CALL FOR INTEREST XXXVII CYCLE - ENVIRONMENTAL SCIENCES

SSD	BIO/01 - GENERAL BOTANY	Supervisor	Rodolfo Gentili
Title	Impact of microplastic pollution on terrestrial plants under climate change		

Short description

Microplastic pollution (MP) can affect the development and life cycle of living organisms by direct and indirect pathways. In the last years, scientists have observed and investigated the MP in marine ecosystems, and more recently in inland freshwaters, with increasing alarm. In terrestrial environment MP has been still scarcely investigated, although recent works have suggested that plastic wastes are probably more in soils than in the oceans.

The will focus on the impact of MP on terrestrial plants growing in agriculture areas and along coastal sand dunes. Specific aims of the project will be:

- To characterize the chemical compounds released by the most abundant microplastics and their uptake by plants at different temperatures;
- To assess the effects and response of plants to different microplastic debris at different temperature by measuring plant morpho-functional traits (growth parameters, photosynthetic efficiency, and reproductive fitness);
- To evaluate the risk of microplastic sediments movement/transport in conserved (vegetated) and not conserved (not/scarcely vegetated) sand dune systems (Mediterranean region).

The research will envisage both field and laboratory activities. The project will involve foreign institutions active in the study of microplastics in terrestrial environments (e.g., Leibniz-Institute of Freshwater Ecology, Berlin; Centre for Ecology and Hydrology, Wallingford, Oxfordshire, UK)

SSD	BIO/06 - COMPARATIVE ANATOMY AND CYTOLOGY	Supervisor	Chiara Urani
Title	Neurotoxicity and neurodegeneration: does the environment play a role?		

Short description

Neurotoxicity and neurodegenerative diseases (e.g., Alzheimer's and Parkinson's disease) are linked to environmental contamination. Epidemiological and environmental data suggest a role played by metal exposure to increased risk of developing amyotrophic lateral sclerosis. The general aim of the project is the identification of the role of metals (essentials and non-essentials) in processes of neurotoxicity and neurodegeneration. The research work will comprise integrated approaches: 1) environmental data collection from available databases (ARPA), elaboration and analysis; 2) in vitro biological approaches using cell models as alternative methods for mechanistic and possible recovery studies of neurotoxic metal effects; 3) computing and statistics of data collected and correlation with epidemiological information from National Registry of Rare Diseases. The project has components of data collection and elaboration to be supported and integrated with laboratory work.The research will be carried out in collaboration with ARPA Lombardia, Settore Ambiente; the EU Commission, Joint Research Centre (Ispra, VA); the University of Milan, Environmental Hygiene Lab. The candidate is expected to spend a period abroad to implement in vitro methods by developing models of human-derived neuronal cells, and to compare the role of different environmental conditions on the risk of developing ALS (Thomas Jefferson University, Institute for Neuroscience, Philadelphia USA).

SSD	BIO/07 - ECOLOGY	Supervisor	Sara Villa
Title	**Sustainable manure: vermicomposting as cost-effective method for reducing veterinary pharmaceutical residues in manure**		

Short description

The use of veterinary medicinal products (VMPs) has increased enormously and the environmental pollution caused by these substances is an emerging environmental problem. According to the European Medicine Agency, Italy is the second consumer in the EU of VMPs. VMPs are excreted by the treated animals in the form of unchanged parent substances and metabolites, and consequently, reach the environment following the shedding of manure on the soil. The greatest concerns derive from their potentially harmful effects on natural systems and human health.

In the last few years, the process of vermicomposting has been proposed as an alternative tool to improve the management of solid waste. Vermicomposting is the process by which worms are used to convert organic wastes into a humus-like material. Earthworms promote favourable conditions within the soil, enhancing bioremediation also of organic contaminants in soil. Sustainable development requires the development of environmental management and a constant search for green technologies to treat aquatic and terrestrial habitats contaminated by increasing anthropogenic activities. The hypothesis of this proposal is that earthworms in association with bacteria naturally occurring in manures will enhance the quality and environmental sustainability of biofertilizer produced from VMPs contaminated manures. The project will investigate if vermicomposting using *Eisenia fetida* could be a useful technology to promote the breakdown of VMP residues in manures.

SSD	BIO/07 - ECOLOGY	Supervisor	Simone Montano
Title	Effects of coral diseases on the performance of large scale coral restoration projects		

Short description

Tropical coral reefs, once known as rich and diverse ecosystems, have lately experienced an unpreceded decline in health, biodiversity and services they provide to human kind. As coastal communities are facing the consequences of degraded reef ecosystems, active coral reef restoration has become an increasingly popular mitigation tool and has lately sparked a large number of projects, research and management protocols. In this context, diseases can have devastating effects on coral populations and are a known concern in coral restoration. Restoration frequently involves monospecific nurseries and branching corals, which are particularly susceptible to disease, and further poses the risk of introducing diseases to transplantation sites and adjacent reefs. For example, the white band, likely a bacterial disease specific to the genus Acropora, has caused significant mortality, particularly in combination with stressors like temperature in the Caribbean. In the Indo-Pacific, white syndrome (WS) was first reported in 2010 amongst others and found to be the most widespread disease in the Indian Ocean, but causes and disease dynamics remain largely unstudied. Further research on mitigation strategies in a coral gardening context is required, considering the potential economic loss associated with high stock mortality. The project aims to assess the most impacting pathologies affecting farmed corals and in exploring the nursing performance of different coral genera located in lagoon mid-water rope nurseries and iron frames structure in the Maldives. By monitoring lagoon nurseries in several different locations, the project aim to investigate the suitability of this coral restoration tool in lagoon habitats across atolls and the effect of coral diseases on their performances. The Project aims also to report benchmark results for survival and growth of *Acropora, Pocillopora* and *Porites* fragments for the Maldives. Based on these observations, the projects will aim to further point out important considerations of the methodology used in order to improve nursing success as the first step of the coral restoration process. The project will be carried out in collaboration with Corales de Paz (Colombia), and the Maldivian Marine Research Institute (MMRI) Maldives. The candidate may spend a period abroad to in-depth studies histopathology of diseases affecting farmed corals, and in developing mitigation tools to control that threat (Thierry M. Work, National Wildlife Health Center Honolulu Field Station).

SSD	BIO/19 – GENERAL MICROBIOLOGY	Supervisors	Andrea Franzetti (Unimib) Tatiana Stella (M^3R srl)
Title	**New biomolecular strategies for the monitoring of biodegradation processes and for the remediation of contaminated sites**		

Short description

This research activity will be carried out in the frame of a High-Level Training Apprenticeship PhD. This PhD course allows an enterprises to hire a young graduate (under 29 years old) through an apprenticeship contract, who will work in the Enterprises and carry out a research project of common interest. Training periods in the Enterprises and at the University are specified in the contract, as well as the PhD course to be attended. The company involved is M^3R srl (Monitoring and Management of Microbial Resources). M^3R is an academic spin-off of the University of Milano Bicocca founded in 2019 as a highly specialized consultancy company in the environmental remediation sector. The company's activities are mainly aimed at the microbiological aspects of bioremediation processes to support the entire remediation process and to identify the best intervention solutions. The PhD project deals with the research, development and validation of new molecular markers to study specific microbial metabolisms. These markers will be applied to characterize microbial community in different environmental matrices (soil, groundwater and air), to assess the presence of microorganisms (bacteria, fungi and archaea) which could be metabolically interesting for environmental applications, to evaluate the biodegradation potential of contaminated sites and to monitor the biodegradation processes. Furthermore, the PhD project will be focused on the development of new biological technologies to remediate contaminated environmental matrices and on the application of the developed molecular markers and technologies to specific case studies: from a preliminary evaluation of the problem, a case-specific remediation strategy will be planned through the design of a solution which is economically and environmentally sustainable and through the set-up of treatability tests at laboratory and/or pilot-scale to simulate different treatment conditions to select the best bioremediation solution.

SSD	CHIM/12 - CHEMISTRY FOR THE ENVIRONMENT AND FOR CULTURAL HERITAGE	Supervisor	Marina Lasagni
Title	Microplastic as a carrier of micropollutants in the marine environment		

Short description

Plastics are ubiquitous and unfortunately occur in all the compartments of the marine environment (coastline, surface water, water column, seabed, and biota), also affecting areas considered pristine. Since the permanence of plastic in each compartment is recognized as the critical factor in determining their degree of degradation, and therefore the formation of microplastics (MPs) with the related chemical profile, investigation on field supported by advanced analytical tools is required (i.e., by infrared spectroscopy and mass spectrometry). Moreover, due to their hydrophobic properties and large surface area to volume ratio, MPs may act as carriers of hazardous contaminants and act as a new partitioning medium for environmental micropollutants. The project aims to develop and apply new methods to trace MPs and their associated contaminants in the marine environment by both targeted and untargeted approaches. The goal is to compare their concentrations in ice/sediments/water/biota (including comparative analyses for, e.g., number of particles, their size distribution, total mass, type of plastics, class, and concentration of associated micropollutants) and to highlight possible correlation with the environmental factors and transport mechanisms.

Possible collaborations will be with P.P.Shirshov Institute of Oceanology (Russian Federation), University of Barcellona (Spain), University of Las Palmas, and Gran Canaria (Spain), Centro Oceanográfico de Canarias (Spain), to study different regions and marine environments.

SSD	CHIM/12 - CHEMISTRY FOR THE ENVIRONMENT AND FOR CULTURAL HERITAGE	Supervisor	Luca Ferrero
Title	**Airborne micro-plastics: from indoor to outdoor and from urban to remote areas; the chemical interactions with particulate matter and gaseous compounds**		

Short description

Plastic pollution is one of the most important problems of the Earth as whole connected environment. The worldwide extensive consumption of plastic materials, due to low cost of production and his versatility, generate severe environmental consequences (Rocha-Santos, and Duarte, 2015). Peng et al. (2020) reviewed the current state-of-art of both Microplastics (MPs) and Nanopalstics (NPs) into the oceans finding that the yearly flux of plastics into the oceans per year in 2017 was more than 33 times of the total amount of plastics present in the oceans until 2015, ~15–51*109 MPs fragments ~93-236*103 tons of MPs (Van Sebille et al., (2015). Moreover, a further increase of ~33*109 tons is expected by 2050 (Plastics Europe, 2016). The origin and evolution of MPs in the environment reflects their capability to partition in different environmental compartment. In this respect, MPs can be classified in two categories: primary microplastics and secondary microplastics (Bergmann et al., 2015). Due to their small size and low density, microplastics can be easily suspended into the atmosphere by wind or air turbulence and can persist in the atmosphere for extended periods of time (Cai et al., 2017; Dris et al., 2016).Moreover, numerous studies as also shown the correlation between the presence of microplastics particles in the atmosphere of industries and chronic diseases (Pimentel, Avila e Lourenço, 1975), (Warheit et al., 2001).Thus, this study aims at investigating the contamination levels of airborne microplastics from indoor to outdoor and from urban to remote areas. A special attention will be given to the chemical interactions with particulate matter chemical components and gaseous compounds

SSD	CHIM/12 - CHEMISTRY FOR THE ENVIRONMENT AND FOR CULTURAL HERITAGE	Supervisor	Elena Collina
Title	Life cycle assessment of plastic materials in the circular economy		

Short description

In the framework of the European Commission circular economy strategy, one of the biggest challenges is finding solutions to the increasing generation and accumulation of non-biodegradable plastic waste. Bio-based polymers (bioplastics) are developed as a replacement material for plastics produced from fossil feedstocks. Particularly, bioplastic production from microalgae is currently being explored. A powerful tool to model the relevant environmental loads and impacts related to the entire life cycle of a product or system from resource extraction to final waste management is life cycle assessment (LCA). Aim of the study is a comprehensive LCA evaluation of bioplastics compared to petrochemical plastics, focusing on a full representation of all environmental impacts attributable to plastic, the inclusion of additives in inventories, careful accounting of carbon storage and release, modelling of plausible and relevant end-of-life scenarios. Possible collaborations with University of Alicante, Spain; University of Umea, Sweden; Swedish University of Agricultural Sciences, Sweden; University of Riga, Latvia.

SSD	GEO/04 - PHYSICAL GEOGRAPHY AND GEOMORPHOLOGY	Supervisor	Alessandra Savini
Title	**Quantitative Analysis of submarine geomorphological data for multidisciplinary geo environmental studies**		

Short description

Quantitative analysis of submarine geomorphological data quantifies terrain parameters and spatial patterns associated with submarine landforms, in order to relate them to geologically significant processes. The project aims at analysing a multi-sensor 3D dataset, obtained through acoustic and optical remote sensing techniques, in different submarine geomorphological settings, for applications ranging from geological risk assessment to offshore biotic and abiotic resource management.

The work will include the participation in ship-based research surveys, the processing of multibeam and backscattering datasets through the use of dedicated software and the application of photogrammetric techniques to seafloor imagery (i.e.: Structure from motion - SfM) for estimating three-dimensional structures from two-dimensional RGB image sequences. Quantitative integrated geo-spatial analyses will be performed on the collected dataset and particular emphasis will be given to the development of an innovative workflow for an automatic classification of submarine landforms based on Object-based Image analysis (OBIA) techniques

SSD	GEO/12 - OCEANOGRAPHY AND PHYSICS OF THE ATMOSPHERE	Supervisor	Claudia Pasquero
Title	Small scale heat, moisture, and gas fluxes at the air-sea interface		

Short description

Oceans store a significant fraction of the excess heat and CO_2 associated to human activities. The fluxes at the air-sea interface control the partitioning of properties among water and air, and are dependent on small scale processes that affect the depth of the ocean mixed layer and the thickness of the marine atmospheric boundary layer. This project aims at using observational datasets and numerical models to disentangle the mechanisms at play at small scales, and to quantify the role of the small scale coupling on large scale fluxes. It involves the study of vertical transport in the oceans and in the atmosphere. Possible research directions involve the study of the effects on nutrient fluxes and the consequent ecosystem response, as well as the effects on cloud cover and rainfall, including intense events such as tropical cyclones and tropical-like cyclones.

The project is part of the study undertaken in the framework of the JPI Oceans and Climate "EUREC4A-OA" project, focusing on the small scale air-sea feedbacks in the subtropical Atlantic region, and it supports the ESA Earth Explorer X Candidate Mission Harmony, devoted to the observation of surface ocean currents, waves, and surface winds at very high resolution. It involves collaborations with Sabrina Speich (Ecole Normale Superieure, Paris), Lionel Renault (Univ. Toulouse, France), Annalisa Bracco (Georgia Tech, Atlanta, USA).