YOUNG RESEARCHERS IN ECOLOGY AND ACQUATIC SCIENCES MEETING

DETAILED PROGRAM & SPEAKERS

TUESDAY JUNE 11TH

9:15 AM	Registrations and gadget collection
9:45 AM	Welcome speech & High interest seminar: speaker Chiara Lombardi, ENEA
11:00 AM	**Session 1: Marine biodiversity and Functioning** Group 1: Novel techniques in marine environments *Apparete, R.; Coppola, A.; delli Carri, T.; Varchetta, R.; Zitelli, R.*
12:15 AM	**Session 1: Marine biodiversity and Functioning** Group 2: It's all about marine pollution *Concari, E.; Dettoto, C.; Maccantelli, A.; Morgillo, A.; Signorini, S.*
1:30 PM	Lunch break
2:30 PM	**Session 1: Marine biodiversity and Functioning** Group 3: Further understanding of underwater ecology *Colotto, F.; Porro, M.; Romano, P.; Secco, S.; Vignati, F.*
3:15 PM	**Session 1: Marine biodiversity and Functioning** Shorts: Where is research going? *Bacchet, N.; Bohao, H.; Cometti, C.; Iacuzzo, F.; Lorenzini, S.; Riontino, A.; Schiavo, A.; Siena, F.*
4:00 PM	**Session 2: Biodiversity, Human Wellbeing and Society** Group 1: Humans and Chemicals *Gualandris, D.; Nigro, L.; Toini, E.*
4:45 PM	**Session 2: Biodiversity, Human Wellbeing and Society** Shorts: Where is research going? *Bogani, D.; Corneo, L.*

We remind the happy hour, offered by the organization team, for all presenters of the event.
It'll start at closure of the last session.
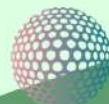
YOUNG RESEARCHERS IN ECOLOGY AND ACQUATIC SCIENCES MEETING

DETAILED PROGRAM & SPEAKERS

WEDNESDAY JUNE 12TH

9:15 AM	Registrations
9:30 AM	High interest seminar: speaker Diego Fontaneto, CNR
10:00 AM	**Session 3: Assessing and Monitoring Terrestrial and Freshwater Biodiversity** Group 1: Ecology snippets from Northern Italy *Palazzi, A.; Tolve, M.*
10:30 AM	**Session 3: Assessing and Monitoring Terrestrial and Freshwater Biodiversity** Shorts: Where is research going? *Abbà. M.; Taurozzi, D.; Villa, B.*
11:00 AM	**Session 4: Ecosystem Functions, Services and Solutions** Group 1: Everything plastics *Cremonesi, C.; Minolfi, V.; Sbarberi, R.*
11:45 AM	**Session 4: Ecosystem Functions, Services and Solutions** Group 2: Consequences of human actions *Calattini, I.; Caorsi, G.; Giannini, D.; Marino, A.*
1:00 PM	Lunch break
2:00 PM	**Session 4: Ecosystem Functions, Services and Solutions** Shorts: Where is research going? *Cherchi, M.; Riseri, D.; Toniolo, L.M.*
3:00 PM	**Session 5: Urban Biodiversity** Group 1: City crawlers *Colombo, B.; Piquet, A.*
3:30 PM	**Session 5: Urban Biodiversity** Shorts: Where is research going? *Armanni, A.; Brambilla, G.; Stucchi, D.; Verduci, V.*
4:00 PM	Closing speech

YOUNG RESEARCHERS IN ECOLOGY AND AQUATIC SCIENCES MEETING

Book of Abstracts

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ABSTRACTS- ORAL PRESENTATIONS

1. Marine Biodiversity and functioning

Nuove metodologie per l'analisi del plancton (ZooScan e A.I.): un caso di studio sito LTER Promontorio di Portofino (LTER_EU_IT_015)

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3. Lorenzo Magnone, Paolo Vassallo, Paolo Povero DISTAV - Università degli Studi di Genova

Lo studio del plancton coinvolge una gamma diversificata di metodi di ricerca finalizzati a comprendere la sua composizione, distribuzione e funzione al fine di rapportarlo ad uno stato di salute ambientale. I tradizionali approcci microscopici consentono l'identificazione e la quantificazione delle diverse specie. I progressi tecnologici hanno permesso lo sviluppo di strumenti che consentono di ottenere immagini digitalizzate utilizzabili da intelligenze artificiali (A.I.) in grado di automatizzare il processo di riconoscimento così da velocizzare le analisi di una maggiore quantità di campioni. L'obbiettivo principale del lavoro è stato quello di integrare alla metodologia classica quella più moderna di digitalizzazione delle immagini tramite l'utilizzo dello ZooScan e classificate da un'A.I., mediante la piattaforma web EcoTaxa, al fine di migliorare ed implementare la metodica di riconoscimento. Durante lo studio sono stati analizzati campioni prelevati nel sito LTER Promontorio di Portofino, in diversi periodi dell'anno, così da testare ed accrescere, gli algoritmi dedicati al riconoscimento dei vari organismi. Si è inoltre cercato di realizzare un nodo dell'A.I. sito-specifico per il riconoscimento dei Copepodi, gruppo che presenta ancora criticità nella classificazione dettagliata con metodologie automatiche. I risultati ottenuti evidenziano che questa nuova tecnica risulta particolarmente efficace per la classificazione di organismi come Copepodi, Appendicularie e Diplostraca mentre per altri gelatinosi e fragili si evidenziano ancora alcune problematiche. In conclusione questa metodologia basata sull'utilizzo del machine learning, con un continuo miglioramento dei dataset, può diventare un ottimo supporto ad altre tecniche di indagine del plancton che richiedono maggior tempo di analisi e costi più elevati.

Modeling shift dynamics in infralittoral rocky reefs

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Mediterranean infralittoral rocky reef ecosystems can undergo a distinctive regime shift, where the healthy state, characterized by a forest of macroalgae supporting a rich and diverse community, is replaced by sea urchin barrens, a degraded state with low complexity and biodiversity. Sea urchins usually play a pivotal role in this process, since, under certain conditions, they can significantly increase in number and alter their grazing behavior, thus favoring this unwanted regime shift. We propose a process-based, dynamical model that aims to describe the dynamics of these communities, with particular focus on the shift between macroalgae-dominated states and sea urchin barrens. The model accounts for the spatio-temporal dynamics of algal cover, as well as the presence of sea urchins and their predators (e.g. sea breams). This allows us to investigate the role of key processes and trophic interactions, as well as the role of protection measures and fishing pressure, in affecting and shaping the state of these communities. Eventually, we aim at expanding the model to explore the combined effects of climate change and marine connectivity.

Caratterizzazione dell'ittiofauna associata a 3 FAD (Fish Aggregating Device) in Mar Ligure

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2, 3. Federico Betti, Giorgio Bavestrello - Università degli Studi di Genova

Qualsiasi oggetto galleggiante, di origine naturale o antropica, che nel contesto di monotonia paesaggistica dell'ambiente pelagico sia in grado di esercitare un'azione attrattiva nei confronti di ittiofauna, si dice che si comporti da FAD (Fish Aggregating Device). La conoscenza sui meccanismi evolutivi alla base di questo tipo di associazione e sulle interazioni ecologiche dei pesci coi FAD in generale è piuttosto limitata e in Mediterraneo sono stati condotti solo pochi studi finalizzati a caratterizzare la comunità ittica che li frequenta. L'obiettivo di questo lavoro è stato quello di descrivere la comunità ittica associata a 3 diverse strutture che si è ritenuto potessero comportarsi da FAD, tutte collocate nel Golfo di Genova. Tramite osservazioni effettuate a cadenza regolare in questi 3 siti per un periodo complessivo di 10 mesi è stato in primo luogo possibile identificare la presenza di una comunità ittica composta nel complesso da 9 specie che coincidevano con quelle osservate in passato da altri autori attorno a FAD nella stessa area. Secondariamente, è stato possibile identificare diversi pattern di distribuzione spaziale dei pesci attorno agli oggetti, distinguendo tra specie aggregate e specie associate ai FAD in base alla relazione di dipendenza sviluppata con queste strutture. Per ciascuna specie inoltre è stato definito uno schema stagionale di frequentazione dei FAD nel corso del periodo di osservazione. Ulteriori considerazioni sono state effettuate per cercare di comprendere il motivo dell'aggregazione o associazione delle varie specie osservate con questi oggetti.

Hydrolytic enzymes fingerprints in surface and deep-sea prokaryotic communities in the Ross Sea (Southern Ocean)

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2. Elisa Banchi, National Institute of Oceanography and Applied Geophysics—OGS, Trieste, Italy, NBFC (National Biodiversity Future Center,Palermo, Italy);
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The Ross Sea is one of the most productive areas in the Southern Ocean, characterized by a significant export of particulate organic carbon (POC) to the deep water layers, reaching up to 50% of surface primary production. This phenomenon is dependent on mineralization processes performed by prokaryotic communities through a complex set of hydrolytic enzymes by which they can cleave large organic molecules.

In this study, we used a metagenomic approach to explore the genetic repertoire of free-living and total prokaryotic communities living in the surface and in the deep -water masses of the Ross Sea. In particular, we focused on the genes involved in the production of exoenzymes such as glycosyl hydrolases (GH), proteases and lipases.

The samples were collected during the XXXII Italian expedition to Antarctica, in three stations along a coast-offshore transect, in surface and bottom (from 550 to 1065 m depth) layers. Then, the DNA samples were collected for metagenomic analysis in unfiltered (total) and 1-µm-filtered (free living microbes) water.

Our results show that the normalized abundance of exoenzymes is generally higher at the surface and in the filtered samples, but the number of exoenzymes families are higher at the bottom.

Our findings indicate that deep-sea microbes in this environment harbour the potential to quickly exploit the pulses of a broad spectrum of organic substrates carried to the mesopelagic by the intense export flux of primary production. In progress analyses will further shed light on the preferred foraging strategies by free-living and particle-attached prokaryotes.

Fin isotopic analysis in Antarctic fish as a non-lethal method for trophic studies

Roberta Zitelli(a), Giulio Careddu(a,b), Simona Sporta Caputi(a,b), Matteo Ventura(a), Davide Giannini(a), Edoardo Calizza(a,b), Loreto Rossi(a,b), Maria Letizia Costantini(a,b)
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Notothenioid fish are a dominant endemic component of Antarctic communities. Their adaptations to low temperatures make them vulnerable to climate warming affecting the region. Occupying intermediate positions in food webs, these fish species link lower trophic levels with top predators. Given this and their peculiar adaptations to extreme conditions, notothenioids are a prime target for eco-biological and physiological studies. Trophic studies often use white muscle for C and N isotopic analysis, which provide medium-long term information on carbon sources and trophic positions occupied by specimens. However, this approach requires specimen sacrifice. The aim of this study was to assess the possibility of replacing isotopic analysis in muscle with non-lethal fin analysis at both population and individual levels in eight notothenioid species. This may help to fulfil the "do not significantly harm" principle of scientific research in Antarctica. The average isotopic offset values, i.e. the difference between isotopic signature of caudal or pectoral fin and muscle, were respectively 1.11±0.03‰ and 0.75±0.04‰ for C and 0.83±0.03‰ and 0.66±0.04‰ for N. These offsets were not influenced by individual standard length but were influenced by C and N content in fins. While muscle and both caudal and pectoral fin isotopic signatures were positively related when considering the entire dataset and the mean values of species, this relationship was absent when comparing individuals within species. Non-lethal fin analysis can thus provide useful information for studies comparing populations, habitats and/or years, yet it should not be applied to describe trophic variability within populations.

Antioxidant cellular response of the soft coral Pinnigorgia flava after exposition to polypropylene nanofibers and polypropylene nanofibers leachate

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After the spreading of COVID-19, the amount of plastics in the ocean was severely enhanced due to the increased production of PPE, in particular surgical masks. Once entered into the environment, these disposable items can both release potential toxic additives and undergo fragmentation leading to the formation of microplastics and nanoplastics. Moreover, microplastics and nanoplastics are considered the most harmful for corals and marine organisms since can easily be ingested. Current information regarding the effects of micro and nanoplastics on coral reefs is limited; especially the toxicity of nanoplastics and nanoplastics leachate from fibers degradation of synthetic fabrics. The alcyonacean was exposed for 72 h to different concentrations of polypropylene nanofibers (0.1 and 1 mg/L) and nanofibers leachate (0.1 and 1 mg/L) under controlled aquaria conditions. The cellular response was assessed through antioxidant enzymatic assays, namely Superoxide Dismutase (SOD), Catalase (CAT), Glutathione Reductase (GR), and Glutathione-S-Transferase (GST). Results showed that for all treatments, oxidative stress was experienced in all samples. However, different patterns of enzymatic activity were observed between nanofibers and leachates, with a general higher toxicity generated by leachates exposition that produced an inhibition and/or impairment of the antioxidant defense mechanisms at cellular level. This study represents a new area of investigation and is one of the first to focus on such stressors on soft coral species. In addition, the results highlight that nanofibers and leachates are indeed a major threat for coral reefs, which are already exposed to multiple climate change stressors and relentless anthropogenic pressures.

Assessment of microplastic ingestion in nineteen fish species of different trophic levels from two poorly investigated Sardinian areas

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2. Italian Institute for Environmental Protection and Research (ISPRA), Rome, Italy

Marine litter is ubiquitous in marine environment, and it is predominantly composed of plastic. Microplastics (<5 mm) and plastic materials released in marine environment could cause both chemicals and physical impacts on marine species. This study investigates the marine litter impact, particularly the microplastics and microfibers ingestion on nineteen fish species sampled in two Sardinian areas, particularly in the Gulf of Asinara and in the Marine Protected Area of Capo Carbonara. Microplastics and microfibers ingestion was evaluated through gastrointestinal tract digestion in KOH 10%. Particles have been then categorized by shape, colour, dimension, and polymer. The polymeric analysis was carried out with μ-FT-IR Spectroscopy. In the Gulf of Asinara was obtained an occurrence of 35.2% (117 / 366 specimens), where Mullus barbatus was the species with a highest microplastic occurrence (75%), while in Capo Carbonara was observed an occurrence of 29.4% (40 / 136 specimens) and the Pagellus erythrinus was the species with highest occurrence (60%). Microplastics ingestion on Macroramphosus scolopax and Sparisoma cretense were investigated for the first time in Mediterranean Sea in this study. Fibers were the anthropogenic particles most found, followed by fragments and film, and the polymeric analysis has showed cellulose, rayon/viscose and PET as the main polymers. This study contributes to increase the information concerning microplastics ingestion by different fish species, particularly focusing on two areas that have been less studied.

Assessment of Phthalate concentrations in four edible fish species along the Italian coast

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Phthalates (PAEs) are an emerging contaminant of concern due to their widespread use in industrial activities and potential release into the environment, but little is known about their presence and accumulation in marine organisms. The aim of this study is to assess PAEs burden in commercial fish species caught in five macro-areas along the Italian coast (North and Center Adriatic Sea, Sardinian Sea, Ligurian Sea and Tyrrhenian Sea). The levels of 11 PAEs of environmental relevance were evaluated in the muscles of B. boops (n=104), E. encrasicolus (n=90), M. barbatus (n=68) and S. pilchardus (n=97) using a specific analytical method. DPrP was <LOD in all species and in all areas investigated, whereas DEHP, DIBP and DBP are the most frequently detected PAEs with highest concentrations. Statistically significant differences were observed between sampling areas and between species, both for the total amount of PAEs and for the concentrations of individual substances. Higher levels were observed in S. pilchardus, especially in the Ligurian study area, with a mean Σ-PAEs value of 332.70 ± 165.33 ng/g ww. The results of this study improve the understanding of PAEs accumulation in Mediterranean species. Furthermore, the known endocrine disrupting properties of the PAEs detected and the commercial value of the species analyzed highlight the need for specific additional studies to better understand the potential impact on the food web and human consumption.

Does ocean acidification affect the limpet Patella caerulea? Investigation of the potential adaptive mechanisms occurring at the Castello Aragonese CO2 vent systems

Signorini Silvia Giorgia1,2, Munari Marco3, Crocetta Fabio2, D'Aniello Ilaria3, Malaga Riccardo3, Nigro Lara1, Della Torre Camilla1,2

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3 Department of Biology, Stazione Idrobiologica Umberto d'Ancona, University of Padova, Chioggia (Venice), Italy.

Ocean acidification (OA) entails a detrimental impact across different taxa, particularly on calcifying organisms. Nevertheless, the limpet Patella caerulea is one of the few calcifying species capable of inhabiting the Castello Aragonese CO2 vent systems (Ischia Island), a naturally acidified site due to volcanic CO2 emissions from the seafloor.

To investigate potential adaptive mechanisms underlying tolerance to OA, specimens of P. caerulea were collected along the northern pH gradient of the vent (N1: ambient pH~8.1; N2: intermediate pH~7.7; N3: very low pH<7.4) and from the promontory of San Pietro, an additional site with ambient pH on the island. The following analyses were carried out on collected individuals: i) morphometric parameters measurement, ii) respiration rate and ammonia excretion rate, iii) untargeted metabolomics, iv) assays of biomarkers related to antioxidant system, energy metabolism, and neurotoxicity.

A strong shell dissolution was evident in organisms living in the acidified sites. Conversely, limpets from low pH sites displayed an increase in their dimension, which is potentially correlated with a different food availability. Accordingly, a significant increase in glycogen content was detected in N2 and N3. Furthermore, metabolomics revealed an induction of carnitine metabolism, pointing out a potential energy expenditure to cope with OA. No oxidative stress was found, while a significant increase in respiration rate was detected in the extreme acidified site N3, but only during summer.

Overall, these results might be indicative of local adaptation of the limpets at the Castello Aragonese vent systems, but further analyses are ongoing to confirm this hypothesis.

Mimicry e camuflage nella famiglia di molluschi Ovulidae: verso un'analisi quantitativa di caratteri elusivi potenzialmente importanti in ambito evolutivo

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I molluschi della famiglia Ovulidae sono noti per essere parassiti di ottocoralli (gorgonie, coralli molli e pennatulacei) dai quali dipendono nutrendosi dei tessuti molli. Il mantello di questi gasteropodi avvolge la conchiglia e presenta colorazioni e morfologie atte a confonderli con l'ospite, rendendo alcune specie difficili da individuare. Sebbene queste strategie di camuffamento siano ben documentate, non sono state analizzate al punto di vista sistematico. Recenti studi molecolari sulla classificazione degli Ovulidi, hanno inoltre dimostrato che parametri precedentemente utilizzati non sono affidabili per una classificazione sistematica.

Questa tesi ha l'obiettivo di analizzare quantitativamente i colori e i pattern cromatici del mantello degli ovulidi per identificare nuovi elementi utili a comprendere meglio il rapporto coevolutivo con i loro ospiti. Utilizzando il pacchetto Colordistance di Rstudio, è stato possibile quantificare i colori del mantello di diverse specie di ovulidi e confrontarli con quelli dei coralli ospiti. Il lavoro si divide in tre parti: l'analisi di Phenacovolva rosea, una specie poco studiata con grande variabilità fenotipica; il confronto delle distanze colorimetriche e genetiche in Cyphoma gibbosum, dove non è stata trovata una correlazione significativa, probabilmente a causa di un campione di dati esiguo; e la quantificazione della capacità di adattamento cromatico agli ospiti in due specie criptiche (Amonovula piriei, Aclyvolva lanceolata) e una aposematica (Cuspivolva tigris), sviluppando un "indice di criptismo".

I risultati mostrano l'efficacia e le potenzialità del metodo nel quantificare i colori e le differenze cromatiche. Tuttavia, la scarsità di fotografie adeguate allo scopo ha limitato i risultati. La metodologia proposta si dimostra efficace e dovrebbe essere considerata per studiare al meglio questi organismi.

The impact of thermal stress on coral pigments and non polar metabolites profile: a preliminary study

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One of the major problems of our century is the rising of the ocean temperatures, causing several consequences on marine ecosystems. One of the most evident phenomena is the coral bleaching, which modify the symbiotic relationship between the polyp and unicellular algae, necessary for the energy balance and survival of the coral system. This project was focused on the development of an innovative experimental method, to be evaluated on a laboratory scale, to study the impact of rising temperatures on coral metabolism, specifically on the pigments in symbiotic algae and on non-polar metabolites. Extractions were performed on two coral species cultivated in the Aquarium of Genoa, Pocillopora damicornis and Stylophora pistillata, following indications from the literature. The pigment analysis was conducted using an HPLC-DAD instrument, detecting the continuous wavelengths in the visible spectrum in the 350 to 700nm window. For non-polar metabolites, an organic solvent extraction and purification procedure was carried out and then analyzed by gas chromatography coupled with mass spectrometry (GC MS) in non-target mode. The collected data were subjected to a statistical analysis and referring to the pigments analysis, significant differences in the medians of the distributions were searched for using the Mann-Whitney tests. For non-polar metabolites, a statistical analysis was carried out comparing the differences between stressed and non-stressed (control) samples and the metabolites identified were put under different classes. In conclusion, this work has shown that the expression of both photosynthetic pigments and non-polar metabolites undergoes significant variations when corals are subjected to temperature variations.

Structural and ecotoxicological effects of the protein corona formed on various nanoparticles using the coelomic fluid of the sea urchin Paracentrotus lividus

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The identification of the proteins present on the surface of nanoparticles (NPs), known as protein corona, and the study of their structural changes, is essential to clarify the environmental safety of NPs and facilitate the regulation of their use [1]. The protein corona they acquire upon contact with biological media plays a fundamental role in mitigating or stimulating ecotoxicological responses. At the molecular level, conformational changes occurring in the corona proteins upon interaction with the NPs could affect fate and biological outcomes [2]. To date, studies have mainly focused on the effects of NPs and the related protein corona on humans, neglecting their effects on aquatic species including marine ones.

Here we investigated how different NPs having various sizes and core compositions, such as titanium dioxide (nTiO2), functionalized polystyrene (PS-NH2; PS-COOH), and silver (AgNPcitLcys) acquire different protein corona compositions upon incubation with the coelomic fluid of the Mediterranean sea urchin Paracentrotus lividus. NPs properties upon corona formation were investigated by DLS and TEM and changes in the corona composition were assessed by SDS-PAGE and LC-MS. The effects of these NPs were evaluated by ecotoxicological analysis on P. lividus immune cells with acute (4-hour) in vitro exposures at ambient (25 ug/L) and higher (25 ug/mL) concentrations. The effects of NPs with protein corona were analyzed based on cell viability, lysosomal stability, and red blood cell count.

Preliminary results suggest that the characterization of NPs in CF shows greater stability over time, the probable cause of which is determined by the formation of a mature corona at 24h exposure. Proteomic analyses have been conducted to characterize the proteins that constitute the protein corona. The results show a heterogeneous protein composition that depends on the dimension, chemical nature, and shape of the NPs. In vitro ecotoxicological analyses have demonstrated statistically significant effects on cell viability even at ambient concentrations. Moreover, a dose-dependent response was observed in both cell viability and lysosomal stability tests.

Assessing the Impact of Gadolinium Contamination on Marine Bivalve D. trunculus: Implications for Environmental and Human Health

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Gadolinium (Gd), a rare earth element, has diverse applications in the technological and medical fields. Used in magnetic garnets, computer memories, and Magnetic Resonance Imaging (MRI), its safety has been questioned due to associations of the appearance of nephrogenic systemic fibrosis and calcium homeostasis disruption observed in the patients submitted to MRI. Studies also reveal its persistence in the body post-MRI and accumulation in organs like the brain, bones, kidneys, and skin. Environmental concerns arise from its release into water bodies via hospital effluents and inefficient removal by wastewater treatment plants, reaching alarming levels also in coastal and marine environments. From these assumptions this study aims to investigate the effects Gd concentrations on the marine bivalve D. trunculus, reflecting varying contamination environmental levels of Gd. Accumulation and oxidative stress were detected in clams in a 14-day experiment of exposure with five increasing Gd (0, 10, 50, 250, 500 μg/L) concentrations. This study reveals that the detected concentrations of Gadolinium induce oxidative stress in D. trunculus, affecting its metabolic capacity, antioxidant enzyme response, biotransformation mechanism, and lipid peroxidation. D. trunculus emerges as a suitable sentinel species for Gd analysis, exhibiting a proportional accumulation of contaminants in its tissue. These findings underscore the risk of oxidative stress even at Gd lower concentrations, common in nature. With Gd's increasing use, environmental concentrations may rise, posing health risks to aquatic organisms and humans through biomagnification. Vigilance is crucial, considering potential indirect exposure through the food chain and direct contact at touristic bathing sites.

Età e accrescimento del pesce falce, Zu cristatus (Bonelli, 1819) (Osteichthyes; Trachipteridae) in Mar Ligure

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Pinto, C.1; Terenziani, G. 1; Lanteri, L. 1; Garibaldi F.1; Università degli studi di Genova

Il pesce falce Zu cristatus (Bonelli 1819) (Lampriformes, Trachipteridae) popola le acque temperate e tropicali degli oceani di tutto il mondo ed è segnalato in tutto il Mar Mediterraneo, in particolare nel bacino occidentale. Nonostante l'ampia distribuzione, le informazioni riguardanti la biologia e l'ecologia di questa specie sono ancora scarse. L'introduzione in Mar Ligure nel 2010 del palangaro mesopelagico per la pesca del pesce spada, che ha portato a un cambiamento delle catture accessorie (by-catch) rispetto al palangaro di superficie, ha permesso di campionare 59 esemplari adulti (20 maschi e 39 femmine) di taglia compresa tra 57-106 cm LS (lunghezza standard) dal 2013 al 2023; nello stesso periodo un ulteriore individuo giovanile indeterminato di 26,5 cm LS è stato rinvenuto spiaggiato. Per la determinazione dell'età è stato effettuato il conteggio delle bande di accrescimento presenti sul corpo vertebrale. L'analisi delle vertebre, trattate con una soluzione di rosso di alizarina, ha permesso di estrapolare i parametri della curva di crescita di Von Bertalanffy (L∞=93,85 k=0,63 T0=0,16) stimando una longevità massima di 5 anni per i maschi e 8 anni per le femmine.

Life history traits of elasmobranch species across a gradient of fishing disturbance off the coasts of Sicily

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Elasmobranch species, despite being commonly found in the Mediterranean Sea, are highly understudied due to the difficulty in sampling and the lack of long-term monitoring programs. In the meanwhile, many elasmobranch species are facing increasing population declines due to multiple sources of disturbance, such as overfishing and climate change. Populations of different species are spread across different areas off the Sicilian coasts, inhabiting heavily exploited fishing grounds, then it is crucial to study their ecological role and to assess their condition within the marine ecosystems. Here we focused on 4 species, namely Scyliorhinus canicula, Galeus melastomus, Etmopterus spinax, Mustelus punctulatus consistently sampled off the Gulf of Castellammare (Southern Tyrrhenian Sea) and off the Gulf of Catania (Ionian Sea) and on Dalatias licha only occasionally found at Castellammare Gulf. The species were caught as bycatch by experimental bottom trawl surveys lasting a year and performed on the two above mentioned gulfs banned to trawling activities since the '90s. Data gathered on the biology and the ecological role of the populations in the study areas represent a crucial knowledge baseline to inform effective spatial management measures. Relationship between the population and the fishing activities and the effects of such relationship have been preliminary tested. Evidence from life history traits (total length, body mass, sex, maturity stage) of specimens have been correlated to environmental parameters, such as depth range, to build the missing knowledge baseline that can be used for future monitoring and management plan in the area.

Assessing the Vulnerability and Exposure of Mediterranean Sea

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This study delves into the vulnerability and exposure of Mediterranean seagrass ecosystems to the impacts of climate change. Employing a multidisciplinary approach, the research evaluates shifts in seagrass habitat suitability driven by climate factors and explores their socio-economic ramifications. Through meticulous data analysis and sophisticated modeling techniques, the study underscores the necessity of evaluating climate-induced risks by integrating species sensitivities and habitat exposures. Such integrated analyses offer comprehensive insights crucial for biodiversity conservation and effective ecosystem management.

Composition and spatio-temporal dynamics of benthic marine biodiversity in the southern ocean

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The Southern Ocean has unique environmental conditions compared to other areas of the world, making it a key area for the analysis of future biodiversity changes. The peculiarities of this polar ecosystem have played an important role in structuring marine biodiversity, being characterized by high levels of endemism, ecological and cryptic diversity. Overall, available data on the development and dynamics of benthic communities have shown a marked sensitivity to anthropogenic and climatic changes, indicating a profound impact at both the community and species levels. However, these studies have rarely been conducted with reproducible and standardized techniques, limiting our understanding of these changes in both space and time. This standard can now be achieved by using the Autonomous Reef Monitoring Structures (ARMS) designed by Leray and Knowlton (2015). The simplified design of these structures provides an easily quantifiable sampling methodology without reducing the complexity of the system while allowing researchers to adopt more advanced technologies for studying fouling organisms, such as high throughput sequencing (HTS). The aim of this project proposal will be the identification of major taxonomic groups in pioneer benthic communities of the Southern Ocean and the structure of these communities at different time intervals. Identifications will be carried out by using a combination of classic morphology-based identification methods and molecular ones (barcoding and HTS techniques). This study is pivotal in acquiring comparative data over the long term to understand the structuring and dynamics of pioneer benthic communities, hence providing the necessary reference baseline for future studies.

Microbial community characterization and dynamics in two italian shallow marine ecosystems affected by methane emissions

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In the marine ecosystem, shallow nearshore coastal environments are major contributors to global methane (CH_4) emissions. Methanotrophic microorganisms can act as "methane filters" by oxidizing CH_4 released from the seafloor, thus potentially preventing its degassing into the atmosphere. The MEFISTO project combines physical, chemical, and molecular biology methods to investigate marine methane emission fluxes with the aim of drawing conclusions about future emission patterns in the context of climate change. In this study, we compare the microbial communities of two Italian shallow coastal ecosystems characterized by natural gas emissions: a seepage zone in the Gulf of Trieste (Adriatic Sea) and the hydrothermal vent area off the Panarea Island (Tyrrhenian Sea). The two sites are placed in very different environmental contexts in terms of temperature, acidification and CH_4 concentration. Since very few studies have targeted the presence of methanotrophs in such areas, in addition to the 16S gene we will also investigate the pmoA gene, which has been shown to be a good taxonomic marker for these microorganisms. The metagenomic analysis will be performed on different environmental matrices, namely sediment, seawater, biofilm, hydrothermal fluid and interstitial water, collected from the two sites. Results from this study are expected to provide useful insights into the role of the microbial community in the fate of CH_4, with the final goal of shedding light on the complex interplay between abiotic and biotic factors determining the actual transfer of CH_4 to the atmosphere.

Growth rate, metabolic responses and recruitment of Ostrea edulis resident population from the Gulf of La Spezia

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The European native oyster Ostrea edulis (Linnaeus 1758), commonly known as the flat oyster, is a calcifying habitat builder providing a set of Ecosystem Services, including climate regulation, food provisioning, biodiversity support and enhancement of habitat complexity and underwater landscape. Being a key-stone species forming habitat targeted as 'vulnerable and declining' (OSPAR Convention), O. edulis beds have been recently subjected to restoration projects across Europe (https://noraeurope.eu). In the Gulf of La Spezia (Italy), the flat oyster has been present since the end of 1800, then direct and direct anthropogenic impacts have massively contributed to the near functional extinction of their habitat. Within RAISE project (PNRR), whose objectives include 'regeneration of port areas by using Natural Based Solutions', an activity aiming at restoring O. edulis natural beds in the Gulf of La Spezia will be developed in the next three years. This project will contribute to acquire knowledge on the resident population: Ob1. Monitoring the growth rate (length, width and thickness and weight) and metabolic responses (respiration and calcification) in adult individuals collected within a harbor and kept them in oyster cages; Ob2. Assessing the recruitment rate and settlement preferences of the population in three sites inside the harbor area, by using natural substrate-oyster shells enclosed in hemp meshes and 'Chinese hats' commonly used in oyster farming. In addition to biological data, physico-chemical data (temperature, oxygen, pH, pCO2, salinity, chlorophyll-a) will be recorded weekly or monthly from the experimental sites. The project, started in May 2024, will be carried out for 6 months.

Indagini innovative per lo studio della Posidonia oceanica

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Posidonia oceanica è una pianta marina endemica del Mar Mediterraneo, protetta ai sensi della Direttiva Habitat 1992/43/CEE, come habitat prioritario. Forma estese praterie sommerse che proteggono la costa dall'erosione, sono un hotspot di biodiversità, catturano CO_2 e producono O_2, offrono vari servizi ecosistemici. L'osservazione della regressione delle praterie sia per cause naturali che antropiche ha aumentato la consapevolezza della vulnerabilità quindi della necessità di preservare tale ecosistema.

Il mio progetto di ricerca vuole contribuire a: (i) esplorare tecniche di monitoraggio innovative; (ii) identificare l'influenza dei fattori naturali e antropogenici sull'habitat di P. oceanica; (iii) descrivere il ruolo svolto dai paesaggi marini di P. oceanica sul biota associato; (iv) indagare, da un ampio spettro di punti di vista, aspetti legati al ripristino delle praterie. Infine si identificano le lacune nelle conoscenze e si propongono prospettive e azioni future.

Gli sforzi di indagine sono rivolti in Puglia, in particolare lungo la costa adriatica per valutare lo stato di conservazione del posidonieto San Vito-Barletta caratterizzato da una certa resilienza ma in regressione soprattutto nei siti dove le pressioni antropiche si fanno elevate.

L'habitat a P. oceanica andrebbe considerato come elemento strettamente connesso al litorale, fondamentale per la salute dello stesso, ove più attori possono contribuire a garantirne lo stato di buona salute: la ricerca, le imprese dell'economia blu, gli amministratori locali, la partecipazione cittadina. Tale approccio può favorire azioni innovative più efficaci in termini di conservazione, gestione e rigenerazione.

Spatially explicit modelling approach to assess fish stocks dynamics and explore the effects of fishery management actions under climate change scenarios

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Fisheries are one of the most important sources of protein worldwide, with an estimated 158 million tonnes of seafood products consumed in 2019 and about 90 million tonnes of captures in 2022. In the Mediterranean Sea, fishing is a cultural, social, and economic activity connecting many coastal communities sharing and relying on common demersal and pelagic stocks. However, the sector is under increasing pressure due to the consequences of climate change, anthropogenic impacts, and the introduction of new invasive species. This research line focuses on developing a predictive tool, based on the principles of Ecosystem-based fishery management, capable of catching future fluctuations of target fish species under the stressors mentioned. While adopting a spatially explicit modelling approach, this work aims to enhance the existing tools for the assessment of exploited fish populations and explore the effects of climate change scenarios on the actual and new possible management strategies. Moreover, the spatial dimension embedded in this methodology allows the evaluation of fishery regulations based on permanent or temporal-spatial closures, with the potential to help design new marine protected areas or expand existing ones. The proposed work provides a new case study, demonstrating the effectiveness of EBFM in marine management strategies in the Mediterranean Sea.

Searching for the last monumental corals

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Coral reefs are suffering from both natural and anthropogenic stressors which are posing threats to the survival of countries that completely rely on them for their ecosystem services, such as the Republic of Maldives.

In the last years, Maldivian reefs have undergone severe mass bleaching such as the 2016 event which impacted 73% of the corals. This couples with threats posed by corallivore outbreaks, coral diseases, human activities, and pollution.

In this scenario, billions of coral colonies might die, potentially including the most enigmatic, resistant, and old ones, colonies over 5m, very likely centennial: the giant corals. Those individuals preserve unique information from a biological, genetic, and paleoclimatic point of view since they have resisted environmental perturbations and they might hold the key to coral reef resilience.

We are presenting preliminary results of findings of giant coral colonies in the Maldives located through the help of citizen scientists. Colonies have been located across multiple atolls and belong to different species with higher abundance of Porites sp. and Pavona sp.. The work aims to raise awareness amongst the general public of the importance and fragility of these organisms, it also aims to offer the Maldivian government a map of possible sensitive areas worth protecting. Finally, this will be the basis for future studies on past oceanographic transformations, models of responses to future environmental changes, genetic and biomolecular patterns both of the colonies and of their micro and macro symbionts.

2. Biodiversity, Human Wellbeing and Society

Assessment of Legacy PFAS Contamination in Ecosystems: Bioaccumulation Patterns and Biological Impacts at a Swedish Drill Site

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This study investigates the occurrence and effects of 14 legacy per- and polyfluoroalkyl substances (PFAS) across various environmental matrices, including water, soil, different plant parts (roots, leaves), arthropods, and annelids, at a firefighting school site in Trelleborg, Sweden. We assessed both aquatic and terrestrial trophic chains, successfully reconstructing up to the apical level. A key component of this research involved also a 30-day long-term exposure experiment using the OECD species Eisenia fetida (oligochaeta) in PFAS-contaminated soil. Our multi-tiered analysis encompassed molecular, enzymatic, behavioural, and high order level effects such as survival and reproduction, providing a comprehensive evaluation of PFAS impact. The results offer significant insights into the bioaccumulation and biomagnification processes of PFAS across different trophic levels in both aquatic and terrestrial ecosystems. This study underscores the intricate interactions and potential ecological risks associated with legacy PFAS contamination. The findings are critical for enhancing our understanding of the long-term environmental consequences of PFAS exposure and for developing informed risk assessment and management strategies.

Assessing Ecological Impacts of Water-Soluble Polymers on *Daphnia Magna*: Insights from Proteome to Behavior

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Water-soluble polymers (WSPs) are ubiquitous in aquatic environments due to their extensive industrial and consumer applications, raising concerns about their effects on freshwater organism. This pioneering study evaluates the effects of four commonly used WSPs, named the polyvinyl alcohol (PVA), polyvinylpyrrolidone (PVP), polyacrylic acid (PAA), and polyethylene glycol (PEG), to the freshwater crustacean *D. magna*.

An integrated approach was applied, assessing the effects of three concentrations (0.001, 0.5, and 1 mg/L) of these WSPs at molecular, cellular, physiological, and organism levels. Acute and sub-lethal effects were evaluated, including mortality, heart rate, and some behavioral performances, encompassing horizontal swimming, vertical migration, acceleration, mobility, thigmotaxis, and phototaxis. Biochemical endpoints, such as Monoamine oxidase (MAO) and Acetylcholinesterase (AChE) activities, along with glycogen (GLY) content, were also measured as neurotoxic and metabolic endpoints. Finally, proteomics was applied to investigate potential mechanism of action of the chemicals.

Results demonstrate distinct responses to different WSPs across biological levels. Notably, PEG exhibited lethal effects and altered AChE activity at medium concentration, while all WSPs affected behavioral performance and heart rate, with PAA showing the most significant impact. Proteomic analysis revealed alterations in protein profiles, with PVA exerting the most pronounced effect. Our study contributes to improve the current knowledge on the toxic potential of a class of xenobiotics still overlooked. These findings highlight the complexity of WSP risk assessment and underscore the necessity for a deeper understanding of their ecological impacts on aquatic ecosystems. This knowledge is crucial for informed environmental management and freshwater ecosystem preservation.

Which plants would you choose to study for new drug discovery? A pipeline for a phylogenetic approach

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Considering the vast number of known plant species, each one containing its wide range of molecules, the use of a strategic approach to identify the plants to investigate is crucial to efficiently discover useful compounds. One approach is the phylogenetic one, as closely related plant species tend to share biochemistry and medicinal properties. The aim of this work is to apply different phylogenetic methods to construct a pipeline useful for the selection of plants with high potential for drug research. Thus, a phylogenetic tree containing 32.223 species was taken from literature and five monophyletic subtrees were extracted for the analyses. Lists of medicinal plants correlated with 12 diseases and 12 biological activities were downloaded respectively from the CMAUP database and the Dr. Duke's Phytochemical and Ethnobotanical databases. For each, the phylogenetic signal was measured using different methods. In the presence of phylogenetic signals, subsequent analyses were done to determine the exact position of phylogenetic clumping by identifying the hot nodes. The trees containing the species descending from the hot nodes were extracted, and those with more than 14 tips were plotted. These trees contain information about the plants identified by the method as having high potential in treating the disease. This work was able to apply a pipeline of different phylogenetic methods that can be used for the selection of potential plants for drug discovery.

Developing an Integrated Approach for Preparedness Against Novel Infectious Diseases Transmission

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In recent past time we have witnessed severe outbreaks of emerging infectious diseases that drastically impacted our lives. The One Health framework has identified four steps – prevention, detection, response, recovery – to improve global preparedness, but there is still a lack of strategies and funds for risk prevention and detection. My work aims to target both known and unknown zoonotic viruses across different critical families, by modelling local and global disease transmission and linking it with the ecological prediction of disease emergence. The goal is to demonstrate that an integrated framework can inform preparedness strategies, focusing on monitoring and early-stage intervention to effectively mitigate the transmission risk. The disease outbreak risk will be evaluated by estimating movement fluxes from potentially risky sources in pantropic regions to sink areas, with Italy serving as first case study. In these regions, compartmental models representing the spread of the disease in local communities will be explicitly connected in a spatial grid architecture, by using realistic demography and mobility data. The output, describing the geo-temporal evolution of the disease after an outbreak, will be integrated with cost estimations to define a multi-objective assessment of surveillance investments and early-stage intervention strategies that could provide insights for pandemic preparedness policy uptake. Throughout the project, the effect of environmental factors and sustainable policies will also be analyzed, highlighting the intrinsic link between safeguarding human health and environmental health.

From Sampling to Results: A Comprehensive Experimental Design to Uncover Host-Microbiome Interactions in Different Environments

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Bacteria live in every kind of environment, natural and artificial. Scientific evidence suggests a deep interconnection between microbial biodiversity and human health. Urban contexts, our new habitat, are characterized by an impoverished microbial diversity. This change likely stems from the idea that sterile environments are safer, not considering that most bacteria are beneficial, not pathogenic. The growing crisis of non-communicable diseases is partially imputable to the abrupt reduction of microbial biodiversity: it's now mandatory to investigate this phenomenon.

Our metagenomic approach integrates wet and dry lab analysis and aims to unveil the intricate host-bacteria interconnection within the environment. Our workflow is used to study the microbiome of different substrates, like surfaces, human skin, stools, water, soil, and even food. We want to bring attention to the micro-biodiversity that influences our lives, showing the critical steps and the required computational analysis to conduct a complete research project, from the bottom, up to the full experimental design.

Before setting up any sampling campaign, comprehending the underlying biological inquiries and hypotheses to be tested is imperative. After the project approval by the ethics committee (only if it involves humans or other animals), followed by the sampling campaign, the DNA extraction, and the 16S rRNA gene sequencing, we are able to perform taxonomy assignments, estimate alpha and beta diversities and, through data analysis, uncover the host-environment microbiome interactions.

In conclusion, defining a robust integrated experimental design is mandatory to obtain statistically significant results, allowing us to give accurate answers to biological questions.

3. Assessing and monitoring terrestrial and freshwater biodiversity

Understanding Habitat Features and Conservation Needs of the Italian Spring Goby (Orsinigobius punctatissimus) in the Lombardy Springs Area

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The Italian spring goby (*Orsinigobius punctatissimus*) is an endemic freshwater fish species considered Critically Endangered by the Italian IUCN committee. It is closely associated with highly specific, irreplaceable, and isolated habitats, such as springs and oxbow lakes of the river Po Valley. Lombardy constitutes half of the species' area, although in the past different authors reported this species as extinct in this region. Due to drought of springs, habitat loss, or fragmentation, its population in freshwater ecosystems of Lombardy has been estimated to have decreased by 70% compared to the last decades (Life_Gestire 2020). The current knowledge about the habitat of the Italian spring goby is outdated and based on old qualitative observations. Therefore, the aim of this project is to provide additional data to precisely identify the features of the species' habitat in Lombardy. In order to achieve this, we surveyed about 100 springs between 2023 and 2024, collecting data about biotic and abiotic habitat features. This allowed us to define the relationship between the Italian spring goby presence/abundance and the springs' characteristics. Results showed that the main predictive variables of the presence and abundance are altitude, substrate, average depth, illumination, and retention of organic debris. This study provides novel insights into the physical habitat preferences of the Italian spring goby. Furthermore, we also present updated and new data on the presence of this species in Lombardy.

Elevational gradients reveal higher vulnerability of spider communities at lower altitudes

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Examining functional traits is becoming an essential element to investigate how changes in the environment may influence biological communities, with cascade effects on the whole ecosystem. By encompassing a succession of different habitats, elevational gradients represent excellent natural laboratories in this respect. We investigated spider communities along three transects in the Natural Park of Orsiera-Rocciavrè (Western Italian Alps). Spiders were sampled by means of pitfall traps within plots placed every 200 metres of altitude from 1,400 to 2,600 metres a.s.l. in 2018 and 2019. Overall, we collected 1,152 spiders belonging to 128 species. Spider assemblages were characterised in terms of taxonomical (species richness, abundance and beta diversity) and functional diversity (total, dispersion and evenness of functional diversity), the latter computed on the base of functional traits, mostly related to range size, elevational distribution, dispersal ability, foraging guilds and body size. Species richness and abundance appeared to be unresponsive to elevation, while taxonomic beta diversity significantly increased, attesting higher species turnover at higher altitudes. All metrics of functional diversity increased with elevation, due to the increased presence of highly dispersive, widely distributed and tolerant species. Conversely, communities at lower elevation were characterised by lower functional diversity mostly attributable to endemic species. Our findings suggest that spider communities at lower elevations are potentially more vulnerable to habitat and climate change, being generally unkeen to altitudinal migrations than their counterparts at higher elevations. Indeed, we acknowledge the importance of considering functional traits in predicting changes in biological communities in a climate warming scenario.

Conservation of freshwater fish: An experiment to test if artificial flumes are siutable for ex situ breeding of protected species

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The long-term conservation of freshwater fish requires key measures such as habitat protection and restoration and alien species management. In association with these measures, also captive breeding programmes can play an important role. Captive breeding has mainly been used for the propagation of species of economic and recreational interest, and even most conservation-oriented activities focus almost exclusively on a few families, mainly Salmonidae and Acipenseridae. It is therefore important to extend knowledge on the procedures and effectiveness of such programmes also to endangered fish species belonging to less studied families.

The LIFE Minnow project (LIFE21-NAT-IT-LIFE Minnow/101074559) provides an excellent opportunity to explore this issue, as it includes the captive breeding of some endangered species for restocking and repopulation purposes. In this context, an experiment is currently underway to test the suitability of artificial flumes for the ex situ reproduction of the European bullhead (Cottus gobio). This species has already been reproduced in breeding facilities, where some critical problems are often encountered: since it is common for males to prey on their own eggs, it is often recommended to isolate the eggs, which, however, in the absence of parental care, are particularly susceptible to the development of pathologies that may lead to their loss. The aim of our study is to test different types of egg incubation to define the best one, and to verify whether the same critical problems occur in the semi-natural environment provided by the artificial flumes as in conventional breeding facilities.

Alpine Temporary ponds (APs): vulnerability of a disappearing ecosystem

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Alpine Temporary Ponds (APs) are unusual and peculiar habitats seasonally flooded, with a short aquatic phase. Considering the ongoing freshwater biodiversity crisis, detailed knowledge regarding the current conservation status of APs is urgently required. Diatoms are a useful ecological tool that allow understanding the ecological status and predicting what may occur in natural ponds after pollution, water crisis and other anthropogenic or natural disturbances. First, APs were mapped by superimposing satellite images, aerial photography, and GIS data. Mapping APs is fundamental for planning conservation activities. Overall, 2158 ponds were identified on Italian Alps (63%) and Apennines (37%). The distribution of the ponds is mainly concentrated in the Central Alps, while the average altitude is higher in Western Alps (2582 m a.s.l.). Apennines show lesser average altitude and higher anthropogenic backgrounds. Subsequently, six ponds where considered, three APs and three control ponds along an altitudinal gradient (0-2000 m a.s.l.) in central Italy. Over twelve months of samplings, we found that APs hydroperiod is limited to five months (June – October). Moreover, control ponds show higher diatom richness then APs. Short hydroperiods can influence diatom communities. Indeed, APs are mainly characterized by pioneer diatom species, typical of mountain freshwaters. Ongoing research is also evaluating differences in diatom communities between Mediterranean and APs, and between APs from different latitudes.

The research contributes to increase awareness on conservation of this neglected habitats and highlight the usefulness of diatoms as bioindicators, highlighting the differences in diatom communities along altitudinal and latitudinal gradients.

4. Ecosystem Functions, Services and Solutions

Monthly variability of floating plastic contamination in Lake Maggiore (Northen Italy)

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Freshwaters represent one of the main environmental compartments affected by plastic pollution. In addition, approximately the 80% of plastic waste comes from terrestrial source and it is transported to the seas through lakes and rivers. Consequently, it is imperative to develop monitoring plans that offer a comprehensive understanding of plastic contamination in freshwater environments. For this reason, the aim of this project was the evaluation of the quantitative and qualitative monthly variations of floating plastics in Lake Maggiore, one of the largest aquatic ecosystems in Europe. Monthly samplings were carried out from January to December 2022 using a manta-net (100 μm mesh), along a transversal transect spanning from coast to coast. Plastics were then quantified and characterized (shape, size, color and polymer) using a μFT-IR.

Results revealed low levels of plastic contamination in Lake Maggiore compared with other lakes worldwide, with a marked qualitative heterogeneity that suggesting a prevalent secondary contamination source. Our data illustrates also a considerable quantitative variability, with 13-fold difference between the minimum value of 4375 plastics/km2 (0.02 plastics/m3) in September and the maximum value of 57.692 plastics/km2 (0.29 plastics/m3) in December. This study represents the first investigation of plastics in a lake through monthly samplings, highlighting the need to consider temporal variation to accurately assess the extent of plastic pollution.

Spatial distribution of microplastic contamination on alpine glaciers

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Plastic contamination has dramatically increased, spreading across all environmental compartments. In particular microplastics (MPs), items smaller than 5mm, are found in environments ranging from deep-sea to high-altitudes. The primary mechanism of contamination in high-altitude environments is thought to be atmospheric transport.

In this study, we examined MP contamination in supraglacial debris of 13 glaciers in the Alps: Clapier, Glacier Blanc, Mont Miné, Prè de Bar, Mandrone, Lupo, Preda Rossa, Platigliole, Sforzellina, Fellaria, Fellaria Ovest, Dosdè, Pasterze and one, the Calderone Glacier, in the Apennines. From 2020 to 2022, 70 samples of supraglacial debris were collected on the glacier' surface. The presence of putative MPs was confirmed in every sample, with a mean of 14 ± 6.39 SE items/sample. Due to time constraints, we characterized the polymeric composition of MPs in 25 samples and first results are focused on anthropogenic particles (APs).

The Lupo Glacier showed the highest concentration of APs: 1,434.78 ± 471.60 SE APs/kg. Population density in a 100 km buffer, altitude and surface of the glaciers were tested as predictors for APs concentration in our sites. Only a marginally significant correlation between population density and particles concentration was found. No significant results were obtained repeating the analyses on identified MPs only. Polymeric composition of identified MPs did not differ among glaciers. However, more time is needed to complete MPs identification. Our study highlights the difficulties in identifying the predictors of MPs contamination in remote areas, which prevent the implementation of mitigation measures and solutions.

Effects of polystyrene microplastics on *Chironomus riparius*: a transgenerational approach

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Since sediments represent the primary compartment of microplastic accumulation, our study aimed to assess the transgenerational effects (over 2 generations) of three concentrations of 1 µm polystyrene (PS) microplastics on *Chironomus riparius* larvae. We applied the Chironomid Life-Cycle Toxicity Test (OECD 233, 56 days of exposure), with some modification for microplastics, to determine EC50, NOEC and LOEC. Additionally, to investigate more in deep the sub-lethal effects, we used a battery of biomarkers related to cellular stress, detoxification activity, neurotoxicity, and energetic metabolism on the second generation of *Chironomus*. Our results revealed a LOEC > 224,000 plastics/kg dry weight for all the parameters of first generation. On the contrary, a LOEC of 22,400 plastics/kg d.w. for emergence ratio in the second generation was observed. Furthermore, for both generations the EC50 was > 224,000 plastics/kg d.w. Regarding the biomarkers, we identified significant differences between treated and control only for superoxide dismutase (SOD) activity, with a significant ($p < 0.05$) reduction of this enzyme in specimens exposed to 112,000 and 224,000 plastics/kg d.w. These results highlighted few toxic effects of tested PS microplastics, despite the high concentration of exposures.

A holistic and integrated approach to evaluate the health status of a freshwater ecosystem and its ecosystem services

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Freshwater ecosystems are essential for the planet but are recognised as one of the most degraded ecosystems in the world. To conserve them, we propose a holistic and interdisciplinary method to assess the health status of the river, considering chemical, ecological, ecotoxicological parameters and the definition of ecosystem services. The Elsa River is a tributary of the Arno River in Tuscany (Italy). We have selected this river as a case study because of the presence of a river park, agricultural and industrial activities and some towns. The chemical parameters of the water (macronutrients, pH etc.) were sampled with a citizen science project to involve the population and the schools of the area. These data were integrated with ecological indices based on benthic macroinvertebrates (EBI and STAR-ICMi), macrophytes (IBMR), diatoms (ICMi) and river functionality (FFI). Squalius squalus was used as a bioindicator for the chemical and ecotoxicological analyses: microplastic ingestion, contaminant concentration and a battery of biomarkers were evaluated. Microplastics have been characterised and quantified in the water column, some emerging compounds such as pharmaceutical residues, and microbiome characterisation are tested in water, sediment and organisms. These parameters will be linked to the ecosystem services being valued. Preliminary results show a negative trend from upstream to downstream from a chemical and ecological point of view. The ecotoxicological analyses on fish also show this trend, underlining the presence of neurotoxicity and genotoxicity effects. This approach will be proposed as a valuable tool to design a more sustainable river management.

Graphene-Related Materials (GRMs) behaviour in reconstituted and natural freshwater systems: when dispersion stability matters

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The widespread application of graphene-related materials (GRMs) in various fields and their consequent release raise potential environmental concerns that are still underexplored. This study aims to assess the GRMs environmental fate by investigating the GRMs Dispersions Stability (GDS) in reconstituted and natural freshwaters. To this end, the GDS of GO, one of the most common and hazardous GRMs, was investigated in 5 commercial natural waters with different ionic content, 8 natural freshwaters from Friuli-Venezia-Giulia, and compared to TG201 medium and dH_2O. Additionally, the impact of GO on growth inhibition (AGI) of Raphidocelis subcapitata was evaluated in natural freshwaters, providing more realistic environmental conditions compared to standard OECD TGs.

Our results revealed high GO aggregation and sedimentation, particularly evident in nearly all freshwaters compared to TG201 medium and dH_2O. Moreover, significant variations were observed among different freshwaters, largely attributable to intrinsic physicochemical properties, mostly clay and ions.

Finally, AGI exhibited significant responses to GO dispersions in natural freshwaters. This underscores the potential role of GO as carrier for pollutants in freshwater ecosystems, given its well-known adsorption properties.

In conclusion, GO dispersed in aqueous media tend to aggregate and settle, changing its bioavailability. While GO may sequester contaminants from the water column, its sedimentation poses potential risk of accumulation in sediments. Due to differences in physicochemical composition between freshwaters and commonly used synthetic medium, TG201 may not properly represent the GO environmental risk. Therefore, a comprehensive ecotoxicological assessment of GO in freshwater environments should consider and investigate potential consequences for benthic organisms.

Effects of organic inputs on sediment composition and food web structure in shallow Arctic lakes

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Climate change impacts Arctic ecosystems, particularly through 'Arctic greening', which increases herbivore density and affects food webs. However, these effects are marginally explored in Arctic lake ecosystems, crucial carbon sinks and biodiversity hotspots.

This study explores the impact of organic inputs from migratory geese in lake food webs. We analysed nine shallow lakes along a spatial gradient from the coastline to glaciers on the Brøgger Peninsula, Svalbard, using C and N isotopic analysis to assess nutrient sources and trophic links. We used Bayesian mixing models to quantify the contribution of goose droppings and other nutrient sources to lake sediments and to examine the diet of Lepidurus arcticus, a key omnivorous species.

The contribution of goose droppings to sediment organic matter (OM) increased with terrestrial vegetation cover, while aquatic animal biomass was the main OM source, independently by vegetation cover. Organic inputs from geese improved the stoichiometric quality of aquatic vegetation and increased N concentration in sediment. Consequently, L. arcticus increased the consumption of sediment, which represents the pool of long-term C accumulation, and aquatic vegetation (newly fixed C) in lakes with high goose-derived input, reducing its consumption of animal prey, hence reducing the internal recycling of C in the food web. This resulted in a higher nutrient flow through the grazing food chain and a reduction in food chain length.

Our space-for-time approach suggests that climate change may lead to simpler food webs, characterised by prevalent consumption of basal resources by omnivores, potentially affecting carbon sink capacity in lake ecosystems.

Floods and macrobenthic communities: new insights from field and mesocosms studies

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Flood events are integral components of river hydrological regimes, impacting benthic communities in various ways. While floods can bring vital nutrients, contribute to substrate restoration, and facilitate nutrient recycling, they also pose direct threats to organisms, habitats, and riparian areas. Understanding the nuanced effects of floods on benthic communities is crucial for effective river management. We present findings from two experiments conducted with the aim to assess flood impacts on macroinvertebrates. A first study was conducted at Riparian Stream Mesocosms, in Landau (Germany) along the urban river Queich, involving 16 channels with riparian zones subjected to controlled flooding events of varying intensity but not extreme. Macrobenthos and Total Suspended Solids samples were taken before and after floods. Additionally, trays placed 40 cm from riparian zones were sampled to evaluate benthic organism contribution to the riparian zone. Results suggest that increasing flood intensity may lead to shifts in macroinvertebrate communities, with some taxa exhibiting resilience while others become more vulnerable. Furthermore, an experiment conducted along the Piota stream, NW Italy, during extreme flood events revealed a notable decrease in abundance and diversity of benthic communities. These findings underscore the sensitivity of macroinvertebrate populations to extreme flood events and highlight the importance of considering the frequency, intensity, and duration of floods in river management strategies. By elucidating the complex dynamics between floods and benthic communities, these studies provide valuable insights for the sustainable management of river ecosystems in the face of climate change-induced challenges.

A warmer future world: effects on plankton communities in mediterranean vulnerable ecosystems

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Global warming is causing significant changes in the dynamics and composition of aquatic ecosystems. Mediterranean region emerges as one of the most sensitive areas.

Of the diverse ecosystems present in the region, coastal lagoons and artificial lakes are considered particularly vulnerable environments.

What role does plankton play in all of this?

The functioning of aquatic ecosystems is largely influenced by the activity of various planktonic organisms.

Predictions indicate that rising temperatures will lead to the loss of plankton biodiversity and the affirmation of smaller species, which will have profound consequences for the structure and efficiency of the pelagic food chain.

The main objective of my doctoral research activity, which is part of a PRIN research project funded by the Italian ministry, is to study the effects of climate warming on natural plankton communities in the Mediterranean Sea, particularly in the Bidighinzu Reservoir and Cabras Lagoon (Sardinia, Italy), including different trophic levels from bacteria to mesozooplankton. The aim is to evaluate the effects of temperature rise on: the biodiversity of the planktonic community, the dimensional structure of the plankton food chain.

The study uses field data and a laboratory experiment to see how plankton communities respond to warming (in a controlled environment) and how they change throughout the seasons with natural temperature changes.

My work will fill a gap in Mediterranean plankton research. Most studies haven't looked at how plankton communities respond to warming, including different food web levels together.

Microfibers in the oceans: novel tools and methods for the chemical characterization, the identification of the possible sources and elucidation of the transport pathways

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Microfibers are ubiquitous contaminants of emerging concern that derive from wear and tear of synthetic textile. Microfibers are currently ascribed to the "microplastics" family, and therefore reported in plastic pollution studies. Research on the prevalence, fate, and impacts of microfibers is a relatively novel topic and it is often unbalanced in favor of plastic polymers. However recent studies show a prevalence of cellulosic fibers in the marine environment. At the present time a comprehensive information regarding the degradation of natural fibers is lacking and this limit the possibility to forecast their environmental fate.

Understanding the degradation rates of natural and synthetic fibers under different environmental conditions is crucial for the identification of their possible sinks and for the assessment of their potential impacts on marine ecosystems. At the same time, the high variability in fiber densities among replicates collected at the same marine location highlighted by the current literature, stresses the need for caution when estimating global fiber abundances or assessing regional differences in fiber densities and call for a thorough revision of the analytical methods used for their identification. Starting from this basis the current master thesis project will focus on the chemical characterization of microfibers sampled from different oceanic environments by means of different analytical techniques (micro-FTIR, micro-Raman and mass spectrometry). The collected data will be used to provide new fingerprinting methods, to understand sources and mechanism of transport of fiber in the oceanic environment, and to highlight the mechanism leading the accumulation of fibers in the suspected oceanic sinks (e.g. sea ice).

Spatial Variation in Greenhouse Gas Emissions and Water Quality in LTER Lakes with FLAMe Technology

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Lakes are a fundamental resource, serving as crucial water reservoirs, supporting biodiversity, and impacting atmospheric dynamics through greenhouse gas emissions. Despite their importance, current research often overlooks fine-scale spatial variations in water quality and gas emissions. Our project aims to address this gap by employing advanced technologies to study spatial variations in water quality and greenhouse gas emissions (CH4, CO2, N2O) in three Long-Term Ecological Research (LTER) deep lakes in Northern Italy and the western USA.

We will use the Fast Limnological Automated Measurements (FLAMe) technology, incorporating various sensors to map water quality parameters (temperature, electrical conductivity, fDOM, chlorophyll a, nitrate) and gas emissions. Our study sites include Lake Tahoe (USA), and Lakes Iseo and Maggiore (Italy), selected for their extensive long-term data and unique environmental conditions. Transects via boat will cover key areas such as littoral zones, inflow regions, and wetlands. Additionally, water column samples will be analyzed for water quality parameters and greenhouse gas concentrations, including isotopic signatures for source identification. We expect to quantify the lakes' roles in greenhouse gas emissions, understand the contrasts between single-point and spatial data, and elucidate the impacts of spatial variability on water quality and gas dynamics. This study will establish a framework for integrating long-term monitoring data with high-resolution spatial data, enhancing our understanding of freshwater ecosystem processes.

By leveraging FLAMe technology and fostering international collaboration, our project will significantly advance the understanding of spatial heterogeneity in lake water quality and greenhouse gas emissions. This initiative will serve as a pilot for future studies, promoting joint scientific, engineering, and policy efforts to conserve vital freshwater ecosystems and training the next generation of researchers to address these challenges.

5. Urban Biodiversity

Unraveling Bumblebee Adaptation to Urban Living through Multi-omics Analysis

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Pollinator insects, such as bumblebees, play a crucial role in ecosystem functioning and food security. However, their biodiversity and wellbeing is being affected by urban expansion worldwide. To understand how two bumblebee species, Bombus terrestris and Bombus pascuorum, are adapting to urban habitats in Italian cities, we are employing a multi-omics strategy. We collected 200 bumblebees individuals from 24 sampling sites in Milan, Rome, Turin, and Florence, including both urban and semi-natural areas. We conducted transcriptomic analysis through mRNA sequencing to identify differencially expressed genes between urban and semi-natural populations. Then, we investigated the influence of urbanization on metabolites production conducting metabolomic analysis using LC-MS. Some preliminary results from RNA-seq and metabolomic analysis confirms clear differences between urban and seminatural populations. Furthermore, we plan on conducting whole genome sequencing to provide genomic data, enabling the detection of genetic regions under selection and exploration of genetic structure in the sampled localities. By integrating these omics data, we aim to provide insights into bumblebee adaptation in urban contexts. The obtained findings can inform policymakers in managing urbanization processes.

Changes in foliage-dwelling spider communities along an urbanization gradient

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Urbanization affects landscape structure, functions and local environmental conditions, with major impacts on biodiversity and related ecosystem services. A proper evaluation of the effects of urbanization on biodiversity is thus compelling, with a specific focus on taxonomic groups providing fundamental ecosystem services. Among these, spiders are renowned regulators of trophic chains and sensitive bioindicators. We assessed the response of foliage-dwelling spiders to urbanization in Turin (Italy), by sampling their communities in urban green areas along an urbanization gradient and in a natural park (control area) a few kilometers from the city. We tested their response in terms of taxonomic (i.e. species richness and abundance) and functional (diversity, abundance, number of feeding guilds, abundance of pollinator feeding spiders) diversity. Species richness and abundance decreased in the city compared to the control area and along the urbanization gradient. Similarly, functional diversity was lower in the city compared to the control area and declined with increasing urbanization. All detected trends confirm our previous results on the ground-dwelling counterpart. Notably, this pattern was mostly due to the loss of specialized foraging guilds, like pollinator-feeders. By evaluating species dissimilarity among sampling sites, we highlighted that species turnover predominantly explained differences in species composition among urban green areas, due to the high frequency of stochastic events. Conversely, urban communities emerged as subsets of semi-natural ones, suggesting an environmental filter favoring species preadapted to urban conditions. Our findings underscore the role of urbanization in shaping spider communities, favoring generalist species and specific functional traits.

Characterization of Hospital and Patients' Microbiome Biodiversity for Nano-detectors Development and Antibiotic Resistance Monitoring

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Since people live in places populated by microbes, there is a significant interconnection between human and environmental microbiota. Indeed, humans scatter their microorganisms through skin, feces, and other body fluids, while they constantly run into microbes through air, surfaces, water, and foods.

Due to this interconnection, it is important to understand the biodiversity of urban microbiota, particularly in places where there is a specific composition of microbial communities created by selective pressure, such as hospitals and other healthcare facilities. Indeed, these are characterized by over-cleaning methods and the overuse and misuse of antimicrobial agents. Moreover, healthcare facilities are crowded environments, frequented by both healthy and sick individuals. This combination creates a unique built environment microbiota, distinguished by antimicrobial-resistant (AMR) organisms, pathogens, and harmless common species.

As part of the ANTHEM project, the presented study aims to characterize the hospital's microbiome and to reduce and monitor the spread of AMR bacteria and antibiotic resistance genes in hospital settings. Based on our microbiome characterization, the long-term aim of the project is to build fast and easy-to-use technological devices grounded on biomolecular techniques. To address these issues, we collected samples and data from patients, and from different environmental sites of the pre-admission ward at different times of the day. Specifically, by characterizing hospital microbial communities using DNA sequencing and bioinformatics approaches, we aim to identify a set of pathogens that are easily exchanged between patients and the environment, and to monitor the spread of AMR bacteria.

Land use influences pollinators in Italian small islands

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The Mediterranean region and Italy are crucial hubs of biodiversity, hosting numerous endemic species due to diverse geo-climatic conditions. However, our understanding of biodiversity and its benefits to society remains limited, particularly in small islands and urban environments. This study aims to deepen our comprehension of ecosystem complexity to tailor interventions to enhance resilience, biodiversity conservation, and ecosystem service provision.

The research investigates landscape degradation caused by human activities, focusing on pollinator biodiversity across the Archipelago of Pontine Islands, the Neapolitan Archipelago and the city of Rome, to compare island and mainland patterns. Islands serve as unique open-air laboratories where physical isolation is integrated with human influence and land use, shedding light on overall pollinator responses.

Sampling employed both active (entomological net) and passive (Pan Trap) methods, with subsequent molecular (DNA barcoding) and morphological analyses.

Findings reveal a link between pollinator abundance and land use type. In Rome, while urbanized areas host greater biodiversity than non-urban ones, abundance is lower. On the islands, possibly due to more sustainable urbanization practices, this discrepancy is less pronounced. We also found diverse and intriguing haplotypes on islands.

Aligned with spoke 5 on urban biodiversity within the National Biodiversity Future Center's initiatives, this study benefits from support from Fondazione Cecilia Gilardi and Fondazione Sanlorenzo. Implications on drafting biodiversity protection guidelines and landscape regeneration are likely follow-ups of this research. Ensuring pollination services in urban locales, positive impacts on economic, societal, and health aspects of human life are expected.

Planning of Urban Biodiversity: a model to improve ES

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As cities grows denser, and climate change is rising temperatures and generating extreme precipitation, urban biodiversity becomes crucial to mitigate impacts and enhance the well-being of citizens. Within the Spoke 5 of the National Biodiversity Future Center (NBFC), the protection and enhancement of urban biodiversity is a key challenge for the nature itself and for the provision of Ecosystem Services (ESs), benefit that nature directly or indirectly provides to human. In this framework, my research focuses on the development of a dynamical model that describe urban forests, through all the lifespan, and quantifies the ESs provided (taking in account different possible scenarios of technological, social and environmental change). The quantification of the biodiversity and of the benefits of different green solution, will help planners and political stakeholder to evaluate which intervention will be more effective, and to prioritize it.

Exploring the impact of urbanization on plant-pollinator interactions: insights from a study in Milan

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Pollinators such as bees and hoverflies play a pivotal role in ecosystems by contributing to the sexual reproduction of most wild plants and crops. This ecosystem function is covered by a wide community, in terms of taxonomic diversity and functional traits. Pollinators are declining because of incompatible landscapes and local practices. Even the global expansion of urbanization is changing landscapes, thereby impacting biodiversity and ecosystem services, including pollination.

As part of the National Biodiversity Future Center (Spoke 5 - Urban Biodiversity, PNRR), this study aims to (i) assess urban impact on pollination ecosystem service; (ii) find situations where the impact is limited; and (iii) propose strategies to enhance urban landscapes for pollinators. Focusing on 725 samples from Milan, this project is part of a larger endeavor involving six Italian cities and totaling 3500 samples, collected between May-July 2023 in green areas across a gradient of fragmentation and size. Employing standardized monitoring and molecular-based techniques, the study explores pollinator diversity, through DNA barcoding, and the plant- pollinator interactions. Contribution to pollination ecosystem service has been assessed through quantitative analysis of pollen loads found on insects bodies. Data were analysed considering specific landscape features (mostly described by the level of green area fragmentation).

The results show how fragmentation of green areas affects pollinator communities and may turn into plant-pollinator networks simplification.

Data from the additional cities will be precious for confirming what is described for Milan. This research provides a basis for comparative studies and long-term monitoring, crucial for urban green space management and conservation.

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