymers that can easily leach into the environments and become bioavailable to the marine organisms. A possible correlation between MPs exposure and the presence of PAEs was highlighted in different marine organisms. Consequently, PAEs presence was proposed as marker to evaluate MPs contamination of marine environments. Octocorals and anemones are benthic cnidarians with a world-wide distribution. They share different physical traits and, recently, anemones were proposed as bioindicators for the detection of microplastics [1]. Currently, there is no data regarding rates of direct transfer of PAEs into cnidarian tissues based on microplastics exposure. At the “Acquario di Genova” facilities, we investigated the capacity of the soft coral *Coelogorgia palmosa* to interact with MPs through ingestion and adhesion patterns measured at 2 different microplastic experimental concentrations (0.01 g/L – 0.1 g/L). Then we assessed PAEs occurrence in different soft coral species using a novel method for determining PAEs in marine invertebrates, bioSPME coupled with LC/MS [2]. However, on-site, there are different MPs environmental concentrations and PAEs levels are extremely variable in terms of space, time and plastics conditions. Thus, we propose sea anemones of the species *Anemonia viridis* (Forsskål, 1775) and *Actinia equina* (Linnaeus, 1758) as target organisms for monitoring the PAEs presence in the waters around the Sinis Peninsula (Gulf of Oristano, Sardinia) to investigate the possible use of these plasticizers as a marker of MPs contamination in the marine environment.

RANDOM OR NOT? COMPARING MICROPLASTIC INGESTION AND PREYS IN *SCOMBER COLIAS* AND *TRACHURUS TRACHURUS.*

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Microplastics represent a rising threat to marine biota [1,5]. As the fishing industry is a fundamental source of sustenance for human beings [2,3], microplastic ingestion by fish deserves appropriate attention. Despite previous studies suggest that the feeding behavior of different fish species may affect the occurrence and the diversity of ingested microplastic types [4], little is known about the selection mechanisms that determine the pathways of microplastics through the food webs. In this study we combine the characterization of ingested microplastics with the analysis of the diet composition of two pelagic fish species, namely the Atlantic chub mackerel *Scomber colias* and the Atlantic horse mackerel *Trachurus trachurus*. Samples were collected during a single fishing trip carried out in spring 2021 off Anzio coast (Tyrrhenian Sea, Western Mediterranean). After the dissection, samples were divided into two subgroups to be analyzed for diet composition and microplastic analysis, respectively. Gastrointestinal tracts to be analyzed for microplastics underwent alkaline digestion (10% KOH) to degrade the organic matter. Then, solutions were filtered on glass microfiber membranes and subsequently observed under a stereomicroscope. Microplastics were characterized by shape, color, and polymer composition. Stomach contents for diet analysis were observed under a microscope and preys were identified at the lower taxonomical level. The preliminary analyses show that *T. trachurus* makes an active selection of fastmoving preys (mostly Teleosts) and ingest almost only threadlike microplastics, such as fibers and filaments. In contrast, the high frequency of Thaliaceans in *S. colias* reveals a more planktivorous behavior, which is associated to the ingestion of a wider variety of microplastic types (including also film, fragment and foam). These results seem to suggest that the microplastic ingestion patterns observed in the two examined species could be linked to the existing differences between their prey searching modalities.

Acknowledgement: A specific grant to F. Bertasi, L. Grossi, V. Marusso, M. Targusi, B. Trabucco and D. Vani for the active participation to the stomach contents prey identification.

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MAY MESOPELAGIC FISHES PLAY AN IMPORTANT ROLE AS VECTOR OF MICROPLASTICS ACROSS THE MEDITERRANEAN TROPHIC WEB? A CASE OF STUDY IN THE STRAIT OF MESSINA

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Microplastics (MPs) are ubiquitous worldwide in marine environment, from the sea surface to deep waters, and also highly bioavailable to marine fauna by direct or secondary ingestion. To date, plastic ingestion is a concern for the health of marine organisms, but few studies focused on the transfer of MPs across marine trophic levels. MPs ingestion has also been documented in deep environment and specifically in mesopelagic fishes from several areas, including the Mediterranean Sea. However, the role of mesopelagic fish in the MPs' transfer across the marine trophic web is still poorly explored. Mesopelagic fishes have high biomasses and play an important ecological role in the food web, performing diel vertical migrations and providing energy for medium and large pelagic predators (e.g., mackerels, cephalopods, swordfish, tunas).
For this reason, the present paper investigates: i) the MPs ingestion in five mesopelagic fish belonging to the families Myctophidae (*Electrona risso*, *Hygophum benoiti*, *Myctophum punctatum*) and Sternoptychidae (*Argyropelecus hemigymnus*, *Maurolicus muelleri*) from the Strait of Messina; ii) the potential transfer of MPs across the pelagic trophic web mediated by mesopelagic food resources.
Mesopelagic fish stranded on the shore of the Strait of Messina were collected and individuals were measured and grouped into size classes. MPs were extracted from gastro-intestinal tract by chemical digestion and their polymer nature was identified by FT-IR spectroscopy technique. Data on MPs ingestion from mesopelagic fishes were crossed with information on feeding habits of several pelagic predators from previous studies carried out in the same study area. Although the ingestion rate of MPs by mesopelagic fish was low, the analysis of the complex trophic relationships in the study area and the amounts of mesopelagic specimens ingested by predators suggest that the concentration of MPs transferred across trophic levels can reach important orders of magnitude at the higher levels.

MICROPLASTIC FIBER CONTENT IN *MULLUS BARBATUS* FROM THE TYRRHENIAN SEA: PRELIMINARY RESULTS

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The research on the levels and potential effects in commercial fish of microfibres, the most prevalent type of microplastics, are limited although microplastic pollution represents a global problem [1,2]. Benthic fish may be more exposed to fibers than pelagic fish [3]. Therefore, in the light of this information, red mullet (*Mullus barbatus*) was selected as suitable fish species for monitoring microfiber ingestion and the pollution in the study area. Overall, 20 samples of red mullet from the Tyrrhenian Sea (FAO subarea 37.1, division 37.1.3) were examined. After dissecting the fish, microfibers were isolated from the gastrointestinal tract using an extraction method previously validated [4]. Ingested microfibers were then observed and photographed using a light microscope (LEICA M205C) with a magnification of 0.78 – 16x. Potential synthetic fibers were classified from natural according to some morphological characteristics [2].
A total of 274 microfibres were recorded. The percentage of fish with microfibres was 55% of which 90% ingested more than one microfiber. On average, red mullet contained 7.44 microfibers/individual. Visual characterization of fibers by typologies allowed classification of 65% of the items as natural microfibres. The most common colours were blue (43%), transparent (22%), and black (19%).The presence of microplastics in commercially important fish species poses a potential risk to human health [1]. Microfiber ingestion was documented also in other studies on red mullet from different Mediterranean areas [5-7]. Preliminary results on red mullet from the Tyrrhenian Sea showed the prevalence of natural fibers. However, few researchers have pointed to the need of placing importance on natural microfiber, despite they can be as dangerous as their synthetic counterparts [8]. The adopted visual approach may be useful to differentiate synthetic and natural fibers, representing a fast and easy method to gain information about the presence and type of fibrous microplastics in complex matrices.

Acknowledgement: This study was supported by the research project "SIstemi di Rilevamento dell'Inquinamento MArino da Plastiche e successivo recupero-riciclo. SIRIMAP PON_project" from the Ministry of Education, Italy.

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TEMPORAL AND SPATIAL VARIABILITY OF MICROPLASTIC INGESTION BY ZOOPLANKTON SPECIES IN THE GULF OF NAPLES (WESTERN MEDITERRANEAN SEA)

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Evidence of microplastic ingestion by zooplanktonic organisms has been provided by numerous experiments conducted in the laboratory; however, still limited is the number of studies that have analysed this process in the field [1]. The present work, funded by the JPI Oceans MicroplastiX project, aims at assessing the presence and variability of microplastics in zooplanktonic taxa that dominate the neustonic communities in a Mediterranean region heavily affected by anthropogenic impacts.
Zooplankton were collected with a Manta net (330 µm mesh size) in different seasons between 2021 and 2022, in three areas of the Gulf of Naples characterized by different ecological features. In the lab, the samples were analysed for estimating zooplankton abundance and composition and microplastic occurrence. Moreover, numerically dominant zooplankton species were sorted and chemically digested for detecting ingested particles.
More than five thousand individuals, belonging to about 20 zooplankton taxa, have been identified and selected so far, including numerous copepod species, cladocerans, doliolids, and decapod, cirriped and fish larvae. Overall the highest number of ingested particles was 3 mp/individual. Ichthyoplankton, decapod larvae, and copepods were the groups with more numerous particles found in the guts.
The number of microplastics ingested in the neustonic layer was higher in coastal than offshore areas and varied seasonally, reflecting also the spatial and temporal characteristics of zooplankton communities. Our results contribute to better understand the diverse role of small zooplanktonic organisms in entrapping co-occurring microplastics e transferring them to higher predators in the Mediterranean Sea.

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TEMPORAL VARIABILITY OF MICROPLASTICS AND THEIR ATTACHED COMMUNITY ALONG THE CAMPANIA COAST

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Coastal marine ecosystems are continuously exposed to anthropogenic impacts from densely urbanised areas, tourism, and recreational and commercial fishing activities, among others. As microplastics (MPs) are now widely recognized as marine pollutants, it is important to evaluate potential influence of the nearshore dynamics in the understanding of spatio-temporal distribution of floating plastic and its potential effects on the retention of plastics represents currently a gap in knowledge. Similar trends of variability are linked to the community of microbes colonizing the surface of MPs, the so called "plastisphere" (Zettler et al., 2013). Geographic location and environmental parameters appear to be the primary influences shaping plastisphere communities, but studies using environmentally collected samples are rare. We present here a comparison of MP in terms of concentration, together with characterization of microbial plastisphere of environmentally-collected floating MP (< 5 mm) along the Campania region, south Italy, in 2018, 2019 and 2020. MPs were characterized for their chemical composition by Fourier-transform infrared spectroscopy (FT-IR), counted and the attached microbial community was analyzed by DNA amplicon sequencing of 16S rRNA gene hypervariable regions V4 and V5 (Illumina). Biofilm coverage and attached microbes were visualized and quantified by Scanning Electron Microscopy (SEM).
Temporal variability along the Campania region coast was found very high, both in terms of total concentrations and community composition of attached microbes. MPs concentration were more abundant in summer than in winter times along the region, probably due to recreational activities and tourism, and their attached microbial community is strongly shaped by temporal variability highlighting the stochasticity of colonization of microbes. Finally, these data shed light of the importance of repeated sampling to assess MP pollution and its attached community in coastal areas because of complex circulation and multiple terrestrial discharges.

MICROPLASTICS IN SPRING AND RAINFALL COLLECTED FROM SUBTROPICAL REGIONS IN OKINAWA, JAPAN

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Microplastic (MP) pollution is one of the environmental problems that has been attracting attention in recent years. Plastics are washed from the land into rivers by rainfall and eventually into the ocean. Further fragmentation by sunlight and chemicals completes the microplastics [1]. Once added to the water cycle, microplastics do not stay in marine areas but spread to freshwater regions.

Some of the plastic discharged from South and Southeast Asia, a hotspot for marine debris, travels northward through the Sea of Japan on the Kuroshio Current [2,3]. Okinawa Prefecture is one of the first islands reached by this Kuroshio Current. Therefore, while there have been reports on microplastics in the marine surface layer in the waters around the main island of Okinawa, there have been few reports on freshwater areas.

In this study, we collected microplastics and investigated water quality to understand the presence of microplastics in freshwater and rainfall in Okinawa Prefecture. Sampling was conducted once every two weeks from August to December 2021. Precipitation and airborne particle samples were collected at the University of the Ryukyus (N26°8, E127°27). Spring water samples were collected at Kakinohana Higawa (N26°10, E127°47), Ukinju (N26°7, E127°47) and Komesu Beach (N26°4, E127°42). To investigate water quality, biochemical oxygen demand (BOD) was measured using a dissolved oxygen meter (FUSO, JP) and dissolved ions (F^-, Cl^-, NO_2^-, Br^-, NO_3^-, PO_4^{2-}, SO_4^{2-}) using an ion-chromatograph (Thermo Fisher Scientific, UA). After collecting the sample, the sample was separated using the difference in the specific densities of the aqueous sodium iodide (NaI) solution (density: 1.6 g cm^{-3}) and the plastic. The water quality survey results found that microplastics were detected during the period and the point where BOD and phosphate ions exceeded a specific value.

Acknowledgment: This work was supported by the Sasakawa Scientific Research Grant from The Japan Science Society.

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MICROPLASTIC ABUNDANCE, DISTRIBUTION AND CLASIFICATION IN THE SIRIU RESERVOIR - BUZAU RIVER, ROMANIA

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Since the last decade, Microplastic (MP) pollution investigations on riverine – lacustrine systems have raised a high scientific interest due to the gaps in ecological status of these environments. Freshwater reservoirs collect high volumes of litter, especially during high flood periods, accumulating them in the sediments of the adjacent rivers (Castañeda et al., 2014) and inside the reservoirs, on depositional banks, as well as in the surface water layer of the reservoir (Su et al., 2016).
This study presents a pioneer research of microplastic pollution in an artificial lake – river system in Romania. The study area of Siriu Lake – Buzau River is located in the southern area of Eastern Carpathians, where upstream localities comprise a population less than 10.000 inhabitants; in the region low agriculture and tourism activities are reported.
During the flood period (November 2022), 6 water samples, 7 sediment samples and 2 sediment cores (45 cm length) were collected, in order to evaluate the MP pollution degree. Quantification of MPs were performed at NIRD GeoEcoMar laboratory, by microscopic investigations on the samples conclude an average concentration of 3 particles per m^3 of filtered surface water and an average abundance of 268 particles per Kg of sediment. Highest MP concentration were identified in the Buzau River, downstream the reservoir (up to 6 MP/m^3) and in the confluence point of the river with the reservoir (445 MP/Kg). Most of the particles observed in both water and sediment samples are fibers (77.6%), followed by fragments (12.1%), foils (8,7%) and spherules (1.6%). More than half of the particles are black colored, along with blue, green, white/transparent, red and yellow ones.
Qualitative investigations using micro-FT-iR on several polycarbonate and fiberglass membranes identified the main presence of polyethylene, polypropylene, polyacrylonitrile and polyethylene terephthalate.
On-field observations and MP characteristics determined a proximal source of the plastic pollution, as most of the identified particles were generated by macroplastics as bags, products related with domestic construction, vehicle tires and textile items.

Acknowledgement: Financial support was covered by Contract 846c and 847c, adjacent to Project No. BSB 963 “Protect-Streams-4-Sea” of EC through the Black Sea Basin Programme 2014-2020 and Project No. 23PFE/30.12.2021 ”*AMBIACVA*” of UEFISCDI.

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PLASTIC DEBRIS FROM FACE MASKS: RELEASE RATES AND EFFECTS

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During the Covid-19 pandemic, personal protection equipment (PPE) was widely used to control the virus further spared. Millions of single-use face masks, FFP2 and surgical masks, shields are mainly produced from plastic polymers such as polypropylene, polystyrene, polyacrylonitrile, polyester, and polyurethane. Face mask s can be considered as a potential new microplastic source. It is noted that face masks are easily ingested by higher organisms, such as fishes, and microorganisms (*Proteobacteria, Bacteroidetes* and *Firmicutes*) in the aquatic life which will affect the food chain. We presented the results from an initial screening of the marine environmental hazard of three leachates (1, 3 and 7 days) from surgical and FFP2 masks under simulated environmental conditions to various life stages (*i.e.* nauplii, meta nauplii, juvenile and adults) of *Artemia franciscana.* Differences in toxicity were observed according to the brand of face masks and leaching duration. Results showed that surgical masks leachates at 7 days under room temperature and 50°C mainly affected the survival meta nauplii (70%) and juvenile (60%); whereas FFP2 masks leachates only under room temperature were able to caused acute toxicity in all life stages. This screening study demonstrates that leachates from different face masks differ in toxicity to *A. franciscana* and that the toxicity varies under simulated environmental conditions.

UNTANGLING WATER-COLUMN MICROPLASTICS, A CLOSER LOOK INTO TURBULENCE

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With the recognition of rivers' role in microplastic discharge to marine environments, riverine microplastics have become a research priority. Our present knowledge about riverine microplastics can be clustered into two categories; floating and sediment-bound, while microplastics in the water column remain understudied. The limited sampling campaigns confirm microplastic occurrence along the water column [1]–[3], where discrepancies in findings persist, partially due to sampling challenges (e.g., using nets along the water column). Hence, the need for process-based models became apparent. Recently, the Rouse model was proposed to predict the concentration depth profile for microplastics, adopting concepts and assumptions from sedimentology [4]

In essence, the Rouse model is a one-dimensional turbulence mixing model, originally developed for sediments, where extended research has provided the numeric values for the model constants. Due to the wide range of microplastic properties (e.g., shape, size, and density), direct projection of these values from sedimentology to microplastics is questionable. The primary parameters in turbulent mixing are the eddy viscosity, the material diffusivity and their ratio (i.e., Prandtl-Schmidt number), all of which remain unknown for microplastics. The lack of datasets is a key barrier facing model validation. Further, the Rouse model is best suited for describing mixing induced by steady uniform turbulence, which may not cover the full spectrum of turbulence in reality. Employing a combination of physical and numerical modelling, we aim to untangle and better understand the role of turbulence mixing in microplastics' concentration depth profile. The datasets obtained from the physical modelling will quantify key turbulent mixing parameters and will facilitate the validation of the Rouse model. Further, the numerical modelling will allow for examining extended flow conditions and microplastics properties.

The research outcomes will provide a better understanding of microplastics occurrence in rivers, hence are fundamental for improved sampling and modelling of riverine microplastics.

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DETECTION OF ATMOSPHERIC MICROPLASTICS IN PARTICULATE MATTER (PM10 & PM2.5) OF MEXICO CITY

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While our understanding of marine microplastic contamination has advanced dramatically in recent decades, our knowledge of atmospheric microplastics and their impacts in urban areas is still developing. Atmospheric microplastics has attracted scientific attention due to its pervasiveness and persistence, raising concerns about potential public health implications from inhalation [1, 2]. This study presents the first report on the occurrence and distribution of atmospheric microplastics in Mexico City (Latin America's second most densely populated city). Particulate matter samples (PM10 and PM2.5) were collected using active samplers at seven monitoring stations during the dry and wet seasons of 2020 for microplastic analysis. The results revealed the ubiquity of microplastics, with mean concentrations (items m^{-3}) of 0.205 ± 0.061 and 0.110 ± 0.055 in PM10 and PM2.5, respectively. The spatial and seasonal distribution of microplastics showed variations, with greater abundances in locations closer to industrial and urban centers. PM2.5/PM10 ratio was 0.576, suggesting that microplastics were partitioned more towards PM2.5 than PM10 in Mexico City. The most predominant shape was fibers (> 75%). A variety of microplastic colors like blue, red, green and transparent were observed with blue being the most common color (> 60%). More than 66% of microplastics identified were in the size fraction of < 500 µm. The polymer types identified were cellophane, PE, PET, PA, and cellulose (rayon) using ATR-FTIR spectral analysis. This work provides the first evidence of widespread airborne microplastics contamination in one of Mexico's megacities, where particulate air pollution is a longstanding concern, necessitating further investigation and regular monitoring.

Acknowledgement: VCS gratefully acknowledges financial support from DGAPA-UNAM postdoctoral fellowship program, Instituto de Geología, Universidad Nacional Autónoma de México. We´d like to thank Mtra. Olivera Rivera Hernandez (SEDEMA) and Ing. Juan Manuel Campos (SEDEMA) for providing access to particulate samples in Mexico City in 2020. We gratefully acknowledge Luis Alberto Moreno Ruiz and Hugo Martínez Gutiérrez from Centro de Nanociencias y Micro y Nanotecnologías, IPN for their assistance in ATR-FTIR and SEM-EDX characterization of this work.

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MICROPLASTICS IN THE SEA CUCUMBER HOLOTHURIA (HALODEIMA) ATRA AND SEDIMENT AROUND OKINAWA ISLAND

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This study focused on the ingestion of microplastics by Sea Cucumber (*Holothuria (Halodeima) atra* Jaeger, 1833), a marine invertebrate typically found in coral reefs. Feces, sediments, and seawater samples were collected from four sites (Chatan, Kin, Yomitan, and Itoman) around Okinawa Island in Japan to investigate microplastic occurrence. MPs were found in all samples and ranged from 0.0 to 10701.90 (particles kg-1) in sea cucumber feces and from 0.0 to 74.8 (particles kg-1) in subtidal sediments. No significant difference was observed in microplastic occurrence in the sediment samples. Still, there was a significant difference between the MP density in the fecal matter of *H. atra* and the subtidal sediment in Chatan, suggesting selective feeding of MPs by *H. atra*. The total organic carbon content at Chatan was the highest among the sites, suggesting that the selective feeding of MP by *H.atra* was caused by the formation of aggregates of MP with organic matter such as phytoplankton. However, phosphate ion, one of the inorganic nutrients, showed high values at all sites except for Chatan, which raises concern that inorganic nutrient runoff from land may lead to the proliferation of phytoplankton at other places and cause selective feeding of MP by benthic organisms in the future. This study highlights the impact of microplastics on marine benthic organisms. Research on MPs focusing on water quality indicators is warranted to understand better the relationship between the marine environment and MPs and their effects on benthic organisms.

ECOTOXIC EFFECT OF PLASTIC BAGS LONG TERM LEACHING IN SEAWATER

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Plastics are present everywhere, especially in the marine environment where large amounts of plastic waste accumulate.
Besides the conventional petroleum-based plastics, bioplastics and plant-based materials, largely marketed as sustainable alternatives, can also be found.
Both kinds of plastics contain a complex mixture of known and unknown chemicals that may be released in the water matrix posing a higher impact than the plastic particle itself.
In this view, the aim of this work is to evaluate the potential ecotoxicity of different types of plastic bag leachates in seawater. Conventional (Polyethylene) and compostable bags (Mater-Bi) were cut in pieces and placed in artificial sea water for a period of 3 months in different amount. Leachates were weekly collected and tested by different marine organisms (*Dunaliella tertiolecta*, *Vibrio fischeri* and *Paracentrotus lividus*).
Results showed that *D. tertiolecta* was the organism mostly affected by both leachates already after the first week, with a similar toxic effect. In the case of *P. lividus* the effect became evident starting from the 8th week for the conventional plastic bags and the last week of exposure for biodegradable ones. Instead, all the leachates exerted a hormetic effect upon the bacteria *V. fischeri*.
The present study showed, that both types of bags can release processing compounds in the marine environment, underlining that special attention should also be paid to chemical selection to be used as additives in plastic manufacturing.

AQUEOUS DISPERSIONS OF POLYPROPYLENE: TOWARDS REFERENCE MATERIALS FOR NANOPLASTICS CHARACTERIZATION

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Plastic pollution in the environment is a rising concern for the health of our planet. The plastic litter that pollutes our environment leads to microplastic particles. They can be found (nearly) everywhere. The processes that lead to microplastic can also form nanoplastic particles, which have a size below 1 µm. Because of the small size they can penetrate tissue more easily. Only few risk assessment studies of nanoplastics were carried out so far.

Using polystyrene (PS) nanoparticles to test effects on organisms is easy because it is commercially available. However, this falls a little short, as the polyolefins i.e., polypropylene (PP) and polyethylene (PE), are produced in a larger proportion than PS.[1] Moreover, these plastics are mainly used for disposable products, which means that they also account for a large proportion of plastic waste. Therefore, the percentage of polyolefins in environmental nanoplastic is presumably high. It is important to test the toxicological effects also with nanoplastics made of PP and PE to have more realistic results.[2]

Herein, we present an easy and repeatable method to prepare an aqueous dispersion of polypropylene nanoplastics (nano-PP). They are stabilized electrostatically, resulting in a strongly negative zeta potential of -43 mV (± 2 mV) and making no surfactant necessary to keep the dispersion stable.

The size and the size distribution were determined via Dynamic Light Scattering (DLS) and gives a hydrodynamic diameter of 180.5 nm (± 5.8 nm) and a PDI of 0.084 (± 0.023).

Finally, ca. 480 bottles of the dispersion with a volume of 10 mL each were prepared to serve as a potential reference material for further testing of detection methods or risk assessments.

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MICROPLASTICS BACTERIAL COMMUNITY: A POTENTIAL HAZARD FOR FOOD-SAFETY?

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Microplastics are novel environmental pollutants posing several questions about their impact on both environment and human safety [1]. Despite concerns about their chemical-physical properties, environmental microplastics are a carrier for allochthone bacterial communities [2]. In particular, within marine environment, they can have impact on trophic- and food- chain, posing serious threats for animal and human health [3].
We investigated, by a 16S metataxonomic approach, the bacterial communities hosted on the surface biofilm of microplastic samples (n=9) collected in the North of Adriatic Sea over two sampling campaigns made in 2021 and 2022. Microplastics microbial communities belonging to both sampling campaigns were quite similar in terms of both richness and evenness. Surprisingly, the Beta-diversity analysis revealed the presence of peculiar community clusters differing from the marine water microbial community. Microplastics belonging to 2021 strongly differed from that obtained in 2022 for their microbial community structure.
Since no significant differences in seawater chemical-physical parameters (temperature, salinity, pH), were observed in the two sampling campaigns, we can speculate a possible role of microplastics chemical properties and aging in shaping such peculiar microbiota. In addition, microplastics microbial communities showed the presence of taxa ascribable to genus of well-known food-borne pathogens such as Campylobacter, Listeria, and Salmonella.
Taken together these preliminary results point out that marine microplastics can be considered as a potential threat for food safety since they can be ingested by fishes, and by filter-feeders organisms such as bivalves, then resulting in the magnification on the food web of microplastic-resident pathogens bacteria.

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MICROPLASTICS IN SEDIMENTS AND SELECTED MARINE ORGANISMS OF THE GULF OF TRIESTE

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Due to geomorphological and hydrological characteristics of the Gulf of Trieste, the accumulation of pollutants and microplastics is more intense. There are relatively few results on the microplastic pollution in the Gulf of Trieste, mostly in the Slovenian part of the Gulf of Trieste, in seawater [1-3], beach sediments [4,5] and in marine organisms [6]. Although these results show that microplastic particles are present in the Slovenian part of the Gulf of Trieste, the distribution of plastics and microplastics in marine sediments and marine organisms is still completely unexplored. This work aims to investigate the presence of microplastics in sediments and selected marine species of the Slovenian Sea and to compare the results with those for the northern Adriatic. The study includes analyses of sediment and selected marine organisms. The microplastic particles were initially identified and classified by optical microscopy. Infrared spectroscopy and scanning electron microscopy (SEM) were used to identify and characterize the microplastic chemical composition and surface. The highest concentrations of microplastic particles in sediment samples are present in municipal harbors and marinas, where higher accumulations were also expected. Fragments of polyethylene and polypropylene were the most common microplastic particles. SEM images of microplastics from the Gulf of Trieste show that microplastic particles serve as a vector for the transport of algae and diatoms. Preliminary results show that microplastic particles are present also in selected species of fish and ascidians. The results obtained will contribute to a better knowledge of the distribution and possible sources of plastics and microplastics in the investigated part of the Gulf of Trieste. Investigating long-term changes in the accumulation of microplastics in the sediment will be essential to understanding the historical trend of this pollution and the response to human activities.

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MYCOLOGICAL APPROACHES FOR THE PREPARATION OF ENVIRONMENTALLY FRIENDLY MATERIALS.

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17 Sustainable Development Goals were set in 2015 by world leaders. Among them the number 12 was chosen, namely to ensure sustainable consumption and production patterns, which has the aim of substantially reduce waste generation through prevention, reduction, recycling, and reuse by 2030 [1]. To this end, the use of non-renewable resources must be reduced to produce materials and consumer products [2,3]. Renewable materials have the potential to contribute to the new economy by replacing petroleum-based products such as plastics [4,5]. The beneficial properties of plastic such as stability, durability, have brought its utilization to an unsustainable peak and its demand is continuously increasing [6]. Fungal mycelium is a sustainable alternative to petroleum-based polymeric plastics. It grows naturally as the colonial structure of the fungus and self-organizes as a network of tubular hyphal filaments which mould to any required shape. It is composed of chitin, glucans and an outer layer of proteins such as mannoproteins and hydrophobins [7]. Fungal mycelium has the potential to emerge as a material of choice for light-weight structures with several advantages such as low density, low production cost, minimal processing energy input and 100% biodegradability [8]. These bio-based mycelium products could be used as packing, thermal and acoustic insulation to substitute expanded polyurethane packaging, single-use plastic and pot containers for the horticultural sector amongst many others [6,9]. The most explored fungal group for mycelium-based material is the Basidiomycota with a specific focus on *Daedaleopsis, Trametes, Ganoderma* and *Pleurotus* genera [10]. No studies have been carried out on *Trichoderma* spp. and Polypores, which can become new potentially useful candidates. Our project aims to test the mycelium of indigenous fungi to produce an alternative sustainable material which can be used as plastic substitute, to partially solve the problem of Sustainable Development Goal 12.

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HIGH-QUALITY CARBON MATERIALS FROM SYNTHETIC INDUSTRIAL FIBRE WASTE

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In recent decades, global fibre consumption has steadily increased, leading to a higher amount of post-industrial and post-consumer fibre waste. This generates an enormous amount of synthetic waste, most of which is disposed of in landfills. However, it could be recycled into a new production cycle in terms of circular economy and industrial symbiosis [1].
The textile sector is one of the most important product value chains in the new Circular Economy Action Plan. Through research and innovation, important actions can be taken to promote sorting, reuse and recycling, with positive impacts on the environment and human health. In synthetic (clothing) textiles, the most commonly used fibre is PET (polyester), which is usually blended with polyurethane (PU). The PET-PU separation is not an easy process to handle. For this reason, in this study, we focused on obtaining a high-quality carbon material from PET-PU industrial waste with bioabsorber properties. These preliminary results show a carbon material with high surface area and interesting adsorption abilities for a simulated wastewater treatment.

Acknowledgement: Radici Group for the supply of samples

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ECOTOXICOLOGICAL EFFECTS OF WATER-SOLUBLE POLYMERS ON FRESHWATER SPECIES

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Water-soluble polymers (WSPs) are a new class of emerging contaminants still overlooked by scientific community. These substances, soluble in water under specific conditions of pH and temperature, are not registered under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) of the European Union and, consequently, no clear information about their production and presence in the environment are available. In addition, WSPs escape from the current legislation, adopted by many countries around the World, to reduce the impact of conventional plastics. This scenario is complicated by the heterogeneous plethora of synthesized and used WSPs, as: polyvinyl alcohol (PVA), adopted in packaging, polyacrylamide (PAM), used as flocculant in wastewaters, polyethylene glycol (PEG) and polyvinylpyrrolidone (PVP), used in pharmaceuticals and personal care products, and polyacrylic acid (PAA), used in paints [1]. For these reasons, to fill the knowledge gap about the WSP impact on aquatic environment, the aim of this study was the evaluation of chronic toxicity induced by three WSPs, as PEG, PVP and PAA, in form of powder solubilized in water, on zebrafish embryos. We exposed the specimens from 0 to 120 hours post fertilization (hpf), in static conditions and in triplicate, to 1 µg/L, 0.5 and 1 mg/L of abovementioned WSPs. We daily checked the eventual acute effects (mortality) and at the end of exposure we investigated the potential chronic toxicity through an integrated approach of biomarkers and functional proteomics. Regarding biomarkers, we performed the measurement of behavioural alteration as well as genotoxicity end-points. On the other hand, we performed the proteomics following the gel free method to investigate the modulation (up or down regulation) of proteins after the WSP exposure. The integration of these approaches allows to investigate the possible mechanism of action (MoA) of WSPs in freshwaters species, providing important information about the risk assessment of these substances.

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UPTAKE AND ECOTOXICOLOGICAL EFFECTS OF MICROPLASTICS AND NANOPLASTICS ON GELATINOUS ZOOPLANKTON

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Micro and nanoplastics are ubiquitous in the marine ecosystem, representing an emerging threat due to their small size able to be taken up by many organisms. The aim of this study was to investigate for the first time the ecotoxicological effects of polyvinylidene difluoride (PVDF), polylactic acid (PLA) microplastics (MPs) and polystyrene nanoplastics (NPs) on gelatinous zooplankton (Cnidarian jellyfish). With this aim, the ephyra stage of the Aurelia sp. jellyfish, recently suggested as valid model organisms in ecotoxicology, was exposed to both environmental and high concentrations (0.01-0.1–1-10-100 mg/L) of PVDF, PLA and fluorescent 100 nm polystyrene NPs to evaluate the uptake and ecotoxicological endpoints, such as Immobility and Frequency of pulsations. After 24, both MPs and NPs were observed in jellyfish gelatinous tissue, thanks to a novel techniques, namely three-dimensional (3D) holotomographic microscopy. Such uptake did not affect survival, but it impaired the behavioral alteration in terms of pulsation mode suggesting a mechanical disturbance in Aurelia sp. ephyrae. Among the investigated materials, polystyrene NPs resulted to be more toxic than PLA and PVDF MPs, in term of EC50. This study provides a first step towards understanding and clarifying the potential impacts of NP and MP contamination in gelatinous zooplankton, a key component in marine ecosystems and in the marine food web.

DEGRADATION BEHAVIOUR AND RATE OF BIODEGRADABLE POLYMERS IN MARINE ENVIRONMENT

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During the past 50 years, the production and consumption of plastics has grown exponentially together with environmental problems arising form plastic waste owing to inappropriate waste management, indirect waste transport, direct discarding or losing. Biodegradable polymers have been proposed to reduce environmental impacts of polymeric materials in specific applications [1]. As consequence of the increased usage of biodegradable polymers in commercial products, the degradability and security of biodegradable plastics in seawater received worldwide concerns. Because seas and oceans are characterized by lower average temperature, less illumination, and fewer microbial communities per unit volume, traditional biodegradable plastics, such as PBS and PLA, which normally have superior degradation properties in soil and/or compost, degrade more slowly in marine environments [2]. In a previous study, degradability of several biodegradable polyesters buried in sand was studied [3]. Results indicated that PLA hardly degraded in sand in 9 months, whereas PHB showed the fastest degradation reaching a weight loss of about 90% after 7 months. In this work, the degradation of biodegradable polyesters at three different depths along the water column, simulated in mesocosms, is reported. The studied polyesters exhibited different degradation rates and mechanisms, material degradability depends from polymer type and exposure area along the water column. PHB samples resulted affected by abiotic and biotic degradation processes. The degradation rate of PHB is higher for samples floating on sea surface than for samples exposed to seafloor.

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NEW INSIGHTS INTO PLASTIC DEGRADATION: ECOTOXICOLOGICAL EFFECTS OF PLASTIC LEACHATES IN MARINE INVERTEBRATES

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Plastic pollution is a well-recognized problem, representing a global threat to marine ecosystems. Plastic litter can leach a variety of substances into marine environments; however, few studies are available on leachate toxicity and therefore plastic degradation on marine biota. To fill this gap, we investigated the ecotoxicological effects of plastic leachate exposure on four marine invertebrates. Plastic litter was collected from several Italian beaches (Genoa, North Western Mediterranean); among them, PET plastic bottles were used to assess leachate ecotoxicity in the nauplii of the crustaceans *Amphibalanus amphitrite* and *Tigriopus fulvus*, in the larvae of the sea urchin *Paracentrotus lividus* and in the rotifer *Brachionus plicatilis*. Lethal (mortality) and sub-lethal endpoints (immobility, swimming speed alteration) were investigated after 24 and 48 hours exposure. No mortality or immobility was detected in any species at any exposure time; however, a significant swimming speed alteration was observed in the nauplii of *A. amphitrite* and in the rotifers of *B. plicatilis* after 48 hours. These results account for the ecotoxicological risks associated to PET leachates. However, they need to be confirmed by chemical characterization, to clarify if the toxicity may be ascribed to specific additives or sorbed chemicals released during leaching process. In conclusion, these findings suggest that leachates of environmental plastics do not trigger lethal but behavioural responses.

RESIN PELLETS AGING AND DEGRADATION INVESTIGATION FROM LONG TERM IN SITU EXPERIMENT: FIRST RESULTS

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Experimental studies in recent years highlight the presence of an increasingly high quantity of microplastics worldwide [1]. The "resin pellets" represent a significant share among the first generation microplastics in the millimeter range (from 1 to 5 mm). They disperse in the environment, even unintentionally, during transport, storage and processing and recent studies show that their content varies from 3% to about 30% of all microplastics surveyed on beaches [2]. A three-years experiment was carried out on a simulated beach and in marine water in Santa Teresa Bay (Gulf of La Spezia, Italy). In detail, special cages have been installed on the underwater observatory, LabMARE coastal station [3], placed at ten meters deep. The submarine station is equipped with a sensor for monitoring environmental parameters, recording data every 10 min. The experiment, aimed at investigating the behavior of plastic items and HDPE, PP, PLA and PBAT pellets, began on March 3, 2020 and is still ongoing.
Here, the comparison between the properties of the raw pellets and those placed in the two different environments after six months, is discussed. Through chemical, spectroscopic and thermal analyses (GPC, SEM, FTIR-ATR, DSC, TGA) of granules, variations in color, surface morphology, chemical composition, thermal properties and molecular weight, and polydispersity of materials are analysed to show the different influences of environmental conditions.

Acknowledgement: The authors thank the Italian Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta for some of the materials useful for the setup of the experiment, DLTM for the availability of LabMARE coastal underwater platform, Dr. Andrea Bordone and Dr. Giancarlo Raiteri (ENEA) for the temperature data of the seawater, and Dipartimento Polizia di Stato—Centro Nautico Sommozzatori of La Spezia (Italy) for the precious support in sampling activities. The authors also thank the Win on Waste group at Area della Ricerca CNR of Pisa (WoW, https://wow.area.pi.cnr.it/).

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REMOVAL OF NANO- AND MICROPLASTICS FROM MARITIME ENVIRONMENT BY USE OF BIODEGRADABLE FLOCCULANTS

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Currently, microplastics and their accumulation in open oceans threaten marine wildlife and by extension, also potentially humans. Removal methods for microplastics are thus urgently needed to be developed and adapted to this environment.

One solution for removal of plastics from marine environment is proposed in the EU project IN NO Plastic[1] and targets the so-called "hot spots": ports, river mouths and industrial areas on shore using sea water as cooling water. These "hot spots" are heavily contaminated by plastics and microplastics and represent the entry point of these into the sea. Within Europe, the location of these industrial hot spots coincides with large industrial cooling water systems (CWS) in power industry located on seashores such as the UNIPER power plant in Rotterdam, The Netherlands and The EDF nuclear power plant in EdF's Gravelines France- industrial partners in our project.

We have investigated at lab scale the feasibility of a coagulation /flocculation process using natural and biodegradable flocculants, iron salts and chitosan, for removal of micro- and nano plastic particles from sea water. A "model" mixture of polystyrene and polyethylene particles ranging from 200-3000 nm, with different surface properties has been utilised. Effects of different coagulants and flocculants, dosage, process conditions, real and synthetic sea water and particle characteristics on removal efficiency have been evaluated.

Our results show that a combination of iron coagulants and chitosan, a biodegradable biopolymer of marine origin, was particularly efficient in removing the submicron-sized plastic particles from sea water. The removal efficiency for the optimal combination was above 90%. The kinetics of the process, monitored by photometric dispersion analyser revealed rapid floc formation induced by precipitation of ferric salts, followed by growth into large structures facilitated by the addition of chitosan. The formed flocs exhibited high sedimentation rate, achieving water clarification in less than 45 minutes. The flocculation efficacy was affected by the type of the flocculant and its dose as well as the particle size, material, and the nature of the surface conditioning. Overall, the optimal combination of iron chloride and chitosan exhibited robust performance in different samples of sea water, with different particles and within the whole environmentally relevant pH range.

Acknowledgement: We would like to acknowledge funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000612, IN NO Plastic project.

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PHOTODEGRADATION OF LLDPE AND PLA THIN FILMS INDUCED BY HYBRID HUMIC ACIDS/ZNO NANOPARTICLES WITH ADVANCED ROS-GENERATING PROPERTIES

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Nowadays a life without plastics seems unthinkable since it finds applications in many different fields. By the way, the intensive use of plastic materials involves high levels of waste and release into the environment. Most of them are difficult to degrade and can persist in the environment for a century because of their degradation resistance [1]. It appears necessary to define effective strategies to remove them from the environment. Among the several commercial polymers, polyethylene (PE) and polylactic acid (PLA) are widely used in packaging field [2][3][4]. In this work, hybrid humic acids/ZnO nanoparticles were synthesized through a solvothermal route and tested as photocatalysts in the photodegradation of LLDPE and PLA thin films under UVA/light irradiation. The combination of TEM/SEM, XRD, TGA/DSC, ATR/FTIR, EPR and DRUV analyses allowed to define the structure-property-function relationship of the nanomaterials as well as to monitor the chemical, structural and morphological changes induced on the polymeric films during the photodegradation treatments. Experimental results demonstrated the validity of this eco-sustainable experimental approach to obtain hybrid catalysts with enhanced Reactive Oxygen Species (ROS)-generating properties suitable for the photodegradation of plastics, and microplastics, in aqueous environment.

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ASSESSMENT OF MICROPLASTIC INGESTION AND QUANTIFICATION OF ELEVEN PHTHALATE ACID ESTERS IN MEDITERRANEAN EDIBLE FISH SPECIES

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Microplastics ingestions may represent a vehicle of contaminants and plastics additives within marine organisms. Phthalate acid esters (PAEs) are chemicals widely used as plasticizers to improve the properties of plastic materials. It has been shown that they can be easily released into the environment and reach all environmental compartments including biota. PAEs are considered a class of pollutants that cause significant damage to the environment, wildlife, and humans. However, few studies have assessed the presence of phthalates in edible fish species. This study aimed to evaluate and compare the levels of PAEs in the muscles of edible fishes, from the North-Western Mediterranean Sea, according to the microplastics ingested by the specimens.

Microplastics ingestion was evaluated in Boops boops, Engraulis encrasicolus, Mullus surmuletus and Sardina pilchardus, collected in different areas of the North-Western Mediterranean Sea. A new methodology has been developed to detect the concentration of 11 PAEs (Dimethyl phthalate, Diethyl phthalate, Diallyl phthalate, Dipropyl phthalate, Diisobutyl phthalate, Dibutyl phthalate, Benzyl butyl phthalate, Dicyclohexyl phthalate, Bis(2-ethylhexyl) phthalate, Di-n-octyl phthalate, Diisononyl phthalate) in a sub-sample of each species (n=190). The levels of PAEs in the organisms has been related to microplastics ingestion (number of particles per individual, polymeric nature), fitness indexes (Fulton's Factor and Fullness Index) and sampling areas. Results show that almost all the PAEs investigated were detected in the four species, the most abundant were Diisobutyl phthalate, Dibutyl phthalate, Bis(2-ethylhexyl) phthalate. The highest levels of PAEs were observed in the organisms that had ingested microplastics, except for B. boops. S. pilchardus had the highest levels of PAEs. In addition, sampling areas statistically influence the load of PAEs in all the four species investigated. The results obtained in this study represent a step forward in the assessment of the relationship between the PAEs and microplastics occurrence in edible fish species.

Acknowledgement: This study was partially funded by: Interreg MED project "Plastic Busters MPAs: preserving biodiversity from plastics in Mediterranean Marine Protected Areas", co-financed by the European Regional Development Fund (grant agreement No 4MED17_3.2_M123_027), by PRIN project "EMME - Exploring the fate of Mediterranean microplastics: from distribution pathways to biological effects" (grant agreement no. 2017WERYZP) and by ENI CBC project "COMMON COastal Management and MOnitoring Network for tackling marine litter in Mediterranean sea".

HIGH DENSITY POLYETHYLENE AND POLYSTYRENE MICROPLASTICS AS VECTORS OF TRICLOSAN TOWARDS MARINE INVERTEBRATES: SIGNALS OF REDUCED BIOREACTIVITY

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Triclosan (TCS) is an emerging contaminant used as a preservative for its antifungal and bactericidal properties. Previous studies have showed different capacity of TCS sorption depending on the MP type, which was related to their physicochemical properties. As a part of the general objective to evaluate the capacity of polyethylene(PE) and polystyrene (PS) microplastics as TCS vectors in marine environments, the marine bivalve Mytilus galloprovincialis was used as a model organism to evaluate effects on immune function after in vivo co-exposure. Acute TCS spill scenario in the presence/absence of microplastics in the surrounding water was simulated under laboratory conditions. Mussels were simultaneously exposed to one type of weathered microplastics (PE or PS) and a high TCS concentration during 72 hours. In general, a decrease in lysosomal membrane stability was observed with all treatments compared to the control after three days, with most treatments resulting in moderate cell stress in mussels. A overall decrease in phagocytic efficiency was also observed in all treated mussels compared to the control mussels, the only exception being mussels individually exposed to PE, where a slight but not statistically significant increase was detected. No differences were observed between treatments in extracellular lysozyme activity and oxyradicals production. In general, mussels co-exposed to TCS+PE and TCS+PS showed effects on immune function that were lower than or comparable to those observed with individual exposures to TCS, PE and PS. Based on the results of this study, an additive effect on immune function derived from the co-exposure of TCS+PE and TCS+PS microplastics can be discarded. However, a weak antagonistic effect is suggested, potentially due to a reduction in their bioreactivity as a consequence of the adsorption of TCS to the surface of the ingested microplastics. The comparison of the results of bioaccumulation of TCS in mussels between the individual treatments and treatments with co-exposure to TCS, which are currently being analyzed, will help to strengthen or refute this hypothesis.

THE MANTA ROBOT: A NEW SAMPLING DEVICE FOR MICROPLASTICS IN DIFFERENT WATER BODIES

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Microplastics (MPs) have become the most ubiquitous type of anthropogenic litter contaminating aquatic environments worldwide. A good perspective on MPs monitoring would be to develop a new method that has the advantage of sampling large volumes of water like the Manta net but with easier usage like the pump or bulk sampling. In this study, a new sampling device that can directly collect samples from the shore without the use of a boat has been developed, the "Manta robot".
The aims of this new developed microplastics sampling method are 1) Being easy to use in every type of water compartment in order to better assess the microplastics contamination in a wider range of aquatic ecosystems 2) Being able to sample volumes equivalent of the ones sampled by Manta net of the same dimensions in a same amount of time 3) Having a clear protocol that involves a control on the sampling speed, sampling duration and sampling location; the protocol should be able to be reproduced a certain amount of times, in order to obtain replicates while sampling 4) Being a fast-sampling method that can be handled by one person.
The microplastics abundance recorded by the Manta robot and the Manta net were in the same range with 4.86 (±1.13) MPs/m^3 and 4.81 (±1.23) MPs/m^3 respectively. The proportion of fibers and fragments found are almost similar for both of the method with 41% of fragment found with the Manta robot technique and 42% found with the Manta net. The colors observed are the same for both microplastics sampled with the Manta net and the Manta robot with a majority of blue particles followed by black particles, then red ones and finally a minority of white and green particles.
The Manta Robot has been proven to be as easy to use as the direct filtration from an in-situ pump, the sampling can be carried by one operator and be put in use directly from the shore without the use of a boat. It has also been proven to have no significative difference in the results with the sampling method known as manta net, which is the overall best actual method for monitoring microplastics in large water area. This new developed method could become the new standardized method for sampling microplastics in surface water.

DENSITY SEPARATION OF CONVENTIONAL AND BIODEGRADABLE MICROPLASTICS FROM SOLID SAMPLE MATRICES

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Since the invention of plastic in the 1950s, production have grown exponentially and reached a maximum of 359 Mt worldwide in 2018 [1]. Plastics are deliberate and accidental released from different origins, through plenty pathways into the environment, which results in a ubiquitous plastic pollution [2]. In total about 6300 Mt of plastic have been produced worldwide so far and nearly 80 % of these can be found in the environment [3]. It is assumed that sinks for MPs are sediments for aqueous and soils for terrestrial environments. To overcome littering problems, biodegradable plastics have been developed with a current share of 0.3 % of the global plastic market. Studies confirmed the longevity of plastics in the environment. The main degradation process is assumed to be fragmentation into smaller plastic particles so called “Microplastic” (MP). Definitions of this term as well as applied sampling strategies, sample treatment methods and measurement techniques for MP analysis differ strongly within the scientific community [4]. For analysis of MP, interfering signals has to be eliminated for a validated identification and quantification. Consequently, samples have to be isolated from the matrices. Therefore, several laboratory techniques are applicable, e.g. visual sorting or extraction. The most common techniques are density separation and chemical digestion. Within this study, we evaluated the recovery rates of conventional and biodegradable MP from different solid sample matrices through density separation with solution of varying density and oxidizing digestion. The type of solid sample matrix influences the recovery rates and has to be considered when choosing a treatment technique. This study represents the first considering a validation of these sample treatment methods for different solid sample matrices with varying plastic types, especially biodegradable MPs, undertaken to date.

Acknowledgement: The authors would like to thank L. Rolfes, E. Trjaszina, R. Wörner and M. Heuer for supporting the laboratory work. We thank M. Zech for the graphic designs.

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FILTRATION/SEPARATION EFFICACY OF MICRO-to-NANO PLASTIC PARTICLES USING NANOCELLULOSE-BASED MEMBRANE

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Water-stable and ecologically friendly membranes were prepared from cellulose nanofibrils (CNF) by esterification of available hydroxyl groups using citric acid mediated chemistry performed in situ during the freeze-casting process, following our previous approach [1], and microscopically analyzed to evaluate their porous structure. The filtration performance (kinetic and flux) of membranes for retention/removal or separation of polystyrene (PS) particles, as model micro/nano-plastics, were evaluated depending on the particles size (ø = 0.1, 0.5 and 1.0 µm) and their surface chemistry (negatively or positively charged, i.e. fluorescently labelled PS) at constant pressure (0.5 bar) by using dead-end filtration mode. The intensities of light scattered by the feed and permeate solutions of un-labelled PS particles were measured via Dynamic Light Scattering (DLS) to evaluate the rejection rate and capacity. The ability to capture fluorescently labelled PS particles was assessed by measuring the fluorescence of the solutions and analyzing the membranes by fluorescence microscopy. The principles of size exclusion or surface interaction were assessed. Text of the contribution: Times New Romans 11 single line (The total length of this file including Acknowledgement and references, must not exceed one page). References, if necessary, in square brackets. Please do not change the margins of this template.

Acknowledgement: This research was funded by the Slovenian Research Agency (Grant No. J2-1719 and Research Program P2-0424).

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DOES CALIBRATION WITH PRISTINE PET ALLOW THE IDENTIFICATION AND QUANTIFICATION OF AGED PET MICROPLASTIC PARTICELS BY DSC?

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The complexity of the different degrading mechanisms that microplastic undergoes in the environment presents a challenge in understanding the risks associated with the microplastic itself and its degrading products. With the growing amount of microplastic in the environment, it is clearer than ever, that these risks need to be addressed and assessed. Therefore, there is an obvious need to not only better understand these complex mechanisms, but also to quantify and monitor the amounts of microplastics released into the environment. Differential scanning calorimetry (DSC) is one of the analyzing methods, which can quantify the amount of microplastics in environmental samples based on the thermodynamic fingerprint of the polymer. Pristine polymer material is usually used as calibration standard. The acceptability of the calibration must be verified with respect to aged polymers. When analyzing environmental samples, the different properties of the aged microplastic may cause the calculated data to deviate from the true values. In this study, we focus on the degradation state of polyethylene terephthalate (PET) polymers, their altered thermal properties, and the probable deviations from the calibrated values. PET particles and PET fibers were subjected to alkaline hydrolysis at different degradation stages. We compare the thermal properties of pristine and chemical aged PET materials. The results show no significant difference in the values of the crystallization and melting enthalpies. This outcome suggests that the DSC method calibrated with pristine PET material can be used to quantify the amount of PET microplastics in environmental samples subjected to natural aging.

Acknowledgement: This work was co-financed by the European Union and co-financed by tax revenues based on the budget adopted by the Saxon Parliament.

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IDENTIFICATION OF MICROPLASTICS IN CHOCOLATE USING MICRO-SPECTROSCOPY TECHNIQUES

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Plastic is currently a subject of global scientific and social concern. Plastic materials are used everywhere, from packaging, to buildings, automotive and electronics, as well as in many other applications. As a consequence, plastic contamination of the environment and of our food chain represents a very serious problem that needs urgent solution. Microplastics (MPs) are the products of mechanical abrasion, degradation by UV radiation and oxidation of plastic wastes and they are defined as small plastic particles in a size range between 5 mm down to 0.1 µm [1].
In the last years, MPs have attracted a growing interest in the scientific community due to their emerging issues as environmental pollutants and a potential health threat. Some recent studies are focused on the concentration of microplastics in marine environment, seafood and water, but systematic studies on food matrices are still lacking and must be developed [2].
Considering this, the aim of this study was to determine whether chocolate, collected during its packaging process, could release microplastics in the surrounding environment.
The chocolate matrix was degraded using combined enzymatic and chemical approaches. The presence of MPs was confirmed via micro-FTIR and micro-Raman spectroscopy analyses.
Polyethylene (PE) appeared to be the polymer generating microplastics, as expected being the packaging composition material.

Acknowledgement: This research is funded by the IMA S.p.A.

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MORPHOLOGY AND MASS QUANTIFICATION COMBINED APPROACH FOR MICROPLASTICS CHARACTERIZATION WITH AGILENT LDIR AND FRONTIER LAB PYROLIZER

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Many analytical laboratories and scientists around the world are seeking new technologies and developments that can analyze microplastics (MPs) qualitatively and quantitatively. For properly evaluate these particles, their evaluation must include two aspects: morphology characterization and mass quantification. Since MPs pollution is strongly related to particle diffusion, a morphology study of particle sizes represents a key information. Besides morphology, quantifying the polymer mass is important too since let to assess the amount related to liter of water, kg of sediment or biota. Agilent LDIR 8700 (laser direct infrared) represent a new leading tecnique based on quantum cascade lasers able to perform an automatic morphology analysis, including polymer identification, in about one hour. Frontier Lab Pyrolizer mounted on GCMS let to close the loop performing quadrupole mass detection with excellent LOD for MPs and additives.

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MECHANICAL RECYCLING OF POLYETHYLENE-RICH PLASTIC FRACTION RECOVERED FROM MARINE ENVIRONMENT TO MITIGATE PLASTIC AND MICROPLASTIC POLLUTION

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Macro- meso- and microplastic pollution in the environment has become a global concern due to their impact on the marine ecosystem. Plastic waste is esteemed to represent 40–80% of the total amount of marine litter [1]. Polyethylene (PE) and polypropylene (PP) represent the most common polymeric fraction found in oceans debris [2]. Recovery and recycling of these materials play a fundamental role to mitigate marine plastic pollution and to remove from the environment a source of secondary microplastics. In this respect, marine plastic debris may be considered secondary raw materials to design recycled plastic materials. The mechanical recycling of marine plastic waste also poses a greater challenge than recycling land-based waste because marine waste contain a considerable amount of sand, salt, shells, algae and marine plants, that could hinder plastic recyclability [3]. In this work, polyethylene-rich plastic fraction (PE-rf) recovered from marine environment has been characterized through spectroscopic, thermal, and morphological analyses. A mechanical recycling approach was applied to realize recycled materials, using recycled polyethylene and different amount of PE-rf ranging from 100% to 20%. The effect of composition of recycled materials on the morphology, thermal and mechanical properties was analysed, demonstrating that the approach allows the valorization of the polyethylene-rich plastic fraction of marine litter.

Acknowledgement: This study was supported by the research project “SIstemi di Rilevamento dell’Inquinamento Marino da Plastiche e successivo recupero-riciclo. SIRIMAP PON-Project” from the Ministry of Education, Italy.

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A PROCESS TO TURN CIGARETTE WASTE INTO SUNGLASSES

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Cigarette waste is a huge problem for sea pollution: that is hazardous debris but are usually not properly disposed as such and are composed of >15,000 strands that can be detached as microfibers [1]. Our research aims to recover and upcycle cigarette waste and repurpose it as usable plastic objects in particular a fashion product such as sunglasses.
We realized a novel, low-cost, simple and efficient extraction method of cellulose acetate powder from discarded cigarette butts, through several washes in water and ethanol and a selective dissolution-precipitation process [3]. The main drawback of recovered cellulose acetate is that its melt processing temperature is closed to decomposition temperature: this requires cellulose acetates to be plasticized. One of our main purposes is to replace phthalate plasticizers, generally used in commercial cellulose ester plastic, now under environmental scrutiny, with eco-friendly plasticizers [4-6].
Moreover, 3D printing of recovery cellulosic materials presents an opportunity to fabricate objects from a cheap and sustainable source. 3D printing technologies could offer new ways to design and manufacture fascinating materials by mimicking the structure and component properties. So our ambitious aim is to realize a recovered acetate cellulose wire for 3D printing to realize sunglasses.

Acknowledgement: The Authors thank to Essequadro eyewear for providing cigarette butts, funding for the exctraction study and testing support for material development

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FUNCTIONAL AND STUSTAINABLE MATERIALS

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Due to environmental concerns and limited resources, the demand for biobased materials continues to increase. Herein, we present the developlment of two different biobased materials. In the first example Chitosan (CS) a natural, biodegradable and non-toxic polymer were modified by chemically grafting polyesters, poly(L-lactide) (PLLA) and poly(ε-caprolacone) (PCL) along the CS backbone via the "grafting to" approach to improve its mechanical properties. PLLA and PCL are a biodegradable, non-toxic polymer with good processability and excellent mechanical properties. The two polyesters were synthesized via the ring-opening polymerization of L-lactide and ε-caprolactone using an organic amine as the catalyst to avoid the toxic metal. Next, the polyesters were chemically grafted onto the CS backbone via amine coupling chemistry. Graft copolymers were prepared containing 50 wt % and 80 wt % PCL and PLLA [1,2]. In the second example, pH-responsive biodegredable polyestres bearing ionizable carboxylic acid side groups were synthesized. The polymers were prepared by the polycondensation of a vinyl functionalized diol with a diacid chloride, followed by a photo-induced thiol-ene click reaction to attach carboxylic acid side-groups along the polyester. The degree of modification of the alkene side groups of the polymer was adjusted at 50, 80, and 100 mol%. The synthesized functional polyesters present pH-responsive behavior and tunable solubility in aqueous media as a function of the degree of ionization of the carboxylic acid moieties [3].

Acknowledgement: This research has been co-financed by the European Regional Development Fund of the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH – CREATE – INNOVATE (project code: T1EDK-04052).

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MITIGATION EFFECT OF DETERGENT ON MICROFIBER RELEASE

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Microplastics released from textile during washing processes, are currently considered emerging pollutants representing one of the main abundant form of microplastics with a wide distribution in the environments [1]. Several works investigated the role of additives (detergent, softener), washing temperature and washing time, different textiles parameters and the effects of water-volume on microfibres release [2-4].
In this study the effect of a liquid detergent, specifically formulated, in reducing the release of microfibers from synthic fabrics during washing tests is reported. Washing tests of polyester fabrics were performed in absence/presence of two different detergents, a commercial product and a specifically formulated detergent, using low and high washing loads.
Results indicate that the use of specifically formulated detergent strongly reduces the amount of microfiber released form polyesters fabrics during both washings performed using low and high washing load. In detail, the amount of microfiber released during low washing load tests pass from 0.269 ± 0.019 in the washing with commercial detergent to 0.040 ± 0.004 in the tests performed using the specifically formulated detergent. The amount of microfiber released in the washings performed using the specifically formulated detergent was close to that released duing washing performed with only water confirming the mitigation effect induced by the usage of this specific product.
The findings pave the way to a potential reduction of microplastic release as conseguence of the usage of appropiate formulation for laundry product.

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