Do polyethylene terephtalate microplastics (PET-μPs) affect or suffer the effects by the sea urchin *Paracentrotus lividus*?

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BACKGROUND

Microplastic (μPs) contamination in marine ecosystems is of growing concern. A number of monitoring surveys have shown that μPs composed by different polymers are floating in surface waters, but many of them sink to bottom sediments. However, the information on the toxicity caused by the exposure to μPs reaching sediments towards benthic marine organisms is still scant.
In addition, most of the ecotoxicological studies on μPs have been focused only on the effects caused by the exposure to plastic items towards the organisms, utterly neglecting the potential biota-induced (physico-chemical) alterations of μPs following ingestion by the organisms, which can affect their environmental fate.

1.EFFECTS OF PET-μPs ON SEA URCHINS

We investigated the ingestion and the potential adverse effects induced by 7-days dietary exposure to three environmentally relevant amount (0.03 - 0.3 - 3 g PET-μPs) of micronized, irregular shaped and sized PET-μPs towards a benthic grazer, such as the sea urchin *Paracentrotus lividus.*

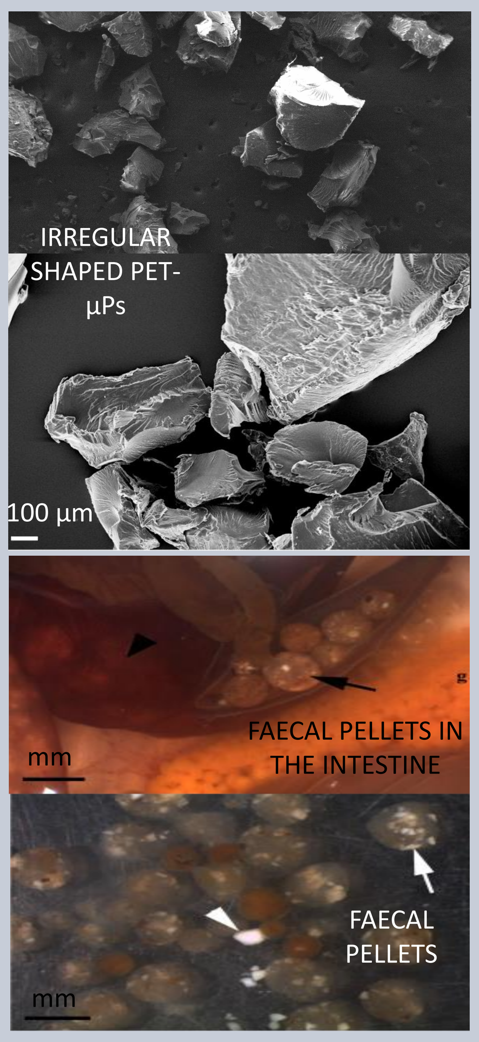
2.EFFECTS ON PET-μPs INDUCED BY SEA URCHINS

We investigated the potential alteration of μPs structure/surface and PET macromolecular chain due to the ingestion and the permanence of PET-μPs within the sea urchin digestive tract.

MATERIALS AND METHODS

EXPERIMENT 1

- dietary exposure for 7 days;
- irregular shaped PET-μPs with size range: <50 μm (6.4%); 50<x<100 μm (8.1%); 100<x<500 μm (68.5%); 500<x<1,000 μm (17.1%);
- three doses: 0.03 - 0.3 - 3 g PET-μPs, corresponding to 760 – 7,600 – 76,000 particles, and 8 – 80 – 800 particles/g respectively;
- at the end of the experimental period animals were sacrificed, dissected and the oesophagus was collected:
  - the proximal (to the mouth) part was used for BIOMARKER ANALYSES (ROS, SOD, CAT, GPx, GST, LPO);
  - the distal part was used for HISTOLOGICAL ANALYSES (Bouin's fixative).



EXPERIMENT 2

- dietary exposure for 7 days;
- irregular shaped PET-μPs with size range: <50 μm (6.4%); 50<x<100 μm (8.1%); 100<x<500 μm (68.5%); 500<x<1,000 μm (17.1%);
- 9 g of PET-μPs, corresponding to 228,000 particles;
- faecal pellets were daily collected, minced with scissors and left in hydrogen peroxide for 6 days to recover PET-μPs;
- at the end of the experimental period the collected PET-μPs were analyzed with:
  - SCANNING ELECTRON MICROSCOPE (SEM);
  - FOURIER TRANSFORMED INFRARED SPECTROSCOPY (FT-IR).

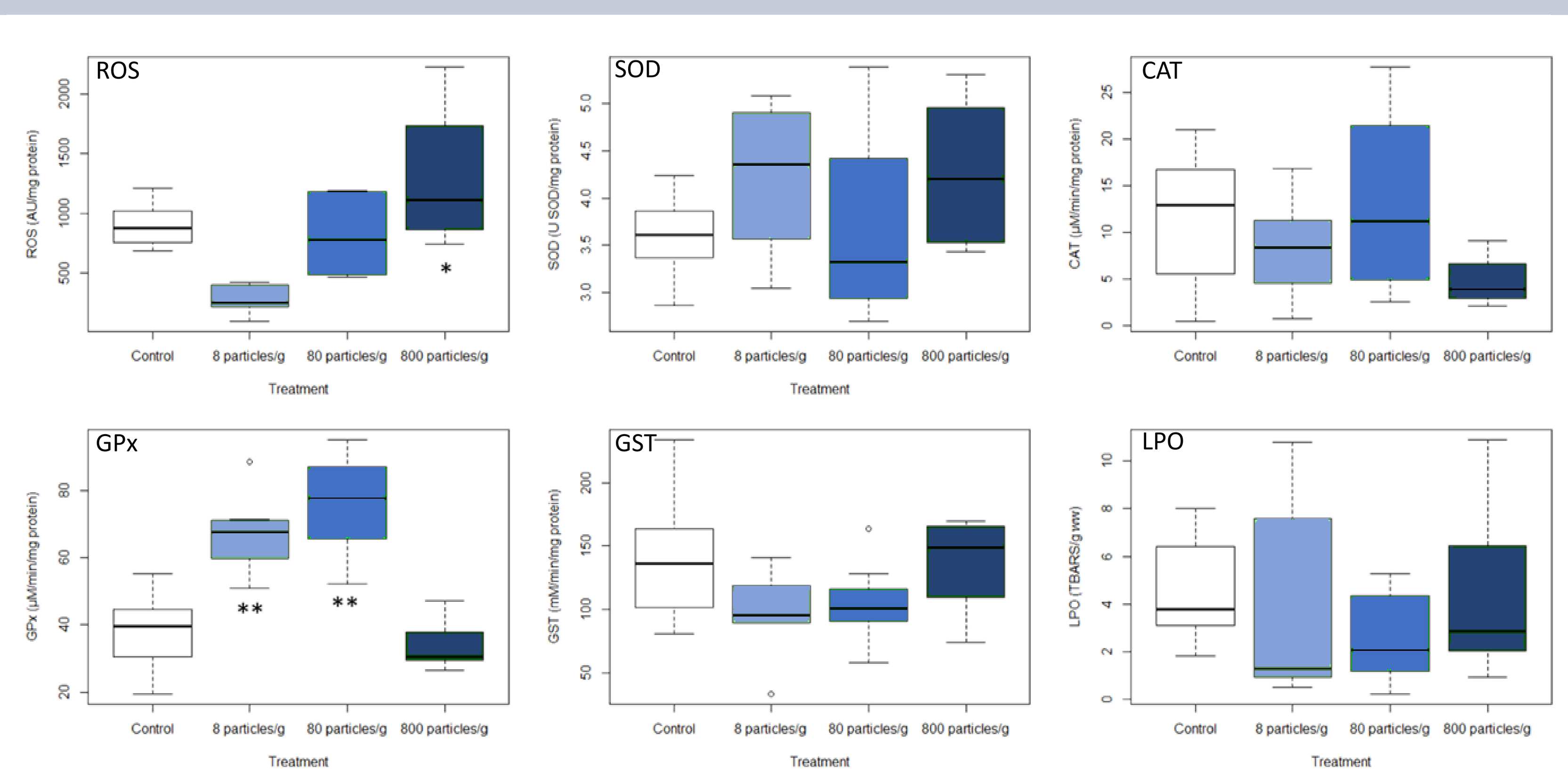
RESULTS

1.EFFECTS OF PET-μPs ON SEA URCHINS

HISTOLOGICAL ANALYSES:

- no differences were observed at the tissue-level between control and treated groups.

oesophagus criptae (*), lumen (l)



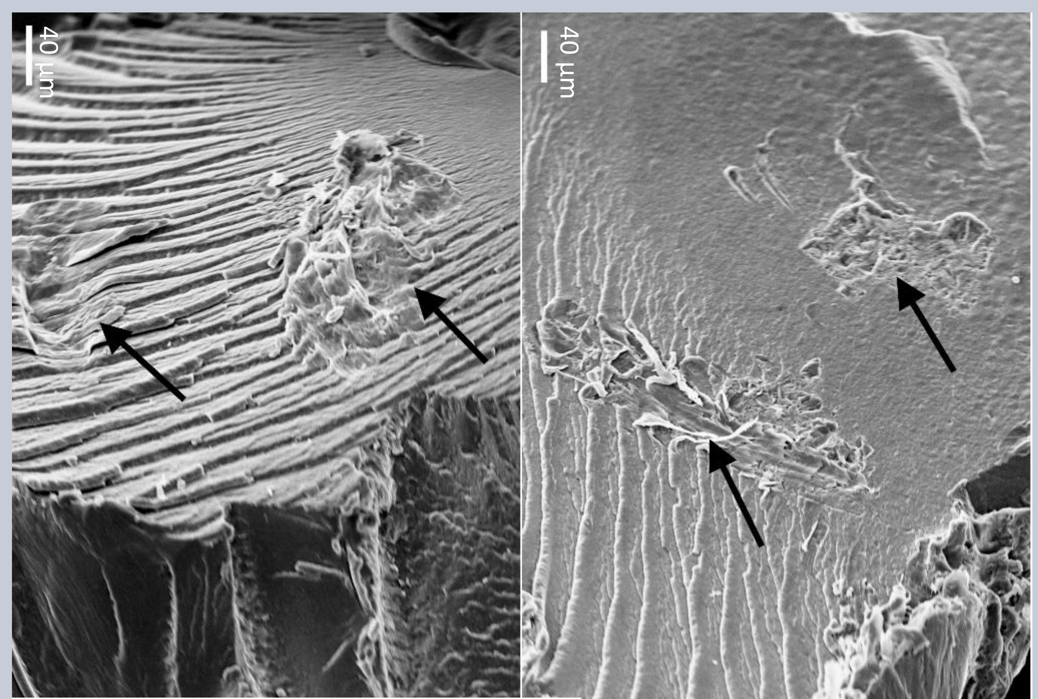
BIOMARKER ANALYSES:

- significant increase in ROS level at the higher concentration;
- significant increase in GPx activity at the low and mid concentration.

2.EFFECTS ON PET-μPs INDUCED BY SEA URCHINS

SEM ANALYSES:

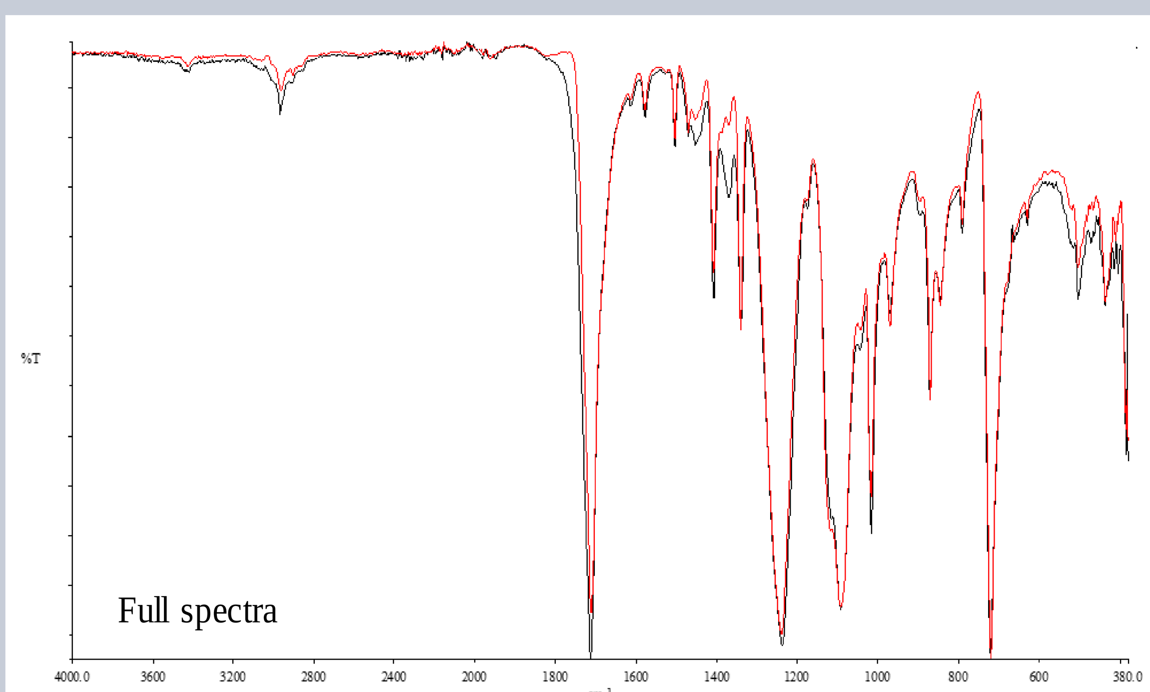
- no marked ultrastructural differences were present between control and ingested PET-μPs;
- in some of the ingested particles superficial signs compatible with sea urchin teeth scrapes were observed (arrow).



PET-μPs WITH PUTATIVE TEETH INDENTATIONS

FT-IR ANALYSES:

- control PET-μPs showed higher intensities in the 1,700 cm^{-1} peak and in the 1,000 cm^{-1} peak;
- the peaks around 3,000 cm^{-1}, related to aromatic and aliphatic C-H stretching, were more intense and sharper in control PET-μPs.



PET-μPs CONTROL (BLACK) AND PET-μPs EXTRACTED FROM FAECAL PELLET (RED)

CONCLUSIONS

1.
- Slight modulation of the sea urchin oxidative status;
- No histological alterations.

NEXT: WILL LONG-TERM EXPOSURE TO PET-μPs ENHANCE THE RISK TO SEA URCHIN?

2.
- Limited structural and chemical alteration of PET;
- Benthic grazers might contribute to the degradation of μPs.

NEXT: WILL LONG-TERM BIOLOGICAL WEATHERING ENHANCE THE DEGRADATION?

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Parolini M., Ferrario C., De Felice B., Gazzotti S., Bonasoro F., Candia Carnevali M.D., Ortenzi M.A., Sugni M., Interactive effects between sinking polyethylene terephthalate (PET) microplastics and a benthic grazer. Journal of Hazardous Material (in press).