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Mesoplastic and Microplastic pollution in the River Emajõgi area

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Figure 1. Research team.

Abstract:

Large part of microplastic pollution reaches the environment via secondary processes – through degradation of bigger plastic pieces. Plastic pollution size class that is bigger than microplastic is called mesoplastic: these are particles with the size of 5-25 mm. Our plan was to collect mesoplastic samples from areas on the river banks of River Emajõgi, and look for microplastics that could be attached and originating from these bigger pieces in the laboratory. We used saturated NaCl solution and vacuum filtering for the separation of the microplastics. As a result, we found mesoplastics in all studied areas. Most abundant colours were blue and red, and angular shape. Most frequent origin of mesoplastics included soda bottles (caps) and fragments of paint. Microplastics were found in all samples but one (beach). Most abundant samples were blue angular particles. Samples contained a numerous amount of blue and purple fibres, the latter originating most probably from expedition participants T-shirts. Blue angular microplastic particles may likely originate from mesoplastic paint pieces and be therefore the result of secondary processes. The results highlight the effect of human activities in the beach area as the source for plastic pollution. In the River Emajõgi study area most plastic pollution found was land-based, not originating from the riverine system. We suggest continuing the work on the sources of plastic pollution, since it is vital information to improve environmental health.

Keywords: mesoplastic, microplastic, River Emajõgi, pollution, Tartu.

Hypothesis:

1. What is the meso- and microplastic pollution on the river banks of River Emajõgi?
2. Where does the plastic pollution originate from?
3. Is mesoplastic the source for secondary microplastic pollution?

Introduction:

You might ask yourself why even study meso- and microplastics? To answer this, one must know the difference between the two. Plastics can be differentiated by their size into macroplastics (>25 mm), mesoplastics (5–25 mm), microplastics (<5 mm), and nanoplastics (<1 μm) (Blair, 2017). Because of the size difference, and therefore physical properties, they act differently in the environment. Mesoplastic itself does not present a direct threat to the environment, but since it is a source of secondary microplastic particles, which are far more dangerous, it is important to research both of them. Since microplastics pollution is a current and quite worrying issue, many studies about the topic have already been conducted. Most of them have shown that microplastic particles are often consumed by microorganisms, and travel through the food chain, but since plastic is durable and very hard to break down, it stays in the environment, causing health issues of various kinds to all organisms within the food chain, e.g. In the oceans, microplastic pollution is often consumed by marine animals (National Geographic Society, 2022). Since we, humans, are the original source of plastic it is our duty as a society to study and keep track of the plastic we produce and send in the environment. Humanity produces more than 430 million tonnes of plastic annually, two-thirds of which are short-lived products that soon become waste, filling the ocean and, often, working their way into the human food chain (UNEP, 2023). This is a global problem, so the way to begin to solve it is to research it on the local level first. That is why we decided to research meso- and microplastic pollution by the river Emajõgi, since this area has not been researched yet.

Materials and methods:

Led by Dr. Randel Kreitsberg (University of Tartu), we went to look for meso- and microplastic particles along the River Emajõgi. To find the answer to the hypotheses, we decided to split our sample-collecting areas near the river into three: asphalt road, sand, and waterline, which we later compared with one another.

- First, we collected mesoplastic (5 - 25mm) in 3 different areas (sand, road, waterline) for 30 min.
- Macroplastic (more than 25 mm) bigger than that was collected and was measured in volume.
- We divided mesoplastic that we found by: shape, size, colour and material type / origin

Figure 2. Map of the study area (Estonian Land Board, XGIS 2.0, 2023).


Figure 3. Mesoplastic sampling in River Emajõgi area.

- Then in a lab we washed off any microplastic from the mesoplastic
- We used a saturated salt (NaCl) solution to float any microplastic particles.
- Then we took 50 ml samples from the upper water layer
- After that we filtered out any microplastics or other particles from the samples using filter paper

- Under a microscope we identified all microplastic fragments on the filter paper

Figure 4. The filtering device.

- Then we described microplastic fragments that we found and made a table cataloging the number of micro plastics, colour and shape.

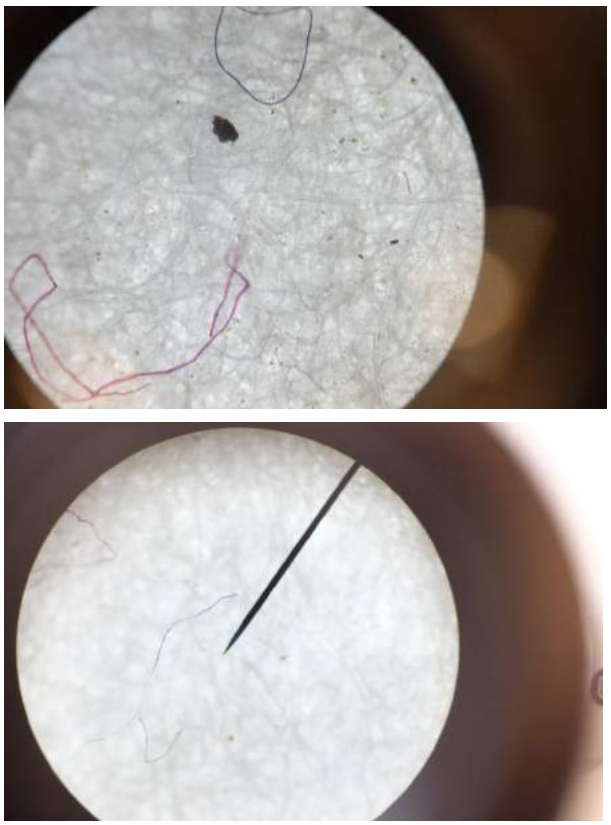

Figure 5. Examples of found microplastics. Notice the purple fibre, that is probably originating from Globe Learning Expedition participant t-shirt.

Results:

Macroplastics were found most abundantly in sand and road study sites, but not in the waterline.

Mesoplastics were found in all studied areas. Distribution of mesoplastic particles according to shape and colour is visible in Table 1. Most abundant colours were blue and red, and angular shape. Most frequent origin of mesoplastics include soda bottles (caps) and fragments of paint.

Table 1. Mesoplastics in the study area.

AREA	SANDYBEACH			ROAD		WATERLINE
Group	1	2	3	1	2	1
Litres of litter	3	0,5	1	1	1	0
Number of mesoplastic	17	9	26	15	32	4
Colours	Red/blue	blue	yellow	red	blue	white
Shapes	round	angular	angular	angular	angular	round/angular

Microplastics were found in all samples but one (beach). Road area had the highest amount of microplastic particles. Distribution of microplastic particles according to shape and colour is visible in Table 2. Most abundant samples were blue angular particles. Samples contained a numerous amount of blue and purple fibres, the latter originating most probably from expedition participants T-shirts. Blue angular microplastic particles may likely originate from mesoplastic paint pieces.

Table 2. Microplastics in the study area.

AREA	SANDYBEACH			ROAD		WATERLINE
Group	1	2	3	1	2	1
Number of microplastic	2	8	0	16	7	3
Colours	blue	red/blue	0	red/blue	blue	blue
Shapes	angular	round	0	libre	angular	round

Discussion:

After the data analysis we understood that, most of the plastics that were found near the River Emajõgi are the effect of visitor activities, because it was public place (the most of the plastic was found on the beach and on the road; one of the reasons why we didn't find as much plastic on the waterline is that, because there is a nature reserve upstream).

After looking for microplastics on the filters we found some correspondence between some blue angular micro- and mesoplastics. So that means that in this case the microplastic came from mesoplastic, but otherwise we did not find any other correspondence. We also found many purple fibres which we assume are from our t-shirts.

We also compared our data with a study done during August 2018 to study the plastic debris present in beach sediments at the remote islands of the Andaman and Nicobar Archipelago, India (Krishnakumar et al., 2019). The total number of plastic pieces found on the beach was 1278 over the course of a month, whereas we found 97 after 30 min. Therefore, we can conclude that plastic pollution is a widespread global issue, and our results are comparable to other research studies.

Conclusions:

Plastic litter in different size classes was found in all study areas: beach sand, waterline and road surface. The results highlight the effect of human activities in the beach area as the source for plastic pollution. In the River Emajõgi study area most plastic pollution found was land-based, not originating from the riverine system. We suggest continuing the work on the sources of plastic pollution globally, since it is vital information to improve environmental health. In addition, international unified methods are needed to compare similar studies between each-other, therefore we recommend developing the global study protocol for GLOBE.

References:

The United Nations Environment Programme. (2023). Everything you need to know about plastic pollution.
https://www.unep.org/news-and-stories/story/everything-you-need-know-about-plastic-pollution

National Geographic Society. (2022). Microplastics
https://education.nationalgeographic.org/resource/microplastics/

Jimenez-Cárdenas, V., Luna-Acosta, A. and Gómez-Méndez L. D. (2022). Differential Presence of Microplastics and Mesoplastics in Coral Reef and Mangrove Fishes in Isla Grande, Colombia. https://www.mdpi.com/2673-8929/1/3/34

The United Nations Environment Programme. (2012). Microplastics.
https://wedocs.unep.org/bitstream/handle/20.500.11822/12079/brochure-microplastics.pdf?sequence=1&amp%3BisAllowed

Kannan, K. and Sumbbiah, K. K: (2019). Assessment of plastic debris in remote islands of the Andaman and Nicobar Archipelago, India.
https://www.researchgate.net/publication/338116495_Assessment_of_plastic_debris_in_remote_islands_of_the_Andaman_and_Nicobar_ArchipelagoIndia

Supplementary Information:


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