μMED

BOOK OF ABSTRACTS

TRAINING SCHOOL
MICRO AND NANOPLASTIC POLLUTION: DETECTION AND MITIGATION, PRESENT AND FUTURE CHALLENGES

Naples (NA), Italy
28th - 30th September 2022
Partenope Congress Centre

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the European Union

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Consiglio Nazionale delle Ricerche
IPCB/DSCTM

Piazzale Aldo Moro, 7 - 00185 Roma
ISBN 978-88-8080-365-2 (electronic edition)

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ABOUT

The presence of microplastics (MPs) has been assessed in all environmental compartments, in food/non food products becoming a global threat. Due to the complexity of the MPs pollution issues, different strategies are under study to mitigate this environmental problem and to prevent their entrance in the environment. This School will offer an overview on methods and techniques under investigation to early career researchers, to allow them to develop innovative solutions to detect and mitigate microplastics contamination.

The school is organized in the framework of the COST Action CA20101 PRIORITY – Plastics monitoring detection remediation recovery. The COST Action aims to develop a research network focused on developing, implementing, and consolidating strategies to tackle the global challenge of micro- and nanoplastic environmental pollution.

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PROGRAMME

28th September 2:30 PM - 19:00 PM			
2:30 PM	**3:00 PM**	**Stefania Federici**, University of Brescia, IT **Aleksandra Tubić** University of Novi Sad, RS	**Opening and welcome from PRIORITY**
3:00 PM	**3:30 PM**	**Mariacristina Cocca**, Institute of Polymers, Composites and Biomaterials - CNR, IT	**WG5: Remediation, recovery and development of sustainable materials**
3:30 PM	**5:00 PM**	**Monica Passananti**, University of Torino, IT - University of Helsinky, FI	**Nanoplastics: state of the art and challenges**
5:00 PM	**5:30 PM**	**Coffee break**	
5:30 PM	**7:00 PM**	**Roberto Avolio, Maria Emanuela Errico**, Institute of Polymers Composites and Biomaterials - CNR, IT **Hamid Amsil**, National Centre for Nuclear Energy, Science and Technology (CNESTEN), MA	**Round Table: Participant presentation**
29th September 9:30 AM - 6:00 PM			
9:30 AM	**10:30 AM**	**Alvise Vianello,** University of Aalborg, DK	**Finding the needle in the haystack: the role of vibrational spectroscopy in microplastic analysis**
10:30 AM	**11:00 AM**	**Coffee break**	
11:00 AM	**12:00 PM**	**Sabrina Carroccio**, Institute of Polymers Composites and Biomaterials - CNR, IT	**Application of traditional and modern MS to microplastics identification**
#######	**1:00 PM**	**Serena Santonicola**, University of Molise, IT	**Microplastics as emerging food contaminants: current detection methods**
1:00 PM	**2:30 PM**	**Lunch break**	
2:30 PM	**3:30 PM**	**Maria Costantini**, Stazione Zoologica Anton Dohrn, IT	**Monitoring and bioremediation of microplastics by marine organisms**
3:30 PM	**4:30 PM**	**Andrea de Lucia**, Institute for the Study of Anthropic Impact and Sustainability in the Marine Environment - CNR, IT	**Could MPs be monitored using marine organisms? Evaluating different fauna species as indicators in assessing vertical**
4:30 PM	**5:00 PM**	**Coffee break**	
5:00 PM	**6:00 PM**	**Richard C. Thompson**, University of Plymouth, Uk	**Overview of microplastic pollution in the environment**
30th September 9:30 AM - 6:30 PM			
9:30 AM	**10:30 AM**	**Jean Marie Raquez**, University of Mons, BE	**Introduction to Biobased plastics: definition and issues**
10:30 AM	**11:00 AM**	**Coffee break**	
11:00 AM	**12:00 PM**	**Nicolas Keller**, Institute of Chemistry and Processes for Energy, Environment and Health - CNRs/UdS, FR	**Mitigation approaches for the removal of micro and nanoplastics in wastewater : the challenges and promises of Advanced**
#######	**1:00 PM**	**Alberto Figoli**, Institute on Membrane Technology - CNR, IT	**Membrane processes for micro and nanoplastics pollutants remediation**
1:00 PM	**2:30 PM**	**Lunch break**	
2:30 PM	**3:30 PM**	**Veronica Ambrogi**, University of Naples, IT	**Circular Economy and Environmental Sustainability**
3:30 PM	**4:30 PM**	**Rachele Castaldo, Emanuele Fiore,** Institute of Polymers Composites and Biomaterials - CNR, IT	**Group Work Activity: Preparing a draft project proposal on identified topics**
4:30 PM	**5:00 PM**	**Coffee break**	
5:00 PM	**6:00 PM**	**Rachele Castaldo, Emanuele Fiore,** Institute of Polymers Composites and Biomaterials - CNR, IT	**Group Work Activity: Preparing a draft project proposal on identified topics**
6:00 PM	**6:30 PM**	**Final exam**	

COLLECTION

OF

TRAINEES' ABSTRACTS

Eco-sustainable design of hybrid redox-active materials to remove (micro)plastics from water

Paola AMATO[1]*, Marica MUSCETTA[1], Claudio IMPARATO[1], Aurelio BIFULCO[1], Mariacristina COCCA[2], Raffaele MAROTTA[1], Giuseppe VITIELLO[1], Antonio ARONNE[1]

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Plastics are synthetic organic polymers with a wide variety of applications due to their durability, versatility, hydrophobicity, and relatively low cost. However, despite their benefits to the daily life, plastics are associated with high levels of waste and release into the environment, in fact most of them are very difficult to degrade [1]. Plastic particles less than 5 mm in size, the well-known microplastics (MPs), have now caught both scientific and public awareness [2]. MPs have a large surface area to volume ratio and, consequently, they can adsorb and transport toxic substances. Plastics contain also additives identified as endocrine disruptors or even carcinogenic substances, such as PAEs and BPA, that can be released over time, leading to huge environmental risks. In view of the harmfulness of plastic wastes, it is necessary to take effective measures to remove them from the environment [1]. To this purpose, hybrid materials were synthesized by combining semiconductor oxides, such as ZnO and TiO_2, with bioderived organic components. These materials have been tested in the degradation of plastics both under UVA/light irradiation and at ambient light.

References:

[1]. Z. Ouyang, Y. Yang, C. Zhang, A. Zhu. *J. Mater. Chem. A* 9, 13402, 2021.
[2]. A.A. Horton, D.K.A. Barnes. *Sci. Total Environ.* 738, 140349, 2020.

Microplastic pollution in karst areas: a threat to caves, groundwater and protected species and habitats

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Microplastics (MPs) are a global problem, contaminating also remote areas, being them extremely mobile. However, MP pollution is poorly known in karst areas, especially in subterranean environment. Groundwater in karst aquifers constitutes about 25% of the global drinking water sources and karst caves are one of the most important and well-known geological features in the world, fragile sites with an exceptional scientific value, rich in endemic fauna, an environmental and cultural heritages, as well as an important economic resource. MPs can endanger the fragile subterranean ecosystems, be ingested by animals, irreversibly damage speleothems and paleontological/archaeological findings depositing on them and pollute karst aquifers. Extending the research started for the Italian project PRIN SHOWCAVE [1], the aim of this study is to investigate and monitor MP pollution in karst superficial and subterranean environments from a geological, biological and environmental point of view, in order to define strategies for protection and conservation purposes. A new detection technique has been developed to study cave sediments [2], subsequently adapted to the different studied matrices. Samples from different karst areas of Italy were collected and investigated. The sediments of three show caves were analyzed, highlighting the presence of MPs and the damaging of speleothems and paleontological remains. Superficial and underground water samples of the Bossea karst system (Piedmont) were analyzed, showing MP pollution in all examined waters, underlining the importance of the entire aquifer karst systems monitoring, even susceptible to contamination by surface pollutants. Different water environment samples of springs and caves in Carso system (Friuli-Venezia Giulia) were collected and will be analyzed to verify the MP pollution in different habitats, hosting particularly protected species such as *Proteus anguinus*. Sediment samples in a not jet explored caves will be collected to verify the MPs pollution even in underground environments not directly affected by human presence.

Acknowledgement: The authors are grateful to all people gave them advice and suggestions and supported them during monitoring.

References:

[1]. V. Balestra, R. Bellopede, A. Cina, C. De Regibus, A. Manzino, P. Marini, P. Maschio, B. Vigna. *GEAM* 163, 24-35, 2021.
[2]. V. Balestra, R. Bellopede. *Environ. Pollut.* 292, 118261, 2022.

Determination of microplastics in environmental matrices by Py-GC-MS: application on sewage sludges

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Over the last decade, environmental pollution caused by microplastics (MP) has become of emerging concern, attracting worldwide attention. Clear statements on its environmental risk and mitigation actions have not been fully established yet and standardised analytical methods for MP quantification are still missing. Pyrolysis-gas-chromatography-mass spectrometry (Py-GC-MS) is acquiring increasing importance in this field. This challenging approach to MP analysis can provide highly informative results. In contrast to optical-spectroscopic techniques, with Py-GC-MS is possible to provide concentration results on mass units instead of particle number [1]. Moreover, this high selective technique is not affected by particle shape (e.g. fibre or sphere), colour or size. However, a deep knowledge of the pyrolytic behaviour of polymers and environmental matrices is required in order to recognise potential artefacts [2]. Wastewaters can collect the contamination deriving from domestic activities and the water depuration processes of wastewater treatment plants (WWTPs) can determine the accumulation of MPs in sewage sludges. These matrices can be employed in agriculture as soil conditioners; therefore, they can be an indirect source of MPs contamination of soils. The main objective was to provide information about the main potential source of domestic contamination and clarifying the role of WWTP in MP reduction. Sewage sludges were dried in oven, milled and sieved (at 0.3 mm). Homogenised samples were oxidised with Fenton's reagent and filtered on quartz fiber filter (0.3 µm). Filters were folded and directly inserted into pyrolysis cups. Py-GC-MS analyses were performed under thermochemolysis conditions (addition of tetramethylammonium hydroxide) and polymers were quantified by internal standard calibrations. Thermochemolysis was controlled by specific standard. Procedural blanks were developed to consider the possible contamination derived from the method. The contamination from the laboratory was also taken into account by the periodical analysis of air-exposed filter, located at the working stations of each step of the analytical procedure.

References:

[1]. J. La Nasa, G. Biale, D. Fabbri, F. Modugno. *JAAP* 149, 104841, 2020.
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Journey towards the study of the degradation of microplastics in the marine environment

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On the occasion of the Researchers' Night in Tuscany Bright2018, PolyGreenLab research team of IPCF-CNR and other CNR colleagues working in other Institutes located in Pisa and La Spezia founded WOW (Win on Waste), a group committed to environmental issues related to support a more efficient waste management, the safeguard human health and the environment [1]. The group makes use of qualified technical-scientific skills, deriving from multi-year experiences in interdisciplinary research such as recycling of plastics, the recovery and valorisation of biowaste materials, the investigation of the environmental impact of waste and on the dissemination and training of social society. Since then, PolyGreenLab's and Wow's members, have given life to numerous activities: Bright from 2019 to 2021 and the production of videos and educational projects [2], [3], and support in operations of cleaning and classification of plastic and microplastic disperse in the environment on Parco di San Rossore Beach. The outreach activities carried out in order to further spread awareness on the problem of Marine Litter have led to the development of activities promoted by CNR in citizen science approach to validate monitoring activities carried with unmanned aerial vehicles (UAVs) [4].

In collaboration with ISMAR-CNR and INGV, a three-years experiment is still in progress in a simulated beach and in marine environment in Santa Teresa Bay (Gulf of La Spezia, Italy) on the underwater observatory placed at ten meters deep. The experiment aims the investigation of the behaviour of plastic items and HDPE, PP, PLA and PBAT pellets by using chemical, spectroscopic and thermal analyses (GPC, SEM, FTIR-ATR, DSC, TGA) [5].

Acknowledgement: The author thanks Simona Bronco, Lucia Ricci and Leonardo Arrighetti (PolygreenLab, IPCF-CNR), Silvia Merlino (ISMAR-CNR), all members of Win on Waste group at Area della Ricerca CNR of Pisa (WoW) and Marina Locritani (INGV).

References:

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Carbon nanomaterial-based adsorbents for removal of metal ions in wastewater purification

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Due to the rapid industrialization and urbanization, the most valuable resource that is critical for survival of living species is at constant risk of pollution, mainly with heavy metal ions. Heavy metal contaminated wastewater is a serious threat for human health and whole ecosystem. Wastewater purification using adsorption presents one of the fundamental methods based on physical interaction between metal ions and sorbents. Adsorption, as an effective, efficient, and economic method, is the most widely used technique for removal and reduction of heavy metal ions from large volumes of aqueous solutions. Carbon nanostructures (MWCNTs, graphene and MWCNT/graphene hybrid) showing exceptional physicochemical properties are tested as a potential sorbent for wastewater and remediation of environmental problems. Compared with conventional materials, nanostructure adsorbents have exhibit much higher efficiency and faster rates in water treatment. Recent studies have indicated that nanomaterials as sorbents are useful tools for heavy metal removal, due to their unique structure and surface characteristics. In order to improve their activity, nanosorbents' surface was modified using X-ray irradiation and acid treatment. This approach is suitable for removal of heavy metal ions such as, copper, iron, and nickel from wastewater. In this research work, pristine and functionalized carbon nanostructures (irradiated and acid-modified) were evaluated and compared for heavy metal ions sorption. Characterization of nanosorbents was carried out using Transmission (TEM) and Scanning Electron Microscopy (SEM), Thermal analysis (DTA/TGA) and Raman. The concentration of heavy metal ions in solution was determined using Atomic Absorption Spectroscopy (AAS). Three compound system was used as analyte, consisted of Cu^{2+}, Ni^{2+}, and Fe^{2+} ions with different initial concentrations of 0.3, 0.6 and 1.2 mg/L. The concentration of carbon nanosorbent was 0.5 g/L. Pristine MWCNTs and graphene showed excellent adsorption properties unlike the hybrid structure. The best efficiency was shown for adsorption of Ni^{2+} ions for 11.5% and Cu^{2+} for 4.5%, in the analyte with highest concentration.

The relevance of temporal variability on plastisphere community along the Campania coast

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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 spatiotemporal variability are linked to the community of microbes colonizing the surface of MPs, the so called "plastisphere" (Zettler et al., 2013), which might show variability along the temporal gradients. 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).

The plastisphere community data presented here underline again the importance of temporal variability and environmental parameters shaping the microbial community. Different environmental conditions in different seasons would recruit different community attached. This is not the case for higher taxonomic levels, as Proteobacteria and Bacteroidetes, found as the most common phyla, but rather at family or lower level. Not even for morphological features, for examples related to bacilli and cocci which were always the most common prokaryotic morphotypes, which together as diatoms, forms the most abundant members of the plastisphere as visible from SEM microphotographs. The latter analysis shows that the assessment of morphological features is in agreement with molecular results. 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.

Citizen science applied to the monitoring of synthetic microfibers in the Mediterranean Sea: the MicroMar project

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Production of synthetic fabrics is growing, with textiles losing microfibers persisting in the environment much longer than the ones of natural origin [1]. MicroMar is a citizen sciences project aiming to monitor microfibers in the Mediterranean Sea thanks to the joined collaboration between Federico II University, Naples (DiSTAR), and Scripps Institution of Oceanography, San Diego, CA (Deheyn lab.) among the major contributors. The project relies on the effort of citizens volunteering (wildlife reserve, private organizations, research centers, fisherman, etc.) for collecting seawater samples which is filtered and analyzed through microscopy for fiber counting. Data are further analyzed to obtain an overview of these pollutants' geographical distribution [2].

Acknowledgement: The authors thank AIPU association to providing materials for MicroMar project and all those institutions and citizen who spontaneously sampled the water.

References:

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[2]. A. Baudena, E. Ser-Giacomi, I. Jalòn-Rojas, F. Galgani, M. L. Pedrotti. *Nat Commun*. 13:2981, 2022.

GLOVE: the global plastic ingestion initiativ\e for a cleaner world

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Plastics are one of the most used materials in the world. Their indiscriminate use and inappropriate disposal have led to inevitable impacts on the environment arousing the attention of the global community. In addition, plastic ingestion studies are often written in scientific jargon or hidden behind paywalls, which makes these studies inaccessible especially in developing and low-income countries. GLOVE (the GLObal plastic ingestion initiatiVE), is the first web-based and open-access database available at gloveinitiative.shinyapps.io/Glove/ to support scientists, decision-makers, and society with information collected from plastic ingestion studies. The GLOVE web-based application was developed using Shiny, an R package designed to build interactive web apps directly from the R platform. Shiny allows the development of user-friendly interfaces linked directly to statistical functions and routines in the R environment, so that non-expert R users can easily obtain complex plots or tables without the need for coding. GLOVE supports several different modes of interactive use via website through maps, plots, and tables on the main interface and the user can also download the complete table of the GLOVE database for the selected query. It already comprises 530 studies including all biological groups with 245,366 individual records from 1,458 species found in marine, freshwater, and terrestrial environments. Most of the species were fish (62.8%) and birds (23.7%), followed by invertebrates (9.3%), mammals (3.7%), and reptiles (0.5%). The studies (total number of records) identified during the literature search were conducted primarily in Europe (23.3%), and Asia (19%), followed by South America (14.2%), North America (13.6%, including Central America), Oceania (13.5%), Africa (2.7%), and Antarctica (0.3%). The main goal of GLOVE is to improve data accessibility by being a scientifically grounded tool that would be useful for designing effective and innovative actions in the current scenario of upcoming global agreements on the plastic pollution.

A full year of atmospheric microplastic monitoring in a remote high-altitude area in French Pyrenees

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It is becoming increasingly evident that microplastic is ubiquitous in Earth's surface environment [1,2]. Since the mid-20th century, we have managed to produce at least 8300 teragrams (Tg, 10^{12} grams) of non-biodegradable synthetic polymer (plastic). 2600 Tg are still in use, 4900 Tg have been discarded and a further 800 Tg have been incinerated [3]. With time, and by the forces of physical and/or chemical processes, exposed plastics from the two first-mentioned pools are gradually breaking down [4] and thereby contributing to the ever-increasing concentration of secondary microplastic (MP) within our atmosphere. Over the course of my PhD one of our main objectives is to determine the content of MP in pure rainwater collected at the remote location of Bernadouze, French Pyrenees, at an altitude of 1,425 m above sea level, and to compare the findings to synchronously collected dry deposition samples. The protocol has been determined and tested, and the first sample has been analysed by automated Raman microspectroscopy. We wish to determine whether atmospheric MP deposition is affected by seasonal variation and whether precipitation affects the amount of MP deposition and the polymer type distribution.

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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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Nature based solutions for plastic degradation.

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In 2015, world leaders agreed to 17 Sustainable Development Goals. Among them we choose the number 3, Good health and well-being, which includes the target of reducing illnesses and death from hazardous chemicals and pollution by 2030 [1]. Plastic is a polymer, made up of high molecular weight, long chain of hydrocarbons, and in various forms tender services in our life from kitchen to industry and this increase its demand around the globe [2]. The beneficial properties of the plastic such as stability, durability, have brought its utilization to peak and its demand is continuously increasing [3]. However, plastic is not easily biodegradable under natural conditions and has a very slow rate of degradation [4]. Society tries to dispose plastics waste using various strategies namely, landfilling, incineration, recycling, and use in construction of roads, production of fuel [5]. Each of the method is having, either deteriorating effects on the environment or economic exploitation [6]. The degradation of the synthetic plastic mediated by the microbes is known as biodegradation, and it is considered as the most accepted and eco-friendly method [7]. Among the microorganisms which biodegrade plastics, there are fungi which produce enzymes that disintegrate the polymer into several monomers and dimers, which can be used as a carbon source and results in the conversion of the polythene waste into water, CO_2, methane or something more useful [8]. Among other fungi, Trichoderma species have been found efficient biodegraders for microplastics especially for polythene and polyurethane [9]. Sowmya et al. [9] identified two classes of enzymes secreted by Trichoderma, responsible for polyethylene degradation, namely laccase and manganese peroxidase. Our project aims to investigate indigenous strains of Trichoderma and polypores for laccase and manganese peroxidase production to test their plastic biodegradation to partially solve the problem of plastic as environmental pollutant as part Goal 3: Good health and well-being.

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Fate of fossil-based and bioplastics in the marine environment

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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.

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.

Recycling approaches of marine plastic litter

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In the context of environmental problems, plastic and microplastic pollution in the marine environment is one of the most pressing. Plastic production has had a great increase over the years, reaching about 280 million tons per year [1]. Plastics are widely used for their properties and versatility, making them suitable materials for numerous applications. Due to improper disposal of plastic waste, a large amount of these materials end up in marine ecosystems [2]. Among the most common plastics found in the oceans, there are polyethylene, polypropylene, polystyrene and polyethylene terephthalate, materials generally used for packaging [2]. The fishing industry also contributes about 18% to ocean plastic pollution [3]. Finding recovery and recycling strategies (mechanical, chemical or thermal) of plastic waste from the sea is a challenge and an opportunity to contribute to mitigation action of plastic litter in the frame of circular economy. In order to develop efficient recycling strategies for these complex type of litter, some important issues may be taken into account: the heterogeneous composition of the polymeric fraction recovered from the sea, the difficulty of sorting procedure, the contamination and the degradation state of the litter due to material life cycle and permanence in the sea.

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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Distribution and retention of microplastics in stormwater constructed wetlands

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Constructed wetlands (CWs) are key components in stormwater management by reducing pollutants and suspended particles, including microplastics (MPs), in stormwater runoff [1]. Despite their function and ecological importance, there is currently limited understanding about the fate of MPs in these engineering systems. This study aims to quantify and characterize MPs (25 µm to 5 mm) in water and sediment from four stormwater treatment CWs across Gold Coast, Australia. MPs were detected in all water samples except one outlet sample, while they were present in all sediment core samples. The concentration of MPs in the water samples ranged from 0.4 ± 0.3 to 1.2 ± 0.4 particles/L at the inlet. MPs were still detected in the majority of outlet samples, but the concentrations decreased, ranging from 0.1 ± 0.0 to 0.5 ± 0.4 particles/L. However, there was no statistical difference between the concentrations in the inlet and outlet at any of the CWs. Nearly 70% of all detected MPs in water were >300 µm in size, and the majority were polyester fibers. The opposite trend was observed for the sediment samples, with MPs <300 µm accounting for 60% of all detected MPs and the majority polyethylene and polypropylene fragments. MP concentrations in the sediment samples ranged between 736 ± 335 and 2610 ± 1950 particles/kg dry sediment at the inlet and between 148 ± 59 and 1060 ± 326 particles/kg at the outlet. Horizontally, there were significantly more MP particles in sediment collected from the inlet compared to the outlet at all sites except for one CW, which suggests that most MPs in stormwater settle quickly at CWs. Vertically, there was no significant difference between the sediment core intervals at both the inlet and outlet for any of the study sites which could result from the variation in frequency and intensity of stormwater runoff that the wetlands received. In addition, sediment grain size was found to affect the distribution of MPs in sediment, with higher MP concentrations recorded in sediment with a finer grain size. The current study shows that CWs can retain some of the MPs in stormwater runoff and prevent them from further impacting the receiving aquatic environment. However, CWs also become “sinks” with MPs accumulating in the sediment over time. This could be of concern as wetlands also serve an ecological function for birds, fish and amphibians.

Acknowledgement: Hsuan-Cheng Lu is supported by a Griffith University Postgraduate Research Scholarship awarded by Griffith University and a Biosis Ecology Scholarship awarded by Biosis Pty Ltd.

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Oxidative stress and damage in Mediterranean mussel *Mytilus galloprovincialis* after exposure to polystyrene nanoparticles

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While microplastics in the environment have gained enormous attention over the past decade, much less attention has been focused on smaller sized fractions such as nanoplastics (<100 nm) which may arise due to environmental degradation of their larger counterparts [1]. However, nanoplastics represent a significant cause for concern as they may be more bioavailable to a range of organisms. Further, nanoplastics can be of similar size to food for organisms, and for example can enter the food chain via filter feeders [2]. The Mediterranean mussel *Mytilus galloprovincialis* is widely distributed, of high commercial value and has been shown capable of bioaccumulating different xenobiotics, whose toxic effects can be assessed through their impact on oxidative stress levels, making it an appropriate animal model for ecotoxicological studies [3]. For the purpose of this study, the impact of polystyrene nanoparticles (PS NPs) on *M. galloprovincialis* was investigated. Mussels were exposed to a range of nanoparticle concentrations (0-100 mg L^{-1}) for 96 h, followed by 96 h of depuration. The levels of biochemical biomarkers – acetylcholinesterase (AChE), glutathione-S-transferase (GST) and catalase (CAT), and oxidative damage – lipid peroxidation (LPO), were assessed in gills and digestive glands to evaluate the toxicity of PS NPs in mussels, both after exposure and after a recovery period. Antioxidant enzymes' activities (AChE, GST, CAT) and LPO were altered after exposure to PS NPs while analysis of the same biomarkers after the recovery period showed values similar to controls. These results indicate that nanoplastics can give rise to deleterious effects after acute exposure through the generation of oxidative stress. However, activation of anti-oxidative mechanisms in mussels show the ability to mitigate the effects of nanoplastics until mussels complete the egestion of such materials.

Acknowledgement::This work has been fully supported by the Croatian Science Foundation under grant IP-2018-01-5351.

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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.

Microplastics as indicator of landfill leachate pollution

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The fragmentation of plastic waste to microplastic particles (MPs) is initiated by different complex phenomena such as physical, chemical, and biochemical reactions in combination with environmental conditions [1]. Microplastics act as potential transporters of different groups of emerging pollutants such as hydrophobic organic pollutants due to its strong adsorption capacity [2]. The objective of the study was to identify the occurrence of microplastics in three municipal landfill sites with different waste management practices. Leachate sampling was conducted at two sanitary landfill sites (Jagodina, Serbia and Bijeljina, Bosnia and Herzegovina) and one non-sanitary, controlled landfill in Novi Sad, Serbia to determine the content of MPs as the constituents of plastic waste. Laboratory analysis of collected samples was performed according to the proposed method defined by NOAA Marine Debris Division with slight modification to the defined procedure. The preparation method consisted of the following steps: filtration through stainless steel sieve (63 μm), overnight drying, the removal of organic matter with hydrogen peroxide and iron sulphate solution and the density separation by zinc chloride. The weight of extracted microplastic particles was determined by gravimetric analysis. The MPs separated from landfill leachates were observed by stereomicroscope SteREO Discovery. V8 (Carl Zeiss Microscopy GmbH, Germany). The obtained average concentration of MPs in the leachate samples ranged from 0.64 to 2.16 mg L-1 from all three landfills [3]. The higher MPs concentration ranges highlight that analyzed landfill sites where there is non-existence of waste sorting practices represent potential significant sources of MPs in the environment.

Acknowledgement: This research (paper) has been supported by the Ministry of Education, Science and Technological Development through project no. 451-03-68/2022-14/ 200156“Innovative scientific and artistic research from the FTS (activity) domain”, the Bilateral project „Microplastic impact on occurrence of plasticizers in surface water and effects on human health“ and by the Interreg DTP project “F(ol)low the Plastic from source to the sea: Tisa-Danube integrated action plan to eliminate plastic pollution of rivers – Tid(y)Up“.

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Evidence of microplastic-mediated transfer of PCB-153 to sea urchin tissues using radiotracers

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This work reports the first experimental microplastic-mediated transfer of a key PCB congener 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).

Detection and characterization 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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Daphnia magna as a model organism to assess the effects of nanoplastics pollution

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Environmental pollution due to anthropogenic activities involves the release of a great number of contaminants into the environment which exert a great impact on biota. Emerging contaminants consist in a wide range of products of anthropogenic origin, for which the effects on non-target organisms are still poorly known and for which no reference legislation is currently available. Among polymeric materials released into the environment, the greatest contribution is provided by thermoplastic nano and micro-polymers, including polyethylene terephthalate (PET).

A widely used bioindicator organism highly sensitive to environmental conditions changes and pollutants exposure is the cladocero *Daphnia magna*. It has a fully sequenced genome, a well-understood life history and ecology, and a huge library of toxicity responses, due to these characteristics it is used in ecotoxicology studies.

In our study, *Daphnia magna* was used as model organism for assessing the toxicological effects of model PET nanoplastics (similar to those found in aquatic environments [1]), on microcrustaceans. The study is carried out in collaboration with the Department of Innovation Engineering (University of Salento).

We evaluated the time-dependent effects of the exposure of *Daphnia* to autofluorescent label-free PET nanoplastics by spectrofluorometry and fluorescence imaging experiments.

The obtained preliminary results highlighted the presence of PET nanoplastics throughout the whole gastrointestinal tract of *Daphnia* compared to the control and represent the basis for further investigation addressed to the physiological and behavioral responses of *Daphnia* to PET nanoplastics exposure. For this reason, participation in the nanoplastics Training School could provide greater awareness of the issues relating to the release of nanoplastics into the environment, thus contributing profitably to our studies and research goals.

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Nano/microplastics impact on human health: PS and PMMA microspheres exposure alters the expression of miRNAs related to skin aging in human keratinocytes

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Humans are exposed to nano/microplastics (N/MPLs) through inhalation, ingestion and dermal contact. As for skin absorption, certain cosmetic products, such as toothpaste, face and body scrubs containing primary N/MPLs [1], the use of disposable personal protective equipment (PPE) mainly made of plastic polymers (that peaked during the COVID-19 pandemic) and the environmental N/MPLs pollution may contribute to the exposure load [2]. Indeed, the repeated skin contact with N/MPLs particles, over a prolonged time, may result in the alteration of the physiological epithelial differentiation process and premature aging of skin cells. In order to test this hypothesis, we studied the effects of polystyrene (PS) and polymethylmethacrylate (PMMA) N/MPLs exposure on a human keratinocytes cell line (HaCat). Since real life exposure to these kinds of products is not constant over time, we selected 24 h as a time point and decided to focus on a low and on a high concentration (25 - 250 µg/ml). We investigated the main physiological cell processes through Trypan blue exclusion dye assay, qRT-PCR and Western blot. At 24 h after treatment, we observed diminished cell vitality, both for PS and PMMA treated HaCaT, in a concentration-dependent manner. However, we did not observe significant changes in classic cell proliferation, senescence and apoptosis markers at 24 h. We then focus our attention on the expression of a panel of miRNAs key regulators of several molecular pathways. Specifically, after just 24 h, PS induced the upregulation of two miRNAs with a demonstrated role in keratinocyte senescence and proliferation regulation, while PMMA downregulated them, both in a concentration-dependent manner. So, PS and PMMA may exert opposite effects on miRNA levels, leading to an impairment of cell vitality through the modulation of different biological processes. Further studies will be performed to determine the influence of N/MPLs on miRNA expression in human cells.

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Ingestion of microplastics by a marine fish community in the coastal waters of Israel, Eastern Mediterranean Sea

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High densities of microplastics have been reported in the coastal surface waters of Israel, located on the easternmost boundary of the Mediterranean Sea. However, a large knowledge gap of this pollutant exists with very little research having been conducted both nationally and regionally. My research has focused on providing baseline information in Israel on the interactions of marine fish species and microplastics and the potential driving factors for their ingestion. To do this, a large survey of 771 specimen from 33 species were analyzed for microplastic ingestion. From these species, it was found that small planktivorous fish were more prone to ingestion, especially of plastic films. Based on these results, we have further expanded our research to investigate the role of small planktivorous fish on the movement of microplastics in the water column. With small planktivorous fish being an important component of trophic connectivity, understanding their relationship with microplastics has value oceanwide.

Sustainable polymer film for agriculture: a study of the effect of UV irradiation on biodegradation

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The disposal of plastics, in constant increase in the agricultural sector, represents a serious problem of environmental sustainability. Biodegradable plastic systems can potentially replace the commonly used PE ones in agriculture and several studies have been carried out on commercial biodegradable polymer to verify their applicability in mulching or irrigation pipes [1,2]. However, the effect of UV on their performances and degradation rate in soil has not been investigated in depth. In our study, polymer films based on biodegradable polymers were examined and compared with traditional non-biodegradable materials to verify their biodegradability in soil following UV irradiation. Polymer films based on biodegradable polymers and traditional one of polyethylene (PE) were prepared by film blowing. Carbon black (1%) was added to all the films. Commercial biodegradable Ecovio® and Mater-Bi® samples were used. Mechanical properties and soil burial degradation were investigated, before and after UV irradiation. Polymers film were subjected to photoaging with continued exposure to UV radiation up to different aging intervals. Photo-oxidized film samples with an elongation at break equal to 50% and 0.5 of the initial value were selected for the soil burial degradation test at 30 °C [3]. Weight loss measurements were used to follow biodegradation in soil. Predictably, the degradation in soil was higher for biodegradable polymer-based films than for the PE-based ones. Chemical modifications induced by UV and soil degradation, or a synergic effect, were highlighted by Attenuated Total Reflection-Fourier Transform Infra-Red (ATR-FTIR).

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Microfibers in marine sediments from the Gulf of Naples, Italy

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Microplastics (MPs) are emerging pollutants exhibiting a wide range of morphologies, sizes, and visual properties [1]. Once generated, MPs may travel along oceans and finally be trapped in marine sediments, the ultimate sink [2]. The microscopical analysis of samples is largely employed in microplastic research protocols, with with the application of physical and chemical analytical procedures [1]. This study focuses on microplastic distribution in marine sediments (submerged and emerged) of NE of Naples City. The study applied an original approach for MPs counting and morphological characterization without any pre-treatment of the sand samples, based on optical microscopy analysis. Morphological data from optical microscopy assay were used for subsequent SEM-EDS of the selected microfibers to confirm the presences of contamination and morphological features; and for polymeric composition. The Morphological data collected evidenced the presence only of microfibers with different sizes, textures, color, and reflectivity, especially in submerged sediments. Moreover, microfibers appeared to be bound to sediments particles. SEM-EDS show alterations on the microfibers surface, trapped sediments and local presences of microplastic beads [3].

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The environment absolutely and urgently needs the attention and care of each of us

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So many things can be done to help our planet. The valorization of "the low value residues" for the development of new materials from agri-food waste is one of the many ways to take into consideration. Proteins from legume waste [1] and cutins from tomato wastes [2,3] are some examples that we are studying at CNR IPCF in the PolyGreenLab. Thanks to this background, we participated some months ago in the establishment of the WoW group, acronym of Win on Waste [4], together with researchers and technicians from nine CNR institutes in Pisa and one in Lerici. Numerous dissemination activities were carried out by WoW, both in presence by monitoring, collecting and classificating marine litters on the San Rossore Park's beach with specific attention to plastic items and microplastics dispersed in the environment, and online, with the preparation of webinar and video focused on the problem of micro and macroplastics in the marine environment [5,6]. Thanks to this group, a collaboration with ISMAR-CNR in Lerici and INGV begun and is still ongoing. A new article (https://www.mdpi.com/2073-4360/14/6/1111) was recently published on the behavior in the first six months of standard (HDPE and PP) and biodegradable polymer (PLA and PBAT) pellets in the marine environment (seawater and sandbox) [7]. The study here described is still in progress and will be continued until March 2023. Chemical spectroscopic and thermal analyses (GPC, SEM, FTIR-ATR, DSC, TGA) were performed on the granules before and after exposure to natural conditions with the aim to identify the physical-chemical modifications occurring in both environmental conditions. New studies are underway in collaboration with the Italian Istituto Zooprofilattico Sperimentale del Piemonte, Liguria and Valle d'Aosta (IZSPLVA) and Legambiente.

Acknowledgement: The author thanks Simona Bronco, Cristina De Monte and Leonardo Arrighetti (PolygreenLab, IPCF-CNR), Silvia Merlino (ISMAR-CNR) and Marina Locritani (INGV), Roberta Diciotti (ISTI-CNR) and all members of Win on Waste group at Area della Ricerca CNR of Pisa (WoW).

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Microplastics released from textile: detection and mitigation

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Environmental pollution due to microplastics, plastic fragments with dimensions lower than 5 mm, represents a global problem that has become particularly relevant in recent years[1]. In 2017, it was estimated that microplastics released from textiles during the washing process, named "microfibres", contributes by about 35% to the global ocean pollution of primary microplastics[2]. The release of microfibres during the washing process of synthetic textiles is due to the mechanical and chemical stresses that clothes undergo in washing machines. Several washing process parameters, conditions, formulations of laundering additives have been correlated to microfibre release as well as the washing load and some of them have been identified to affect microfibre release[3-5] . This research activity aims to reach two main goals: 1) improving the analytical protocols to identify and quantify microfibre released during washing processes, identifying specific trends in the release, and 2) developing new membrane able to capture microplastics released from textile in the wastewater. For these purposes, washing trials of polyester fabrics will be performed and analysed using different protocols and polymeric membrane will be realised using conventional and non-conventional approaches.

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Contamination assessment of food matrices by micro- and nanoplastics

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Microplastics (MPs) are ubiquitous in various environmental compartments, so the human population can easily be exposed to their harmful effects [1]. In particular, the likelihood of exposure, through ingestion of contaminated food, is considered quite high and poses a risk to food safety and human health [2]. Studies published so far show that drinking water, crustaceans/shellfish, fish and salt are important food sources of microplastics for humans [3]. The main objective of this research work is to assess human exposure to microplastics through food by co-developing analytical procedures for the identification and quantification of microplastics in food-type matrices such as sea salt, honey and oil. For each food matrix, a specific separation protocol will be developed to isolate plastic fragments contained in different food samples. The microplastics thus separated will be characterised from a morphological and chemical-physical point of view and quantified through specific analytical approaches. To validate the analytical method, the recovery of microplastic particles will be tested on a positive control. [4] In particular, the samples, after appropriate pre-treatment, will be analysed with different analytical techniques: morphological techniques [fluorescence microscopy, optical microscopy, scanning electron microscopy (SEM) and transmission electron microscopy (TEM)], spectroscopic techniques [Fourier transform infrared spectroscopy (FTIR) and FTIR microscopy], thermal techniques [differential scanning calorimetry, DSC, thermogravimetry (TGA), coupled FTIR/TGA techniques for the analysis of volatile products]. Finally, the risk associated with human exposure to microplastics will be assessed by considering microplastic concentrations per food product and using estimates of average European food consumption.[5]

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Cellulose nanofibrils as promising reinforcing additives towards high-performance biobased materials

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In light of the urgent demand for more environmentally friendly materials, natural polymers such as cellulose open up for a new spectrum of opportunities. Cellulose is the most abundant natural polymer and a unique raw material, highly attractive when targeting a variety of different applications. The use of cellulose-based materials for the production of a broad range of biodegradable products such as paper, cardboard, construction materials and textiles dates back thousands of years. During the past hundred years, many of those products have been put aside in favour of fossil-based products, often showing significantly better properties. Nowadays, cellulosic materials have drawn new interest. In this context, new opportunities for developing high-performance materials can be explored thanks to the isolation of nanoscopic forms of cellulose. Within plant tissues, cellulose is the structural component providing impressive mechanical properties. Plant tissues are extraordinary composite materials where elementary fibrils of cellulose are organized in bundles and embedded in an amorphous matrix of lignin and hemicelluloses. Nanoscopic celluloses such as cellulose nanofibrils (CNFs), isolated from them, show even superior properties due to a higher structural homogeneity, higher extent of crystallinity and extremely large specific surface area. These features make CNFs promising candidates as biobased reinforcing additives for composite materials of industrial interest.

The authors aim to explore the potential of CNFs as mechanical reinforcement. Nanocomposite materials containing CNFs are obtained by melt processing as well as by curing coating formulations. To ensure compatibilization, different routes for chemical modification of the CNF surface are used, tuning the surface properties depending on the specific application. Finally, the composite materials obtained are characterized with a focus on the mechanical properties, highly dependent on the effectiveness of the nanofibrils dispersion in the matrix.

Acknowledgement:
The authors would like to thank AB Beckers jubileumsfond for funding this research.

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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Identification and quantification of microplastics in drinking water by micro-Raman spectroscopy

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Microplastics (MPs) are defined as small plastic particles in the microscale, typically between 1 µm and 5 mm in size. Microplastics enter the environment in an uncontrolled manner, either through the decomposition of macroplastics or as intentionally produced micro-sized particles. Although there is little information on microplastics contamination of drinking water, a limited number of studies have demonstrated presence of MPs in drinking water. Although MPs pose a potential threat to human health with exposure through the air we breathe, the food we eat, and the water we drink, no government in the world has mandated monitoring of microplastics in drinking water. The lack of standardized methods for determination of MPs in drinking water makes reproducibility and easy comparison between studies difficult. Therefore, we focus on the development and optimization of a method to identify and quantify MPs by micro-Raman spectroscopy. Drinking water is analyzed for microplastics contamination by filtering the water on silicon filters, which are then analyzed down to 1 µm using micro-Raman spectroscopy. Since Raman measurement of the entire filter surface is tedious and time-consuming, and can even take more than 24 hours for a single filter, we used a subsampling model where only a portion of the filter is analyzed and the results are extrapolated to the entire filter surface. In addition, a method of removing inorganic matrices was introduced to increase the ratio of plastic to non-plastic particles. Preliminary results show that MP is present in drinking water and the most common polymer types are PET and PE.

Photodegradation and microbial colonization of commercial mulching plastics

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Mulching plastics are increasingly used because they improve crop yields and reduce the need for water and pesticides by protecting seeds, reducing weeds, and maintaining soil temperature and moisture. However, they are difficult to recover and contaminate agricultural soils contributing to the spread of plastic pollution [1]. Currently, mulching films are mostly composed of low-density polyethylene (PE), which is non-biodegradable and difficult to recycle. To replace PE, biodegradable plastics based on polybutylene adipate terephthalate (PBAT), polylactic acid (PLA) and thermoplastic starch (TPS) are already on the market. They are not recoverable, as they are destined to degrade in soil, but the impact of the fragments produced from them is still unknown [2]. The aim of this work is to study the fragmentation and degradation of commercial mulching plastics on soil by photodegradation and/or bacterial colonization processes. PE, Ecoflex® (BASF) and Mater-Bi® (Novamont) mulching plastics were selected for the study. Photodegradation experiments were performed on 8 x 8 cm^2 plastics placed on standard OECD soil using a 150 W medium pressure mercury lamp and adjusting the exposure time to simulate UVA and UVB solar irradiation equivalent to 3 and 12 months, respectively. For colonization experiments, the specimens were placed in a sealed chamber and a bacterial suspension of *Pseudomonas putida* was sprayed on their surface. Treated and untreated plastic films were deeply characterized, and the size and number of particles obtained by fragmentation were determined. All tested mulching plastics showed extensive colonization by bacteria and a clear biofilm formation. Their hydrophobicity decreased upon irradiation and colonization, demonstrating the modification of their functional groups. The degradation treatments did not affect the mechanical behaviour of PE but had detrimental effects on the elongation at break of biodegradable mulching films, whose surface was also shown to be altered.

Acknowledgement: This work was supported by the Spanish Ministry of Science and Innovation through the project PLEC2021-007693. LV thanks the University of Alcalá for the POP contract and the visiting research fellowship.

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Microplastics and associated plasticizers: presence and detection in cnidarians used as possible bioindicators for microplastic contamination in marine environment

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Marine litter has become one of the most emerging types of pollutants since it is ubiquitous across all habitats. As a worldwide problem, new methods suitable for monitoring such phenomenon are required. Microplastics (MPs) can become vectors of plastic additives and contaminants adsorbed from the environment. Phthalates (PAEs) are common 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 PAEs presence 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, that share different physical traits. Recently, sea anemones have been 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 MPs 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 MPs 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, 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.

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Role of biodegradable polymers to reduce micro- and nano-plastic contamination: laboratory and in situ degradation and ecotoxicological analyses

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Plastics are materials that are an integral part of our lives. It is estimated that the massive production of this material was around 6,300 million tonnes in 2015 and that around 8 to 14 million tonnes enter the ocean each year. In response to this problem, EU strategies have been put in place to reduce the release of plastics into the oceans, such as promoting recycling, reuse of plastics and the use of biodegradable plastics. Regarding the latter, very little data on their biodegradability and toxicity in the marine environment is available and little is known about their impact on marine invertebrates when in contact with them, especially when ingested[(1)]. This PhD aims to answer these questions and a multidisciplinary approach is used integrating chemical, ecotoxicological, biotechnological, molecular and ecological aspects. We will study the chemical composition of different polymers present on the market and see their impact on five marine invertebrates. The degradation of five biodegradable polymers, BPs, at different depth level of water column simulated in mesocosms will be studied. The analysed BPs are poly(L-lactic acid) (PLA), poly(ε-caprolactone) (PCL), poly(hydroxyalkanoates) (PHA), poly(butylene succinate) (PBS), poly(butylene succinate-co-butylene adipate) (PBSA). Regarding the marine organisms studied, these target species have different feeding strategies and they play essential roles in coastal ecosystems. In addition, they are well established marine model species for ecotoxicological studies. Studies will be carried out on the sea urchin *Paracentrotus lividus*, the shrimp *Hippolyte inermis* and two ascidians *Ciona robusta* & *Botryllus schlosseri,* the isopod *Idotea baltica*. Morphological effects at different stages as well as molecular effects using RNA-seq and Real Time qPCR approaches will be performed to monitor polymer-induced gene expression variations.

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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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Effects of microplastics on selected physical properties of agricultural soils and monitoring the response of the model organism rough woodlouse (Porcellio scaber) to altered environment conditions

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The increasing use of plastics, poor management, disposal problems, and removal of plastics from the environment have led to increasing pollution of the terrestrial environment by plastics or microplastics (MP) in recent decades. While the fate of MP in the aquatic environment is increasingly well understood, little is known about the effects of MP in the terrestrial environment, particularly in agricultural soils. Plastic residues in soil ecosystems are mainly due to agricultural practices. The type, size, and content of MP have different effects on soil physical properties. Studies have shown that MP affects soil structure, hydraulic conductivity, water retention capacity, and water repellency [Qi et al., 2020]. Therefore, it is crucial to study the effects of MP on soil physical properties, especially in relation to water, which are often crucial for the impact and effect of contaminants in soils and agroecosystems. The presence of MP in soil also affects soil organisms, making selected model organisms an appropriate biological tool to monitor the effects of altered environmental conditions on organisms. The aim of this study is to evaluate the effects of different types, sizes, and concentrations of MP on selected soil physical properties and to compare the effects of MP in soils with different textures. We are also interested in the response of selected invertebrates to altered environmental conditions due to the presence of different types, sizes and concentrations of MP.

Acknowledgement: This research is founded by Horizon 2020 MINAGRIS Project [European Union's Programme for research & innovation under Grant Agreement number: 101000407].

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