

Contaminants of Emerging Concerns (CECs) in Marine Ecosystems: Evaluation of Presence and Ecotoxicological Effects

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INTRODUCTION

During the last century, the development of agrochemical, chemical, cosmetic and pharmaceutical industries have led to an increasing synthesis of new compounds, which are daily used by billions of people in the world. Among these, pharmaceuticals and personal care products (PPCPs), endocrine-disrupting compounds (EDCs), flame retardants (FRs), pesticides, and micro and nano-plastics (MPs/NPs) have recently gained a relevant attention from the scientific community: indeed, these can reach coastal and marine waters mainly through urban wastewater treatment plants (WWTPs), which are not able to retain them, as well as through agricultural run-offs, direct discharges and atmospheric deposition.

Nonetheless, many of these substances are virtually ignored by national regulation, despite being detected at concentrations known to exert biological effects in biota. For such reason, these are currently referred to as contaminants of emerging concern (CECs).

EXPERIMENTAL DESIGN

Mussels exposed for 14 days in duplicate tanks to mixtures of micronized microplastics:



CONTROL (CTL)
(no MPs)



ENVIRONMENTAL MPs MIX (ENV)
(1000 items/L)



COMMERCIAL MPs MIX (COM)
(1000 items/L)



'RAPIDO' RUBBER MPs (RBR)
(1000 items/L)

POLYMERIC COMPOSITION OF MIXTURES:

- 43% polyethylene (PE)
- 32.4% polyester (PET)
- 23.1% polypropylene (PP)
- 1.12% polystyrene (PS)
- 0.38% polyvinyl chloride (PVC)

POLYMERIC COMPOSITION OF RAPIDO-MPs:

- 100% styrene-ethylene-butadiene-styrene rubber

SELECTED SIZE:

20 – 50 µm

BIOCHEMICAL AND CELLULAR MARKERS

- Immunocytes sub-populations and functionality (LMS)
- Cholinergic response (AChE activity)
- Detoxification mechanisms (GST)
- Antioxidant system and oxidative damages (CAT, GPx, GR, TOSC)
- Lipid metabolism (ACOX activity, neutral lipids)
- DNA damage

FORTHCOMING ANALYSES

- Transcriptomic analyses (RNA-Seq)
- Microbiota characterization (RNA-Seq)

AIMS

- In field conditions, to assess the presence of some classes of CECs in different marine environmental matrices.
- In laboratory conditions, to evaluate the biological alterations exerted by CECs at biochemical and cellular level, in marine organisms, through specific experimental design.

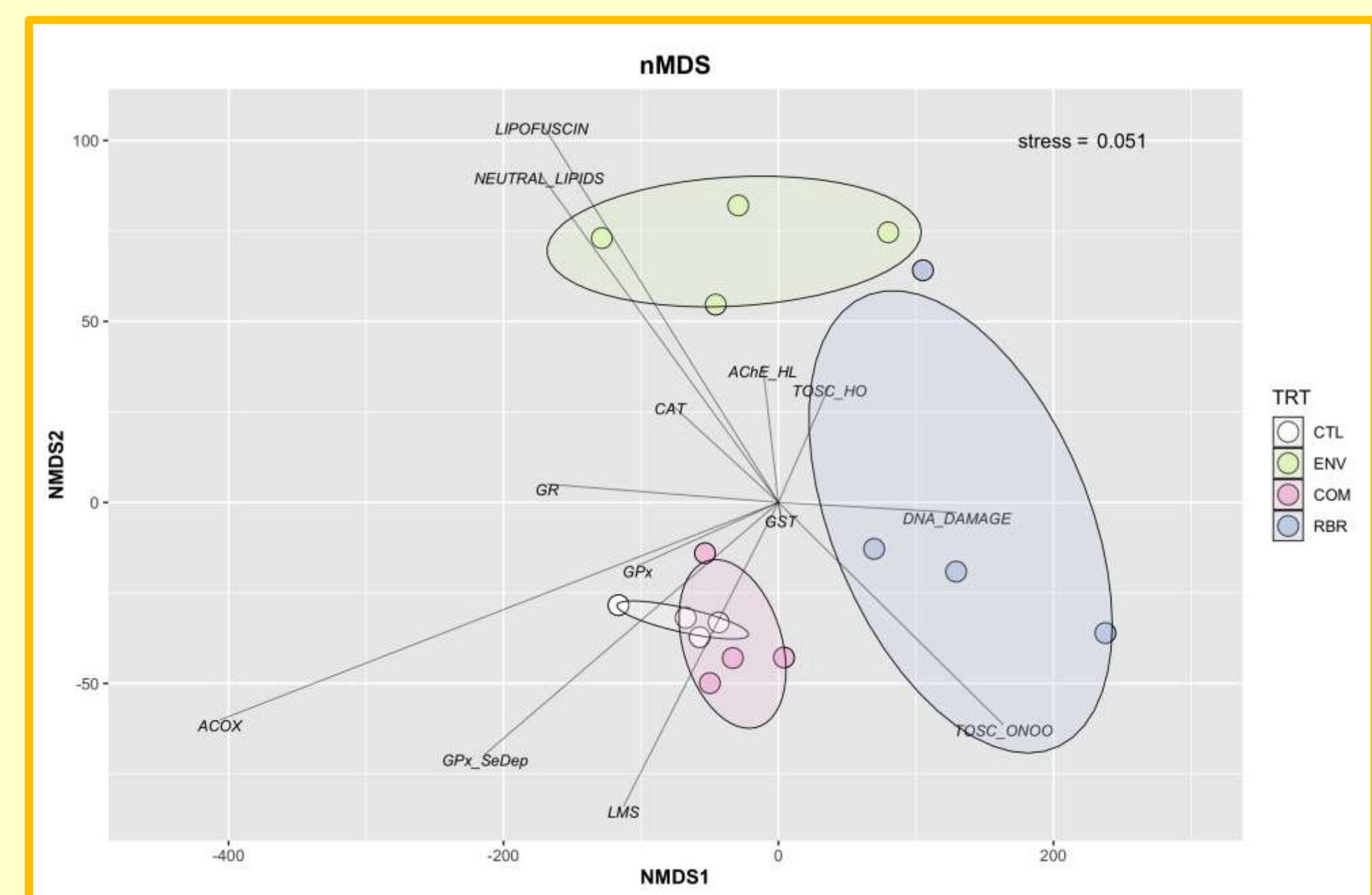
PRELIMINARY RESULTS

ENVIRONMENTAL MPs MIX caused a lowered lysosomal membrane stability, an increase of DNA damage and AChE activity, with slight effects on antioxidant defences but higher lipofuscin and neutral lipids content.

COMMERCIAL MPs MIX had very limited effects, involving lysosomal membrane stability and DNA damage.

RAPIDO RUBBER MPs significantly increased DNA damage and AChE activity, as well as a generalized increase of total antioxidant capacity coupled with a lower ACOX activity.

Overall, nMDS showed a clear separation between FIELD COLLECTED (ENVIRONMENTAL MPs MIX and RAPIDO RUBBER MPs) and both CTL and COMMERCIAL MPs treatments, suggesting harsher cellular disturbances for marine biota caused by MPs generated from stranded items compared to commercial-virgin MPs.



ONGOING EXPERIMENTS

PESTICIDES MIXTURE

EXPERIMENTAL DESIGN

Mussels exposed for 30 days in duplicate tanks to Glyphosate, one of the most widespread pesticides in the world, to AMPA, its metabolite, their mixture; and then their recovery after 14 days:



CONTROL (CTL)
(no contaminants)



GLYPHOSATE (GLY)
(0,5µg/L)



AMPA (AMP)
(0,5µg/L)



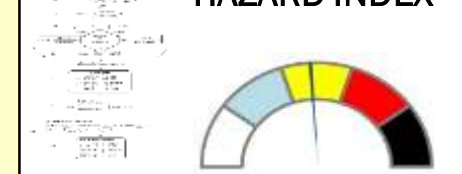
MIX OF GLY/AMPA
(0,5µg/L)

INVESTIGATED CELLULAR SYSTEMS

- Immunocytes sub-populations and functionality
- Cholinergic response
- Detoxification mechanisms
- Antioxidant system and oxidative damages
- Lipid metabolism
- DNA damage

DATA WEIGHTED ELABORATION:
 Results of biological responses will be elaborated through a quantitative Weight of Evidence approach to summarize the hazard associated to each experimental conditions.

HAZARD INDEX



ALKALOIDS MIXTURE

EXPERIMENTAL DESIGN

Mussels exposed for 30 days in duplicate tanks to two of the most widely used psychoactive substances in the world: Cocaine and Caffeine, their mixture; and then their recovery after 14 days:



CONTROL (CTL)
(no contaminants)



COCAINE (COC)
(0,5µg/L)



CAFFEINE (CAF)
(0,5µg/L)



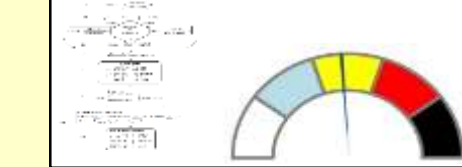
MIX OF COC/CAF
(0,5µg/L)

INVESTIGATED CELLULAR SYSTEMS

- Immunocytes sub-populations and functionality
- Cholinergic response
- Detoxification mechanisms
- Antioxidant system and oxidative damages
- Lipid metabolism
- DNA damage
- Transcriptomic analyses (RNA-Seq)
- Microbiota characterization (RNA-Seq)

DATA WEIGHTED ELABORATION:
 Results of biological responses will be elaborated through a quantitative Weight of Evidence approach to summarize the hazard associated to each experimental conditions.

HAZARD INDEX



PARALLEL ACTIVITIES

- Participation in plastic monitoring plans as national and international project activities (LIFE BLUE LAKES, SOLVING_Cariverona2020, RESPONSE_JPI Oceans).
- Participation in environmental monitoring activities in off-shore platforms.
- Field and laboratory activities related to PNRR project (National Biodiversity Future Center) for emerging chemical compounds.
- Data elaboration and drafting of analytical protocols and scientific reports in national collaboration with NGOs (MAREVIVO, GREENPEACE ITALIA).
- Activities of scientific dissemination and environmental education at first and second grade schools.



REFERENCES

- Benedetti et al., 2022 Emerging environmental stressors and oxidative pathways in marine organisms: Current knowledge on regulation mechanisms and functional effects
- Geyer et al., 2017 Production, use and fate of all plastics ever made
- Pittura et al., 2022 Cellular disturbance and thermal stress response in mussels exposed to synthetic and natural microfibers

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