frontiers | Frontiers for Young Minds
CHEMISTRY AND MATERIALS
Published: 24 October 2024
doi: 10.3389/frym.2024.1390723

# EXPLORING THE TINY WORLD OF MICROPLASTICS IN YOUR OWN "LAB"

***Teresa Serra[1], Jordi Colomer[1], Ivar Zekker[2], Sedat Gündoğdu[3], Nanna B. Hartmann[4], Stefania Federici[5,6], Aleksandra Tubić[7] and Milica Velimirovic[8*]***

[1] *Department of Physics, University of Girona, Girona, Spain*
[2] *Institute of Chemistry, University of Tartu, Tartu, Estonia*
[3] *Department of Basic Science, Faculty of Fisheries, Cukurova University, Adana, Türkiye*
[4] *Department of Environmental and Resource Engineering, Technical University of Denmark, Lyngby, Denmark*
[5] *Department of Mechanical and Industrial Engineering, University of Brescia, Brescia, Italy*
[6] *National Interuniversity Consortium of Materials Science and Technology, Florence, Italy*
[7] *Faculty of Sciences, University of Novi Sad, Novi Sad, Serbia*
[8] *Materials and Chemistry Unit, Flemish Institute for Technological Research (VITO), Mol, Belgium*

YOUNG REVIEWERS:

AKSHARA
AGE: 14

MAHYA
AGE: 11

Microplastics are tiny pieces of plastic that result from the breakdown of larger plastic objects, such as water bottles, shopping bags, food containers, and many other types of waste. Microplastics can be as small as a bacterial cell or as big as a grain of rice. Microplastics exist in many different shapes: some are round and smooth while others are in the shape of fibers or fragments. Scientists have known about microplastics in nature since the 1970s, but lately they are finding these tiny plastics almost everywhere they look—in the air, lakes, rivers, oceans, on land, and even in remote places like Arctic lakes and snow! In this article, we will show you the hidden universe of microplastics, cool tools scientist use to analyze them, and show how you can do your own experiment to analyze microplastics from a nearby beach.

## WHAT ARE MICROPLASTICS AND WHERE DO THEY COME FROM?

In the 1950s, a super strong and versatile new material was discovered. This material is known as plastic, and it is most often made from fossil fuels. It is more accurate to say "plastics" because there are many kinds of plastic. Since their discovery, plastics have been used worldwide for many things such as packaging, bottles, fishing nets, construction, medical equipment, tires, and even clothes (Figures 1A, B).


**Figure 1**

**(A)** Microplastics come from multiple sources, including tyres, soap tablets, plastic bags, synthetic clothes, paints, and maritime transportation. **(B)** Examples of plastic products contaminating the environment. **(C)** Microplastics exist in various shapes (source of the image: own source, with icons from https://ian.umces.edu/media-library/ and some other from https://www.flaticon.es/).

Sometimes plastics end up in nature, usually because they are not thrown into the trash bin (or maybe there was no bin around to start with). Once in nature, interaction with sunlight causes plastic objects break down into smaller plastic particles called **microplastics**. Microplastics can be as small as 1 micrometer (invisible to human eye, the size of a bacterial cell) and as "big" as 5 millimeters (about 0.2 inches, slightly smaller than a grain of rice and visible to human eye) [1]. This breakdown happens to any type of plastic waste, such as drinking bottles, fishing nets, or birthday balloons. Additionally, tiny plastic fragments come from car and truck tires as they wear down from friction with the road surface. Rainfall transports these small tire particles into rivers that end up in ocean waters. Microplastics also come from our households. For example, when we wash our clothes, as many as 700,000 tiny microfibers can sneak out and find their way into the ocean through rivers [2]. All these tiny microplastics coming from various sources have different shapes (Figure 1C), different colors, and are made from different types of plastic materials with names like polystyrene, polypropylene, polyethylene, polyethylene terephthalate, and polyvinyl chloride (PVC).

**MICROPLASTICS**

Tiny pieces of plastic that are small as 1 micrometer up to 5 mm (or 5,000 micrometers) in size. They mainly come from the breakdown of bigger plastic items.

## WHY SHOULD WE CARE ABOUT MICROPLASTICS?

Microplastics are a global concern since they are released into nature, causing pollution of water, soil, and the atmosphere. Most microplastics are carried to the ocean by flooding, by rivers, and by windy weather. Scientists have found microplastics in many places like farmers' soils, deep ocean sediments, Arctic lakes, and even in snow. Some studies also report that animals, like birds, dolphins, and whales, also accidentally eat microplastics [3].

Understanding how common microplastics are in nature is important for figuring out how harmful these tiny plastics are to us. Microplastics can have various effects on the human body. These tiny particles may enter the bloodstream, with some studies suggesting they may increase the risk of heart disease [4]. Additionally, certain chemicals associated with microplastics, such as bisphenol A and phthalates, might interact with our hormones. This interaction could influence factors like weight regulation and overall health [5].

## COOL TOOLS TO FIND AND STUDY MICROPLASTICS

Detecting microplastics in nature, especially the really tiny ones, is not easy because they are not visible to the eyes. Scientists are like detectives trying to find microplastics in nature. They use various tools to extract microplastics from water, air, and soil to further study them [6]. **Microscopy**, especially using a powerful microscope called an **electron microscope**, helps to visually identify and measure tiny microplastics. Under different kind of microscope, microplastics

**MICROSCOPY**

A scientific technique used to see objects that cannot be seen with the bare eye.

**ELECTRON MICROSCOPE**

An instrument that uses a beam of electrons to enlarge image of objects that cannot be seen by bare eye.

stained with a dye called Nile red light up, making them easy to spot. **Spectroscopy** detects different microplastics by analyzing the light they reflect, helping to identify the type of plastic by its unique light "fingerprint". **Chemical analysis** can also be used to identify the chemical compounds each type of microplastic is made from. To do this, microplastics are heated in an oven and broken down into smaller compounds. The components move through a special tube at different rates, and, at the end, another scientific tool takes a "photo" of each component to figure out what it is made of. The name of this technique is **pyrolysis gas chromatography-mass spectrometry**.

Analysis using any of these cool tools is generally repeated multiple times, to check that the results are reliable and trustworthy. Scientists also use multiple methods to double-check their findings, ensuring they get the best information possible.

## ADVENTURE TIME: DETECTING MICROPLASTICS ON THE BEACH

If you want to be an environmental detective and collect your own data about microplastics on the beach, you can! Just follow this simple procedure [6].

For collecting the samples, you will need the following materials (Figure 2A):

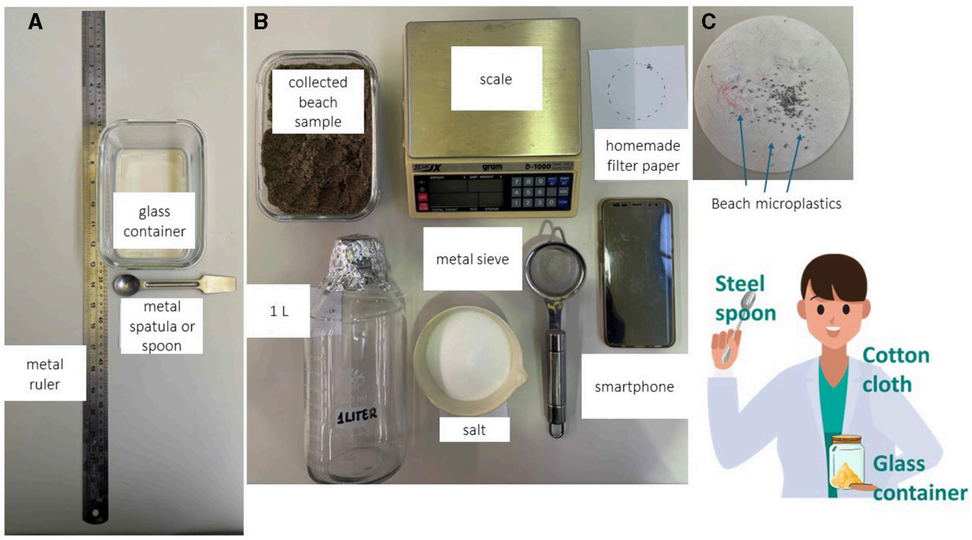


Figure 2

- A 50-cm ruler
- A metal spatula or spoon
- A glass or metal container

**SPECTROSCOPY**

A scientific method used to find out what materials are made of by the way they absorb and reflect light. Every substance has a unique light "fingerprint".

**CHEMICAL ANALYSIS**

A process that separates, identifies, and quantifies substances in different samples.

**PYROLYSIS GAS CHROMATOGRAPHY-MASS SPECTROMETRY**

A scientific technique used to study complex materials, in which they are heated until they break down into their components, which are then separated and identified.

**Figure 2**

Materials needed for **(A)** the collection of your sample, and **(B)** the "laboratory" analysis of microplastics that you can perform. **(C)** An example of a filter with microplastics obtained from a sample.

Go to the beach and follow these steps:

1. Mark a square of 50 × 50 cm on the sand with the spatula.
2. Scrape the area marked with the spatula, up to a depth of ∼1 cm.
3. Collect all the sand and, with the spatula or spoon, place it in the glass or metal container.

When collecting samples, avoid using plastic tools. Instead, opt for glass or metal containers. Wear cotton clothes during the collection and analysis process.

For the analysis in your "lab" you will need the following material (Figure 2B):

- The container with the sample you collected
- A scale
- A glass bottle with one liter of water
- 400 g of salt
- A metal sieve with the finest possible mesh you have (like the one in your kitchen). If you can, try to measure how big the holes in your sieve are (likely a few millimeters or so)
- A smartphone or a camera to take photographs
- A homemade filter paper that you can make by cutting a circle from a piece of paper

Here are the steps to follow for analyzing the microplastics in your sample:

1. Let the sand dry for 2–3 days, until it is completely dried. If the sample has some branches or leaves from plants, remove them with the spoon, very gently. Weigh the sample and write down the result in grams.

   - Using the metal sieve, separate the sample into two parts (smaller and bigger than the mesh size of your sieve). You will only analyze the large particles. To analyze the small ones, you would need a microscope.

2. Mix 400 g of salt in 1 L of water. Mix it vigorously, shaking the bottle or stirring with a metal spoon. If there is a cap on the bottle, make sure it is metal, not plastic. If it is plastic, add aluminum foil between the cap and the bottle.

   - After mixing, put your sample into the bottle of salty water.
   - Mix vigorously again and leave this mixture for 24 h. The next day, very gently pour the upper part of the water (about 5 cm or 1.97

inches) through the same sieve again, this time with the paper filter positioned inside the sieve.

- Leave the filter paper to dry for another 24 h. You can use a magnifier to inspect what you have on the filter paper, or you could use your smartphone to take a photograph of the sample. If you want to be very precise, you could take a photo of the filter paper *before* filtering the water sample. This will help you to detect what came from the sample you filtered vs. what may have been stuck on the filter paper to start with.

3. Count the number of particles obtained. Many of them will be plastic particles (Figure 2C).

Now you can do some scientific calculations:

To figure out the amount of microplastic pollution in your sample, divide the number of plastic particles obtained by the weight of the sample you wrote down at the beginning. This will give you microplastic particles number per gram of sand. Now you can compare the results for different sands and determine which sample has the highest number of MPs.

Any type of laboratory work like this requires an organized, clean workspace. When studying microplastics, you should never use plastic materials because they could add plastic to your sample. So, cotton clothes and latex gloves should be worn. All materials should be glass or metal.

## MISSING PIECES IN THE MICROPLASTICS PUZZLE

While scientists have made amazing discoveries, there are still many missing pieces in the microplastics puzzle. Imagine trying to solve a puzzle with different-shaped pieces that do not quite fit together. That is a bit like how scientists face challenges with different ways of measuring microplastics. We need common rules or tools everyone can use. This way, we can all understand and compare findings better. Scientists worldwide, including our group of researchers, are teaming up through collaborative research networks called Cooperations of Science and Technology (COST). These groups bring together experts from different countries to work on specific challenges, like understanding microplastics! By sharing data and ideas, these collaborations on various topics (Figure 3) supercharge our efforts in solving the microplastics puzzle [7].

Remember, every small action counts—whether it is reducing plastic use and recycling properly, supporting rules that encourage ecofriendly materials, improving filters in washing machines and wastewater plants, sharing knowledge, or sparking conversations


Figure 3

**Figure 3**

Worldwide scientific efforts are being taken to solve the microplastics puzzle, to keep humans and our planet healthy.

about protecting our planet. By doing all these things together, we can make progress in solving the microplastics problem and help to keep our planet clean. Besides using fewer plastic products and disposing of them properly, one of the most important things you can do is to keep exploring and keep asking questions!

## ACKNOWLEDGMENTS

This article is based upon work from COST Action CA20101 Plastics monitoring detectiOn RemedIaTion recovery—PRIORITY, supported by COST (European Cooperation in Science and Technology, https://www.cost.eu). MV acknowledges EU-funded project MS4Plastics (H2020-MSCA-IF-2020—Grant Agreement No. 101023 205). IZ gratefully acknowledges the funding from projects SARASWATI 2, PLTKTARENG5, PLTKTARENG73, NANAQUA, and NEUTEN "Identifying best available technologies for decentralized wastewater treatment and resource recovery for India" and SLTKT20427 "Sewage sludge treatment from heavy metals, emerging pollutants and recovery of metals by fungi", by University of Tartu Development fund PLTKT ARENG5 and by project funded by EU Commission INTERREG "Improving quality of BSR waters by advanced treatment processes", "*In-situ* catalytic bioconversion of pharmaceutically active compounds in wastewater" by CELSA funding, "Reduction of greenhouse gas emissions in the wastewater treatment sector by autotrophic nitrogen removal as an alternative to heterotrophic processes" by EIC funding and by COST actions: CA20127, CA20138, CA22102, CA22110, CA22123, CA22162, CA22146. TS and JC were supported by the Ministerio de Economía y Competitividad of the Spanish Government through Grant PID2021-123860OB-I00.

## REFERENCES


1. Rist, S., Hartmann, N. B., and Welden, N. A. C. 2021. How fast, how far: Diversification and adoption of novel methods in aquatic microplastic monitoring. *Environ. Pollut*. 291:118174. doi: 10.1016/j.envpol.2021.118174
2. Napper, I. E., and Thompson, R. C. 2016. Release of synthetic microplastic plastic fibres from domestic washing machines: effects of fabric type and washing conditions. *Mar. Pollut. Bull*. 112:39–45. doi: 10.1016/j.marpolbul.2016.09.025
3. Merrill, G. B., Hermabessiere, L., Rochman, C. M., and Nowacek, D. P. 2023. Nowacek, Microplastics in marine mammal blubber, melon, & other tissues: evidence of translocation. *Environ. Pollut*. 335:122252. doi: 10.1016/j.envpol.2023.122252
4. Marfella, R., Prattichizzo, F., Sardu, C., Fulgenzi, G., Graciotti, L., Spadoni, T., et al. 2024. Microplastics and nanoplastics in atheromas and cardiovascular events. *N. Engl. J. Med.* 390:900–10. doi: 10.1056/NEJMoa2309822
5. Li, P., and Liu, J. 2024. Micro(nano)plastics in the human body: sources, occurrences, fates, and health risks. *Environ. Sci. Technol.* 58:3065–307. doi: 10.1021/acs.est.3c08902
6. Rani, M., Ducoli, S., Depero, L. E., Prica, M., Tubić, A., Ademovic, Z., et al. 2023. A complete guide to extraction methods of microplastics from complex environmental matrices. *Molecules* 28:5710. doi: 10.3390/molecules28155710
7. Federici, S., Ademovic, Z., Amorim, M. J. B., Bigalke, M., Cocca, M., Depero, L. E., et al. 2022. COST Action PRIORITY: an EU perspective on micro- and nanoplastics as global issues. *Microplastics* 1:282–90. doi: 10.3390/microplastics1020020



**SUBMITTED:** 23 February 2024; **ACCEPTED:** 07 October 2024;
**PUBLISHED ONLINE:** 24 October 2024.

**EDITOR:** Leonardo Fernandes Fraceto, São Paulo State University, Brazil

**SCIENCE MENTORS:** Gangadhar Andaluri and Jonas Rashidi

**CITATION:** Serra T, Colomer J, Zekker I, Gündoğdu S, Hartmann NB, Federici S, Tubić A and Velimirovic M (2024) Exploring the Tiny World of Microplastics in Your Own "Lab". Front. Young Minds 12:1390723. doi: 10.3389/frym.2024.1390723

**CONFLICT OF INTEREST:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## YOUNG REVIEWERS

### AKSHARA, AGE: 14

I am a 14-year-old who loves science and is enthusiastic to learn new things!

### MAHYA, AGE: 11

I am Mahya, an 11-year-old student living in Isfahan, Iran right now. I am interested in helping people to make them feel better. I dream of becoming a doctor and a scientist. As a doctor, I would be in charge of people's health and the environment.

## AUTHORS

### TERESA SERRA

I am an environmental physicist at University of Girona interested in understanding the transport of microplastics in natural environments (lakes, rivers, and coasts). Scientists need to understand the behavior of microplastics so that we can find ways to get rid of them and have a cleaner planet. I find research and experiments fun!

### JORDI COLOMER

I am an environmental scientist at University of Girona working in the areas of (1) sediment transport in environmental systems and (2) nature-based solutions for treating waste waters. I am interested in establishing the distribution of microplastics in very sensitive systems such as rivers, beaches, coastal waters, and lakes, which are contaminated by microplastics. I am also interested in the impacts microplastics have on some living organisms that inhabit water systems. I am particularly interested in sustainable scientific procedures.


### IVAR ZEKKER

I am research fellow at the University of Tartu, Estonia, which is in small northern country. We study elimination of bad chemicals from water, air, and soil using easy bacterial methods, in which bacteria eat pollutants or transform them to safer products. I am passionate about spending time with my family and friends, and playing with my cat and gecko lizard. I love when laboratory work is fun and saves our planet.

### SEDAT GÜNDOĞDU

I am a senior professor at the Faculty of Fisheries at Çukurova University in Türkiye. My research focuses on waste issues, such as microplastics, plastic waste trade, and environmental degradation. I am particularly interested in understanding the distribution of microplastics in various ecosystems and their impact on organisms. Additionally, I conduct voluntary awareness activities on plastic pollution for diverse groups, including children. In my personal life, I spend time with my wife and two cats, Mikro and Venus.

**NANNA B. HARTMANN**

I am a senior researcher at the Technical University of Denmark. My research is about how small particles, including nanomaterials and microplastics, behave in the environment. I am interested in understanding their distribution, if and how they degrade, and how they affect animals. I am also interested in how we can avoid (or minimize) pollution. At the same time, I am passionate about communication and gender equality in science. I spend my free time on yoga, jewelry making, and my family, which includes my husband, two sons, and two cats.

**STEFANIA FEDERICI**

I am a senior researcher at the University of Brescia in Italy. I am a scientist who loves exploring the vast universe of materials. I spend my days studying small stuff like nanomaterials and molecules that stick to surfaces. Like a detective, I use special tools to see things that are too tiny for our eyes! One of my big interests is figuring out how to make materials that help us understand how tiny pieces of plastic, called micro- and nanoplastics, affect our environment. I want to create special stuff that acts like real pollution so scientists can find ways to stop it from hurting our planet.

**ALEKSANDRA TUBIĆ**

I am a full professor at the University of Novi Sad in Serbia. My main research focus is microplastics in the interaction with different chemicals that can be found in the environment. As a professor, I empower students with the knowledge to proactively prevent environmental pollution and implement strategies for mitigating existing issues. Beyond the classroom, I am deeply committed to science communication, particularly with children and the wider public. Environmental protection is not just a career path for me; it is a lifestyle. Collaborating with colleagues worldwide, I find immense joy in contributing to the global effort to enhance and preserve our precious environment.

**MILICA VELIMIROVIC**

I am a Marie Skłodowska-Curie postdoctoral fellow at the Flemish Institute for Technological Research in Belgium. My research focuses on finding the best analytical tools to track nanomaterials, including microplastics and nanoplastics, in the environment. Beyond my research, I also enjoy being involved in citizen science initiatives. I like gardening in my urban garden, playing tennis or pétanque with my husband and two sons, and spending time with them in nature. *milica.velimirovic@vito.be