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Assessing the Impacts of Anthropogenic Pollutants on Earthworm (Eisenia fetida) Biomass and Behavior Using Soil Microcosms

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Assessing the Impacts of Anthropogenic Pollutants on Earthworm (*Eisenia fetida)* Biomass and Behavior Using Soil Microcosms

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Introduction

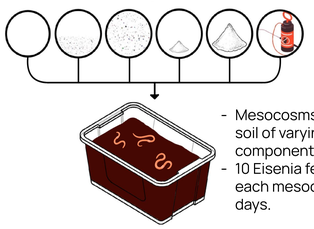
- Anthropogenic activities have introduced microplastics and road salts into the natural environment, affecting terrestrial organisms' activity and soil health (5,6,7,8).
- Agriculturally used pesticides can be found in the terrestrial and aquatic environments via runoff which can bioaccumulate into organisms (2, 11, 12).
- Earthworms offer ecosystem services such as increased water filtration, soil aeration, and fertility; can be used as a model organism for impacts of anthropogenic contaminants (9, 10).
- The purpose of this study was to evaluate the effects of low microplastics (LMP), high microplastics (HMP), low and high salt concentrations, and pesticides in soils as well as evaluating their recognized impacts and potential consequences on terrestrial environments via the use of model organism *Eisenia fetida* (1).

Research Questions

- Does high and low microplastics affect earthworm biomass, behavior, soil respiration, pH and conductivity?
- Does high and low salt (± pesticide) affect earthworm biomass, behavior, soil respiration, pH and conductivity?

Methodology

Mesocosm Setup:

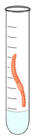


- Mesocosms included 900g soil of varying treatment components.
- 10 Eisenia fetida added to each mesocosm for 28 days.

Treatments:

- Control
- HMP - [0.3%] (<5mm)
- LMP - [0.7%] (<5mm)
- High salt - [1000 mg/L]
- Low salt - [100 mg/L]
- Pesticide - [23.5 ppb]
  - › *Imidacloprid*
- High salt + pesticide
- Low salt + pesticide

Escape Response Assay:



- *1 mL of 200 mM NaCl*
- ⏱ 1st time: Out of solution
- ⏱ 2nd time: Out of tube

Avoidance Trials:

- Mesocosms divided by two treatment soils. Earthworms placed in center and counted after 48 hours to assess soil avoidance.

Behavioral Toothpick Assay:

- 12 toothpicks placed on day 1 and reset every 3 days to assess activity through disturbance.

Soil pH, Conductivity & Respiration:

- Each treatment soil pH and conductivity tested at experiment conclusion.

Results

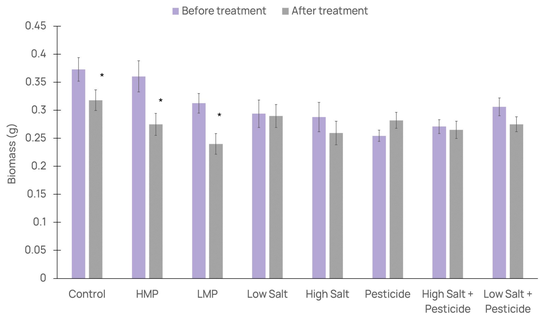


Fig. 1 | Change in the average biomass exposed to varying treatments. Calculated by finding the difference between biomass before and after the experiment. Bars represent average ± SE. ANOVA $p < 0.05$ for the control, HMP, and LMP, indicated by *.

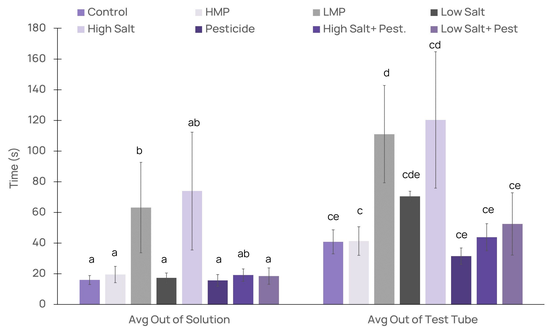


Fig. 2 | Comparison between the time out of solution and the time out of test tube in the individual escape assay for each treatment group in seconds (s). Bars represent average ± SE. Letters indicate significant differences between groups.

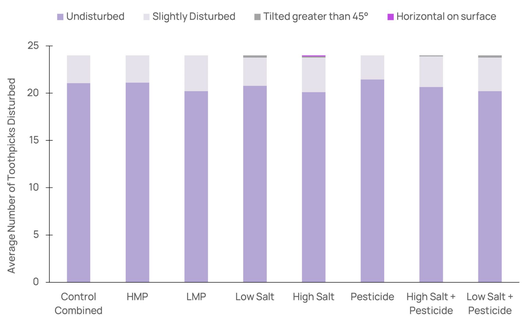


Fig. 3 | Behavioral toothpick assay on earthworms exposed to varying soil treatments. Size of colored sections within a treatment column represent the quantity of toothpicks disturbed, colors represent individual levels of disturbance.

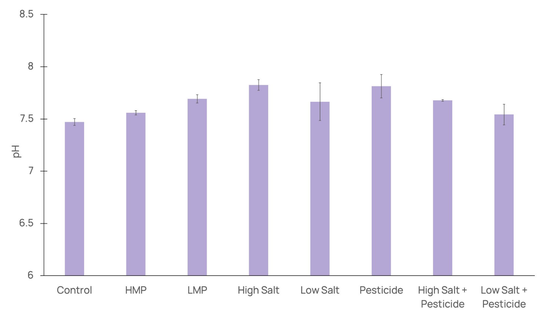


Fig. 4 | pH of each treatment soil. Bars represent average ± SE. ANOVA $p > 0.05$.

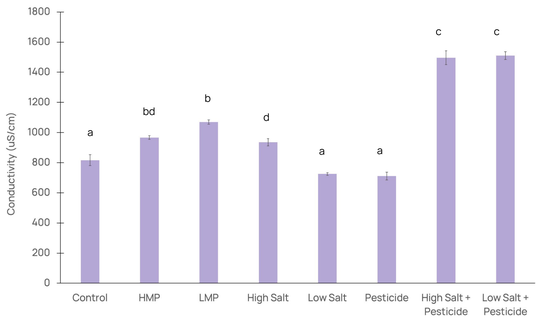


Fig. 5 | Conductivity testing on earthworms exposed to varying soil treatments. Bars represent average ± SE. Letters indicate significant differences between groups.

Table 1 | Avoidance variations of earthworm preference in reference to three treatment bins after collection.

Trial	*1*		*2*		*3*	
Treatment	Control	HMP	Control	LMP	Control	Pesticide
Worm Quantity	2	8	2	8	8	2

Discussion

- The significant decrease in biomass for HMP, LMP and control groups may be attributed to microplastics lacking nutritional value yet occupying volume which prohibited the earthworms from using other nutrients.
- The escape response assay showed earthworms in the presence of HMP had an overall increase in mobility as compared to LMP, aligning with the peanut butter on a cracker theory (Figure 2) (4).
- There were no differences in earthworm behavior (toothpick assay) between treatments. This may be attributed to earthworms aggregate behavior leading to limited conclusions on earthworm activity (13).
- Soil pH did not differ between treatments.
- Conductivity of soils was significant for HMP, LMP, high salt, high salt + pesticide, and low salt + pesticide (Figure 5). This may be attributed to the increase in ions from salt as well as when combined with pesticide treatment. Significance of HMP and LMP may be a result of plastics breaking down and increasing ionic interactions within the soil.
- Avoidance trials of control verses HMP, LMP and pesticide treated soils indicate a possible preference for low and high microplastics in soil, as well as soils without pesticide concentrations.

Future Research

- Measure whole-body respiration rate to determine if experimental treatment affects metabolism.
- Observe differences in reproductive rates of earthworms between treatment groups over extended periods of time.
- Use alternate method for behavioral assay in order to track earthworm movement.
- Dissect earthworms to determine microplastic mass within organisms and their casts after exposure.

Literature Cited

Due to the large amount of literature and sources used throughout creating our poster, we decided to format them all in a easy-to-use QR Code. Just scan with your phone!

Acknowledgements

We would like to thank the Biological Sciences Lab Department for supplying us with the materials and equipment needed to perform this experiment and the Binghamton University Research Day for this opportunity.