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A PIONEERING STUDY ON THE INVESTIGATION OF MICROPLASTIC POLLUTION IN THE WATER OF THE SOMOVA-PARCHEȘ LACUSTRINE COMPLEX, ROMANIA

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Abstract

Although the presence of microplastics in the oceans was first reported in the 1970s, the first studies on lakes were published in 2011. This pioneering study aims to determine the presence of microplastics in the Somova-Parches lacustrine complex, situated in the predeltaic territory of the Danube Delta Biosphere Reserve. The Pollution Load Index (PLI) was also calculated to assess the microplastic pollution level in water. The microplastics concentrations in the water of the 6 investigated lakes varied in the 0.15 - 0.65 particles·m^{-3} range. The PLI index values indicated a low level of microplastic pollution (level 1). The results of the micro-FTIR analyses highlighted the predominant presence of polyethylene and polypropylene polymers in the composition of the collected microplastics. The present study contributes to bridging the knowledge gap regarding the occurrence of microplastics in freshwater.

***Key words**: emerging pollutant, freshwater, Lower Danube water, micro-FT-IR.*

INTRODUCTION

In recent years, due to their versatility, the production and consumption of plastic products have increased significantly worldwide. According to predictions, global production could reach 25 billion tons by 2050 (Liu et al., 2025). In addition, total plastic waste production could be estimated at 12 000 million tons by 2050 (Zhang et al., 2024). The mismanagement of plastic waste contributes to its release into the environment, where it is fragmented into microplastics (MPs) (Gan et al., 2025). Microplastics are considered hazardous substances in the environment due to their composition (e.g. additives), irregular shape, small size and their ability to carry other pollutants that can have a harmful impact on biota (Nguyen et al., 2023).

Although most research has focused on microplastics in marine ecosystems, recent studies have shown that microplastic pollution in inland waters can be 20 times higher than in marine ecosystems (Horton et al., 2017; Pol et al., 2023). Human activity and terrestrial ecosystems are strongly connected to inland waters. Therefore, their pollution has a direct impact not only on aquatic and terrestrial biota, but also on human health (Luo et al., 2024). Lentic ecosystems serve as indicators of watershed health due to their capacity to accumulate pollutants (Dusaucy et al., 2021). For these reasons, it is essential to monitor microplastics in lakes.

The main aim of this study is to evaluate for the first time the presence of microplastics in six lakes from the Somova-Parcheș aquatic complex, Romania. In addition, the pollution level of lake water with microplastics was determined by calculating the Pollution Load Index (PLI).

Somova-Parcheș lacustrine complex is situated in the western part of the Danube Delta, near Tulcea City. The lakes in this complex are fed with water from the Danube River, especially in high-flow seasons (e.g., spring) (Burada et al., 2015). The water quality of the Danube and its tributaries in Romania has been physico-chemical evaluated in numerous articles by calculating the Water Quality Index (WQI).

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According to the obtained results, it was mostly classified in class II - "good" (Frîncu, 2021). Regarding microplastic pollution, according to the study conducted by Procop et al., 2024 the Danube water transports approximately 46-51 tons of microplastics per year on the territory of Romania.

MATERIALS AND METHODS

The area investigated in this study is important because the Danube Delta has been part of the UNESCO (United Nations Educational, Scientific and Cultural Organization) World Heritage Site Biosphere Reserve since 1991 (Popa et al., 2018). In Figure 1, the 6 lakes from which the microplastics were taken can be localized: Morun Lake, Babele Lake, Parcheș Lake, Potica Lake, Câșla Lake, and Somova Lake.

The microplastics were collected from the water with a 150 µm mesh size with a mechanical flow meter that quantifies the volume of filtered water.

The sample preparation, i.e., the isolation of microplastics from organic matter and dense impurities, was carried out according to the method presented in the article by Calmuc et al., 2023.

Microplastics were filtered on Polyvinylidene Fluoride (PVDF) membrane filters with 0.45 µm pore size and 47 mm diameter.

The microplastic filters were analysed using the Spotlight 400 FT-IR Imaging System, PerkinElmer equipment, to identify the polymers in the composition.

The analyses were performed with a resolution of 16 cm^{-1}, a spatial resolution of 6.25 µm, and a spectral range between 4000 -750 cm^{-1}.

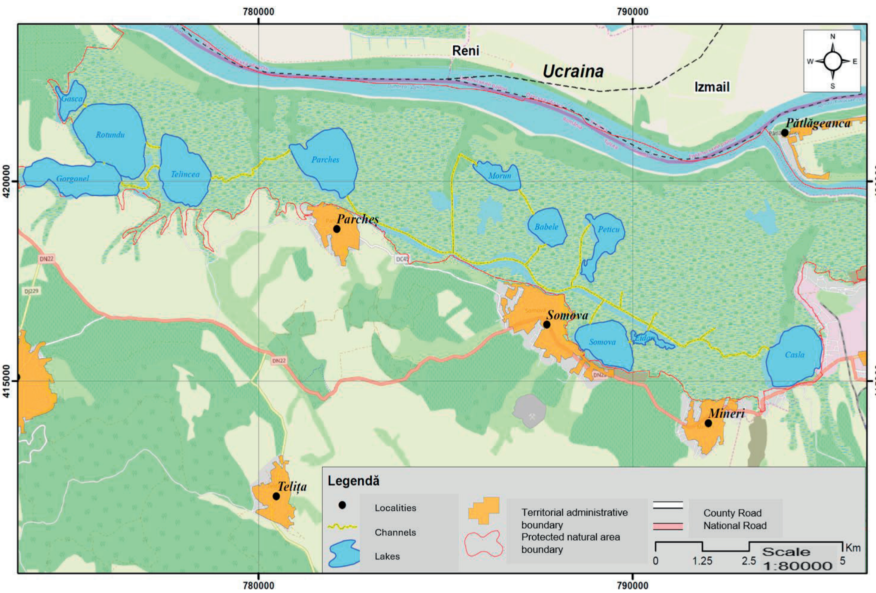

Figure 1. Location of lakes investigated

The Pollution Load Index (PLI) is used to assess the degree of microplastic pollution in the environment and can be calculated according to formulae 1 and 2 (Qiu et al., 2023; Zhou et al., 2024):

$$PLI = \sqrt{CFi} \quad (1)$$

$$CF_i = \frac{Ci}{C0} \quad (2)$$

were:

- CF_i = MPs contamination index;
- C_i = MPs abundance in monitoring stations;
- C_0 = MPs background value (in this study, C_0 represents the lowest MPs concentration recorded in investigated lakes, respectively 0.15 particles·m^{-3}.

According to Table 1, the degree of MPs pollution can be divided into four levels depending on the PLI index score.

Table 1. Pollution Load Index classes
(Qiu et al., 2023; Zhou et al., 2024)

PLI values	Pollution Level
0-10	I – Low
11-20	II – Medium
21-30	III – High
>30	IV – Extremely high

RESULTS AND DISCUSSIONS

Figure 2 illustrates the abundance of microplastic particles recorded in each of the 6 lakes investigated. Particle concentrations ranged from 0.15-0.65 particles·m^{-3}, with the highest abundance recorded in Somova Lake. The main sources of pollution with MPs would be the Danube River that supplies the lakes with water, fishing, tourism, and anthropogenic activities that take place in the localities near the lakes. For example, the village of Somova is located on one of the banks of Somova Lake (where the maximum value was recorded).

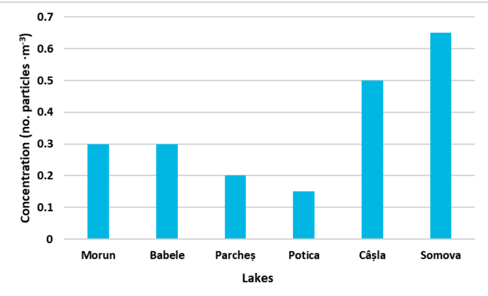

Figure 2. Microplastics concentration in the investigated lakes

Studies showed that MPs concentration in freshwater depends on anthropogenic factors such as population density (Jian et al., 2020). The density of the Somova commune, which includes the villages of Somova, Parcheș, and Mineri, is low, at 33.65 people·km^{-2} (2021) (www.citypopulation.de). Similar results were observed in the study conducted by (Fischer et al., 2016), where concentrations of 2.68 to 3.36 particles·m^{-3} and 0.82 to 4.42 particles·m^{-3} were identified in the surface water from Chiusi Lake and Bolsena Lake, respectively (central Italy). High concentrations of MPs (2425 – 7050 particles·m^{-3}) were observed in the surface water of 20 lakes in the urban area of Changsha, China (Yin et al., 2019).

Based on the morphological classification, MPs collected were film, fragment, and fiber. Fragment and fiber shapes dominate the six lakes, which indicates different sources of pollution (Figure 3) (Li et al., 2021).

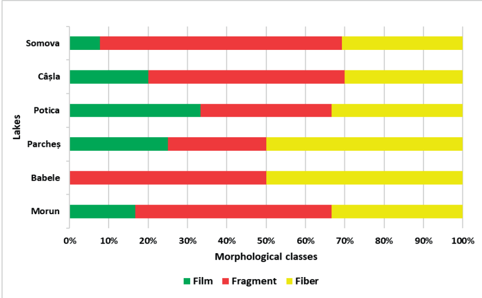

Figure 3. Morphological classification of microplastics

Visible images of MPs particles collected from the six lakes of different colors (green, blue, red), irregular shapes (film - a, fragment - b, fiber - c, d), and sizes are illustrated in Figure 4. An irregular shape suggests that the larger particles' fragmentation can be the source (Rosal, 2021). The sharp edges of irregular shapes can cause physical damage to the stomach wall of fish ingesting MPs (Hossain et al., 2019).

The size classes of microplastics are plotted in Figure 5. In the Somova, Câșla, and Babele lakes, MPs were collected from all four size categories (<150 µm, 150 - 500 µm, 500 - 1000 µm, and 1000 - 5000 µm), while in the Potica and Parcheș lakes, only the 500 - 1000 µm and 1000 - 5000 µm classes were found. The size of microplastics is another important morphological parameter. The presence of larger particle sizes is a source for the secondary of smaller fragments, thus favoring an increase in concentration. Smaller sizes are more bioaccessible and have a higher surface-to-volume ratio, making them more harmful (Sutkar et al., 2023). The polymer composition is another essential parameter of microplastics that provides valuable information for identifying pollution sources. Figure 6 illustrates the image obtained after micro-FT-IR analysis of a microplastic sample on a PVDF filter. Variations in absorbance intensity can be observed, with higher intensities corresponding to greater thickness of the MPs particles.

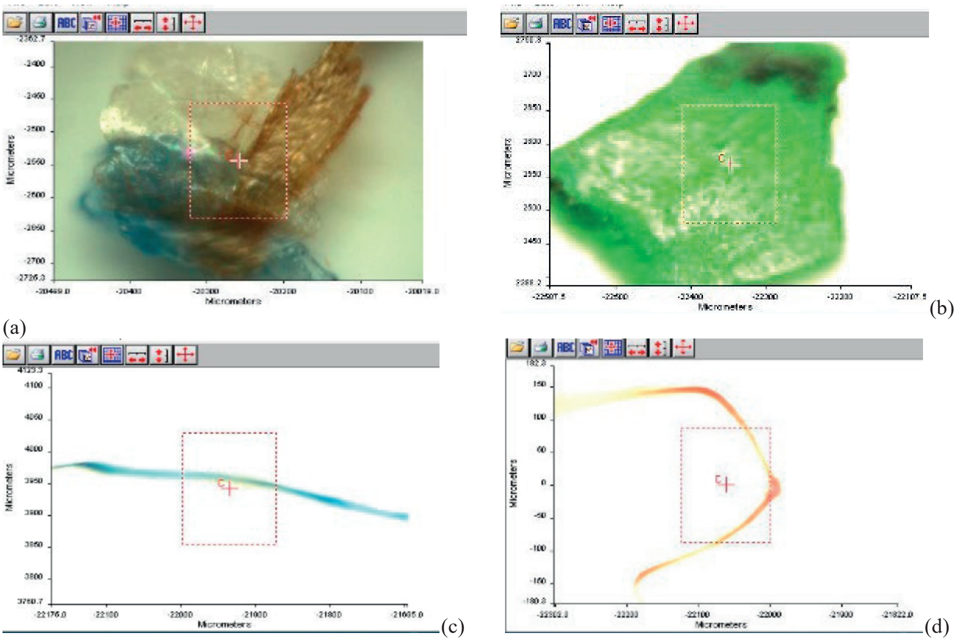

Figure 4. Visible images of microplastics: a) film; b) fragment c); d) fiber

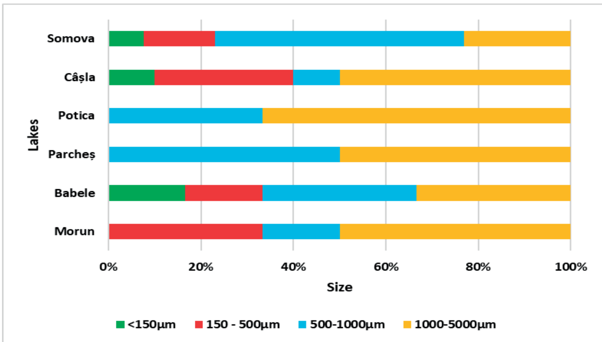

Figure 5. Microplastics size categories

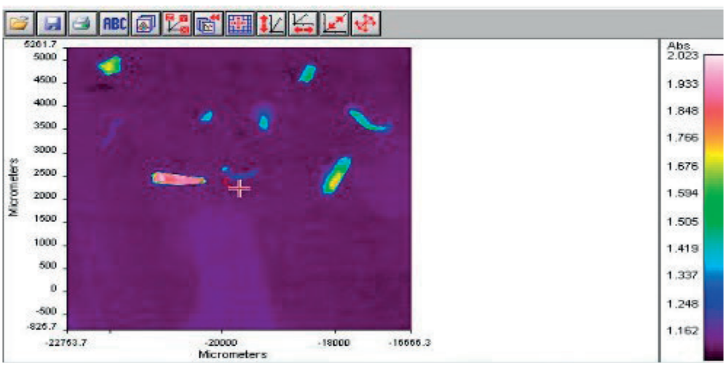

Figure 6. Micro-FT-IR spectral image of microplastics

The IR spectra were extracted from the obtained images (Figure 7) and based on a comparison with the Spectra Databases for Polymers - S.T.Japan Europe GmbH, the polymers composing the microplastics were identified.

The ubiquitous polymer identified in greatest abundance was polyethylene (PE) (Figure 8). The highest polymer diversity was found in Somova and Câşla lakes, where the highest concentrations were recorded. This result is explained by the fact that PE is the most widely used polymer in plastics production (https://www.britannica.com/science/polyethylene.). The second polymer observed was polypropylene (PP), which is one of the most widely used polymers worldwide for packaging (Fernández-González et al., 2021). Polyester (PES), polyacrylonitrile (PAN), and rayon were identified in the fiber composition. Microfiber pollution is caused by fishing nets, rope from lakes, and textiles, in particular by their presence in the air and domestic washing machine effluents (Salvador Cesa et al., 2017).

PVC (polyvinyl chloride) was found in the Somova Lake, which could originate from the degradation of building materials and insulation of cables based on this polymer (Akovali, 2012). In addition, a hydroxyl functional polyester–based paint particle was collected from Somova Lake, which could come from the boat paint. According to the report "Plastic Paints the Environment", published in 2022 by Environmental Action in Switzerland, paints account for 58% of microplastics in the world's oceans and waterways (Paruta et al., 2022).

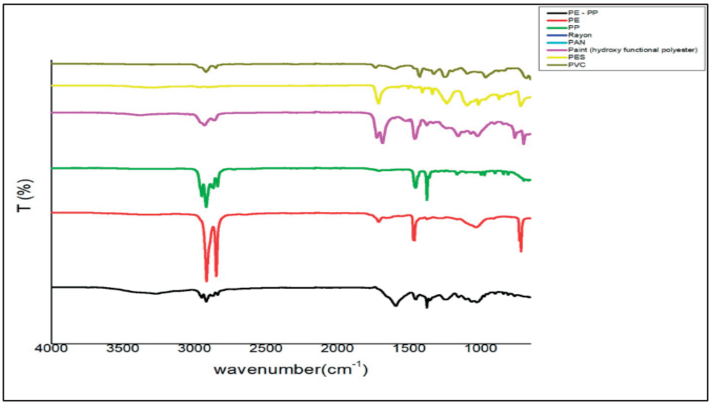

Figure 7. IR spectra of the identified polymers

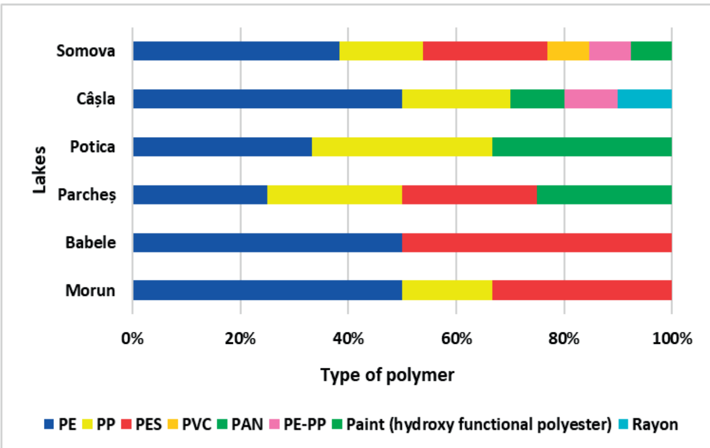

Figure 8. Polymer composition of microplastics

Another aim of the present paper was to assess the level of microplastic pollution in the 6 lakes by calculating the PLI index. The index values are plotted in Figure 9 and are in the range 0.86-1.80, indicating a low level of microplastic pollution (category risk I). Low MPs pollution load was observed in high-altitude glacier lakes in Northern Anatolia, water PLI values ranging from 1.00 to 2.65 (Akdemir et al., 2025).

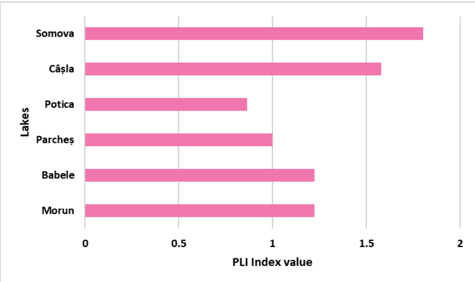

Figure 9. PLI index values

CONCLUSIONS

In this paper, the presence of microplastics in 6 lakes from the Somova-Parcheş lacustrine complex was studied for the first time. The MPs concentrations in the water of the 6 investigated lakes varied in the 0.15-0.65 particles·m^{-3} range. A variety in the shape, size, and polymer composition of the MPs in the collected samples was observed, indicating the diversity of pollution sources. The MPs shapes identified were fragment>fiber>film. The results of the micro-FT-IR analyses highlighted the presence of PE>PP>PES>PAN>PVC>Paint (hydroxyl functional polyester) polymers in the composition of the collected microplastics. PLI values of all the lakes showed minor contamination with microplastics in the risk I category. This pioneering research fills a knowledge gap, providing valuable information on microplastic pollution of previously unexplored freshwater ecosystems.

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