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China Yangtze River

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Effect of microplastics exposure on the microorganisms and aquatic plants in lakes and reservoirs

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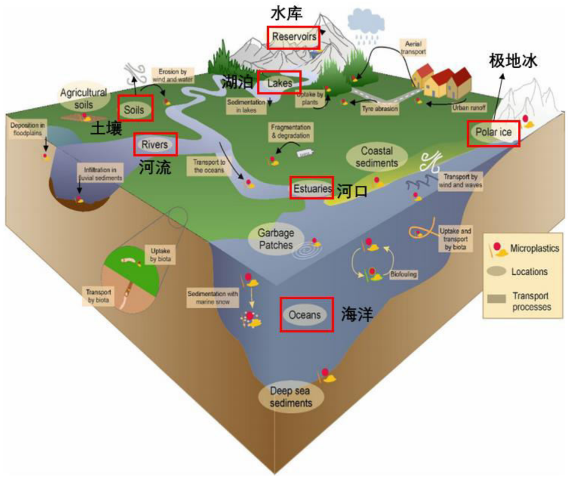
1 Research Background and Significance

1.1 Overview of microplastics (MPs)

- **Definition: plastic particles less than 5 mm in diameter** (Thompson et al., Science, 2004)
- **represented graphically as PM 2.5 in water: United Nations Environment Programme identified MPs as a significant emerging pollutant**



until 2023

Studies have confirmed the presence of microplastics in **human lungs, liver, spleen, kidney tissue and the placenta**

Primary

Secondary

Primary MPs

small-particle plastics specially produced for various applications

Secondary MPs

large quantities of plastic waste formed by physical, chemical, and biological processes

1 Research Background and Significance

1.2 Hazards of microplastics

➢ **MPs' direct toxicity**

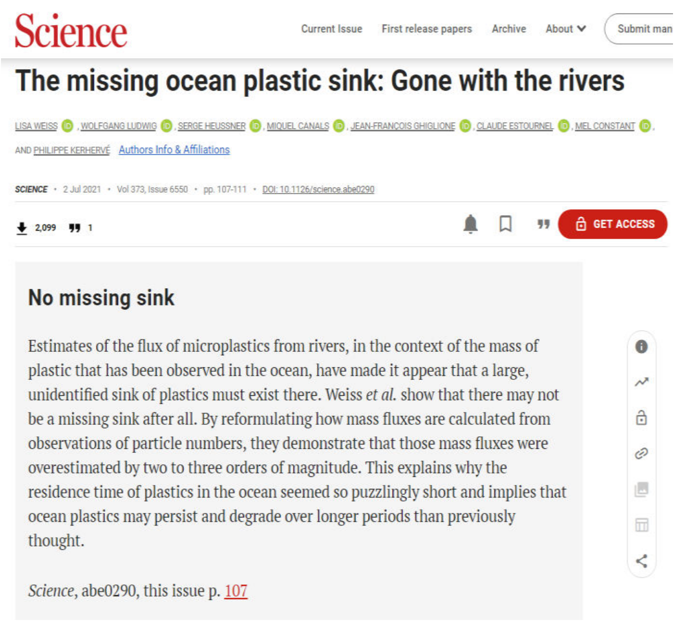
Digestive System, Reproductive System, Photosynthetic System

➢ **Indirect release of toxic substances**

enter the food chain and accumulate in living organisms

➢ **Absorbed toxic substances**

transport chemical pollutants, such as heavy metals and POPs


Science

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The missing ocean plastic sink: Gone with the rivers

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2,099 1 GET ACCESS

No missing sink

Estimates of the flux of microplastics from rivers, in the context of the mass of plastic that has been observed in the ocean, have made it appear that a large, unidentified sink of plastics must exist there. Weiss *et al.* show that there may not be a missing sink after all. By reformulating how mass fluxes are calculated from observations of particle numbers, they demonstrate that those mass fluxes were overestimated by two to three orders of magnitude. This explains why the residence time of plastics in the ocean seemed so puzzlingly short and implies that ocean plastics may persist and degrade over longer periods than previously thought.

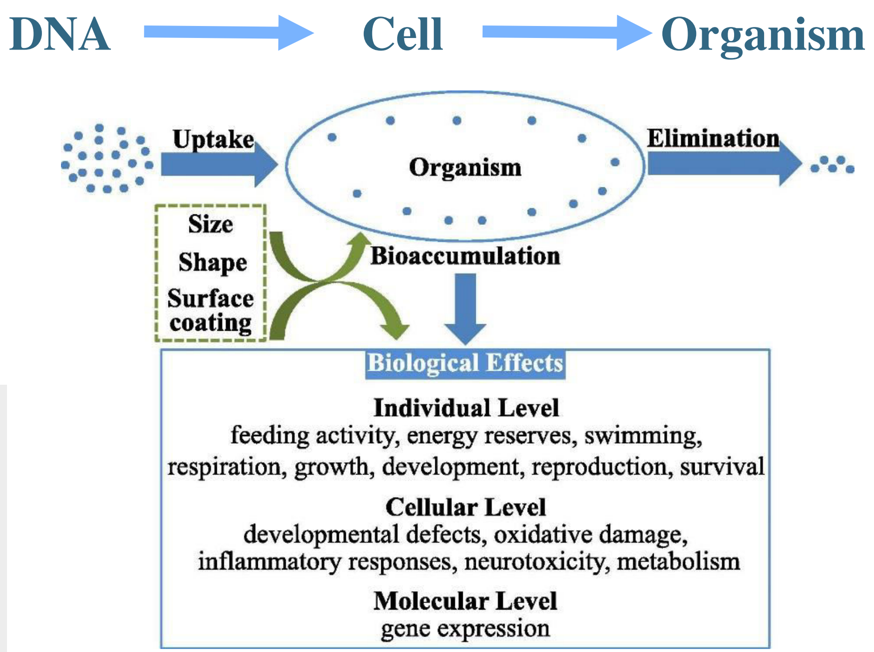
Science, abe0290, this issue p. 107

◆ **The source and distribution of MPs are incredibly diverse:** In 2015, Jambeck estimated that between 4.8 and 12.7 million tonnes of plastic waste enter the ocean annually, with most entering via freshwater rivers.

Mechanical injury, Inflammatory response

Growth, Development, Metabolism

Oxidative stress, Exercise capacity

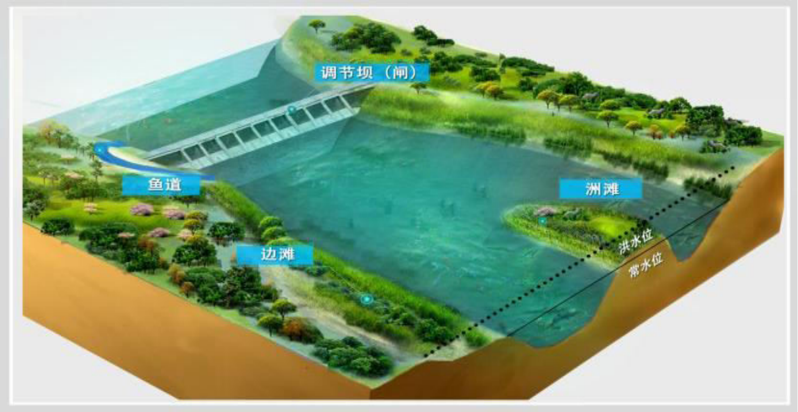


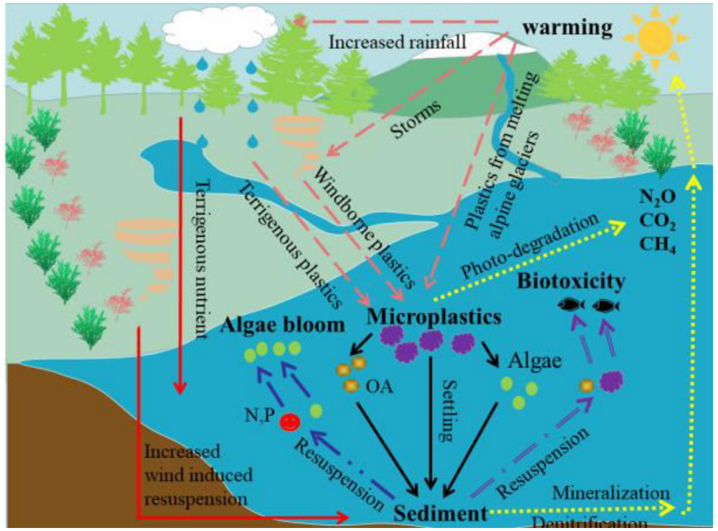
1 Research Background and Significance

1.3 MPs pollution in basin water environment

- **Studying MPs in freshwater is a hot environmental science topic**

  - **MPs in rivers, lakes and reservoirs** have been the subject of extensive investigation.
  - **Transport** of MPs in rivers, lakes, and reservoirs is closely related to their **hydrological characteristics**.
  - MPs may also inhibit the growth of aquatic plants, inhibit the activity of microorganisms, and influence aquatic ecosystems' material and energy cycles**. Indeed, the relevant processes and mechanisms remain obscure**.





(Zhang et al., 2020, STOTEN 135979)

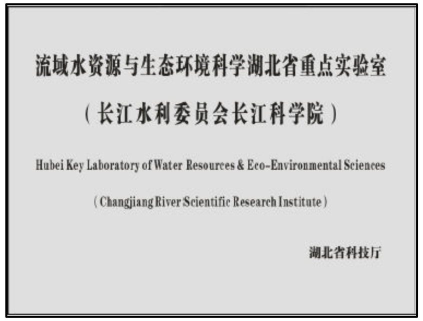
1 Research Background and Significance

1.4 Our proposed research works

Due to the need for plastic pollution control in the water environment of the Yangtze River Economic Belt and the development orientation of our research institute, we will focus on the following areas of research：

- Occurrence and Transport Characteristics of MPs in Lake or Reservoir
- Effects of MPs Pollution on Water Ecology and Environment
- Ecological Risk Assessment and Control Countermeasures of MPs Pollution in Basin Water Environment

Research Team



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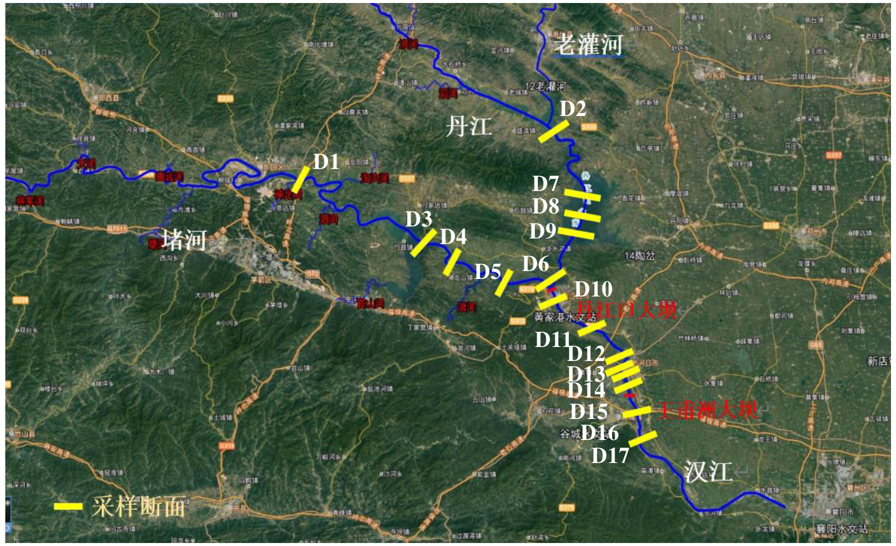
2 Effects on Microbial Community and Function

2.1 Field Investigation

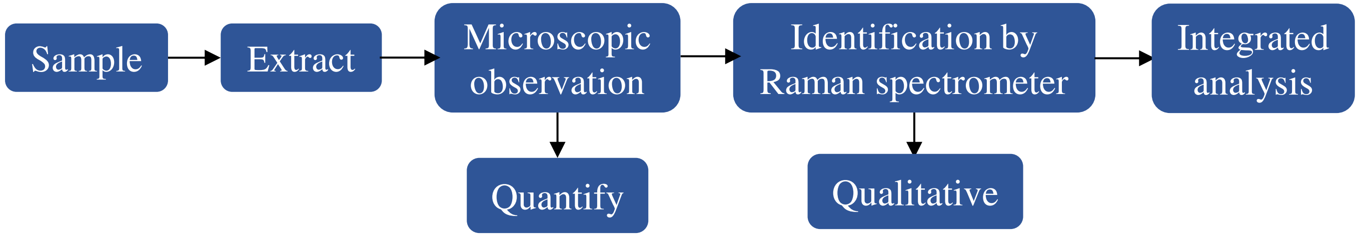
- **Survey Object**: A typical channel reservoir
- **Sampling**: 9 sampling sections at the reservoir's entrance, middle and front (D1~D9), collected surface sediment samples
- **Survey Content**: The occurrence characteristics of MPs, the microbial community structure and functional characteristics, the physical and chemical properties of sediments
- **Time**： August 2021
- **MPs analytical method:** Dual density separation method
- **Microbiological analytical method:** High-throughput sequencing of the 16SrDNA gene, Functional gene chips



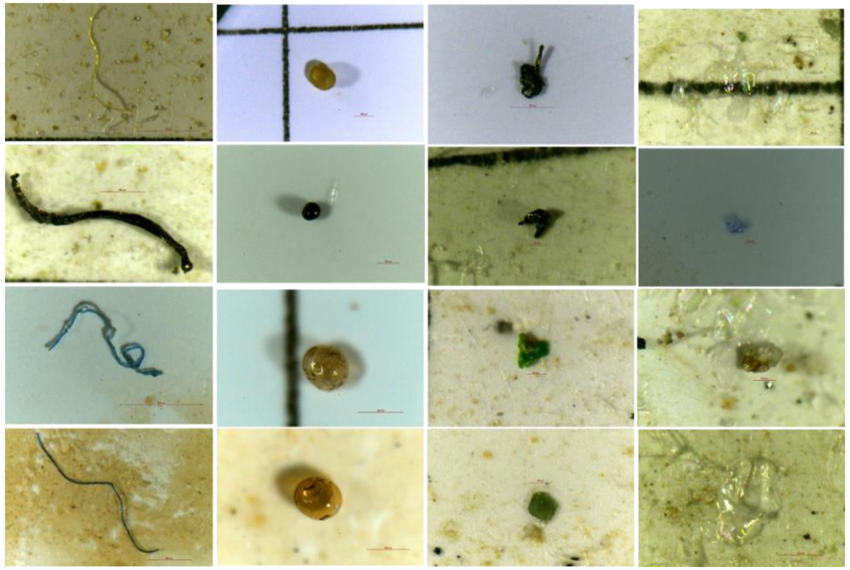
Survey sampling points

2 Effects on Microbial Community and Function

2.1 Field Investigation



The investigation and testing workflow of MPs



Typical microplastics in reservoir sediments

Microplastics testing equipment

Microscopic Raman Spectrometer

The main colors of microplastics are red, yellow, white, green, blue, purple, pink, grey, black, transparent and others.

Spherical, thin films, fragments and fibers are the main shapes.

2 Effects on Microbial Community and Function

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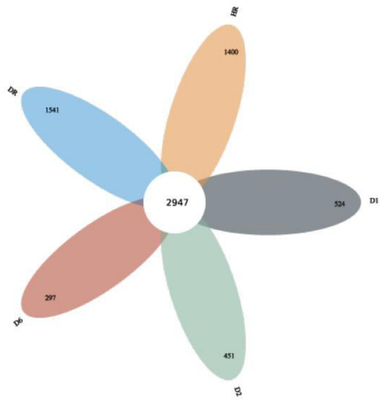
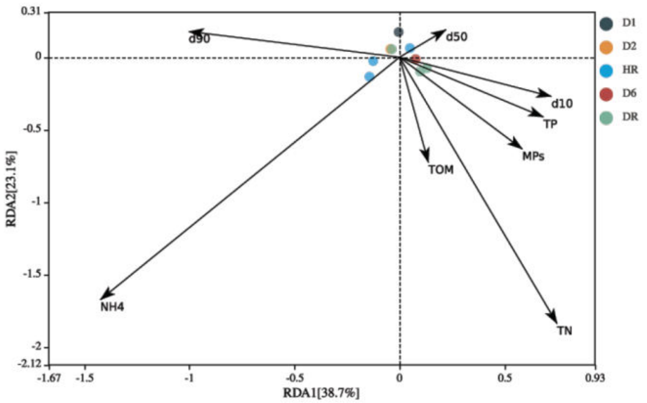
2.2 Microbial Community

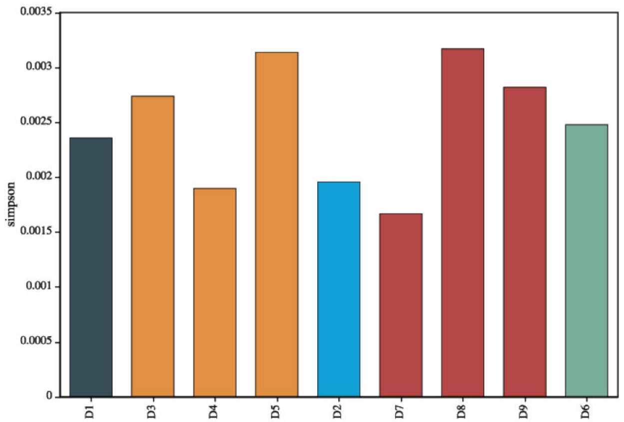
- **53** phyla of bacterial communities were found, with Proteobacteria, Bacteroidetes, Verrucomicrobacteria and Nitrobacteria being the dominant phyla.
- More microbial species in reservoirs, especially in areas with slower water flow, and the fewest near dams.
- **Microbial diversity and abundance were greater** in regions **where microplastics were abundant**. Environmental factors, such as the content of TN and TP, sediment particle size, and microplastic abundance, **may account for 61.8%** of the variance of the microbial community.



Venn diagram of common or endemic species



Redundancy analysis

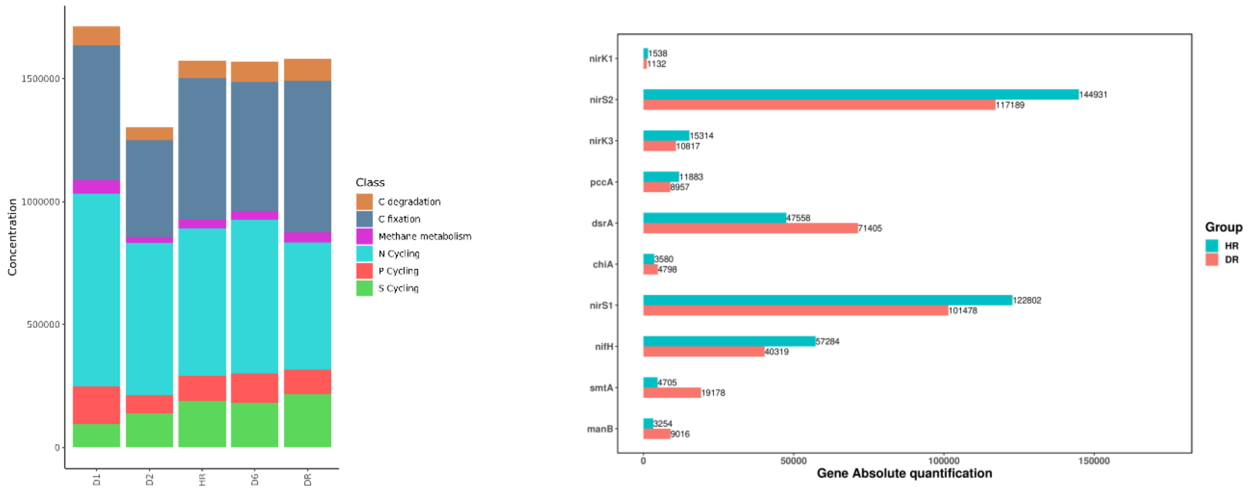


Microbial alpha diversity index statistics

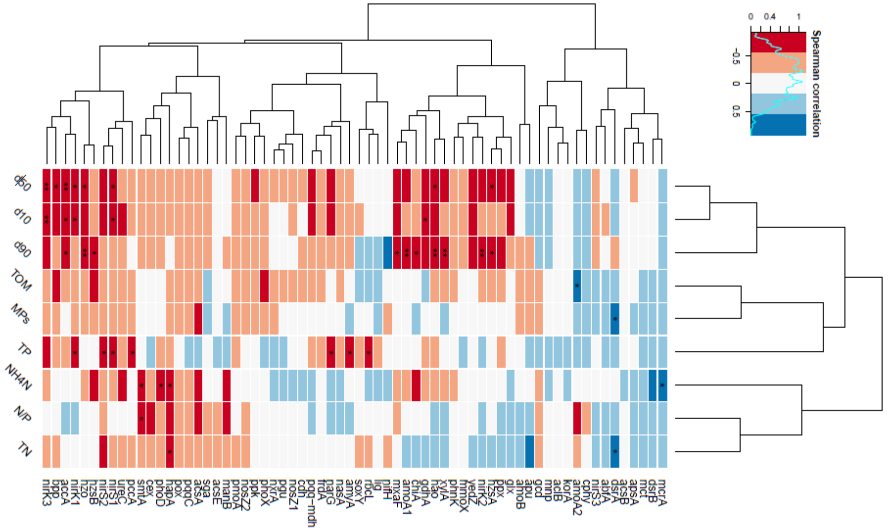
2 Effects on Microbial Community and Function

2.3 Microbial Function

- In regions with **fast water flow**, **N and P** cycling functional genes were **abundant and active**, whereas C and S cycling functional genes were scarce and inactive
- Functional genes C, N, P, and S expression activities in **coarse sediment particles** were **low**.
- In regions with **a high abundance of microplastics** in the reservoir, the functional activity of the **C and N** cycles was **low**, while the functional activity of the S cycle was strong.



Abundance comparison of functional genes of C, N, P and S



Correlation analysis of functional gene abundance and environmental factors

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3 Effects on Aquatic Plant Growth

3.1 Transport and accumulation of sMPs

- **Experimental Methods**: Microcosms
- **Tracer and quantification**: europium-labeled PS
- **Treatments**: ck, 1000 nm PS, 100 nm PS
- **Concentration**: 0.1 g/kg, 1 g/kg
- **Observing targets**:

1） **Sediment**: oxidation-reduction potential (ORP), pH

2） **Water**: DO, conductivity, pH, ORP

3） **Chlorophyll fluorescence characteristics**: Fv/Fm, Y(II), qn, qp, qL, ETR

4） **Photosynthetic pigment content**: chlorophyll a, b, c

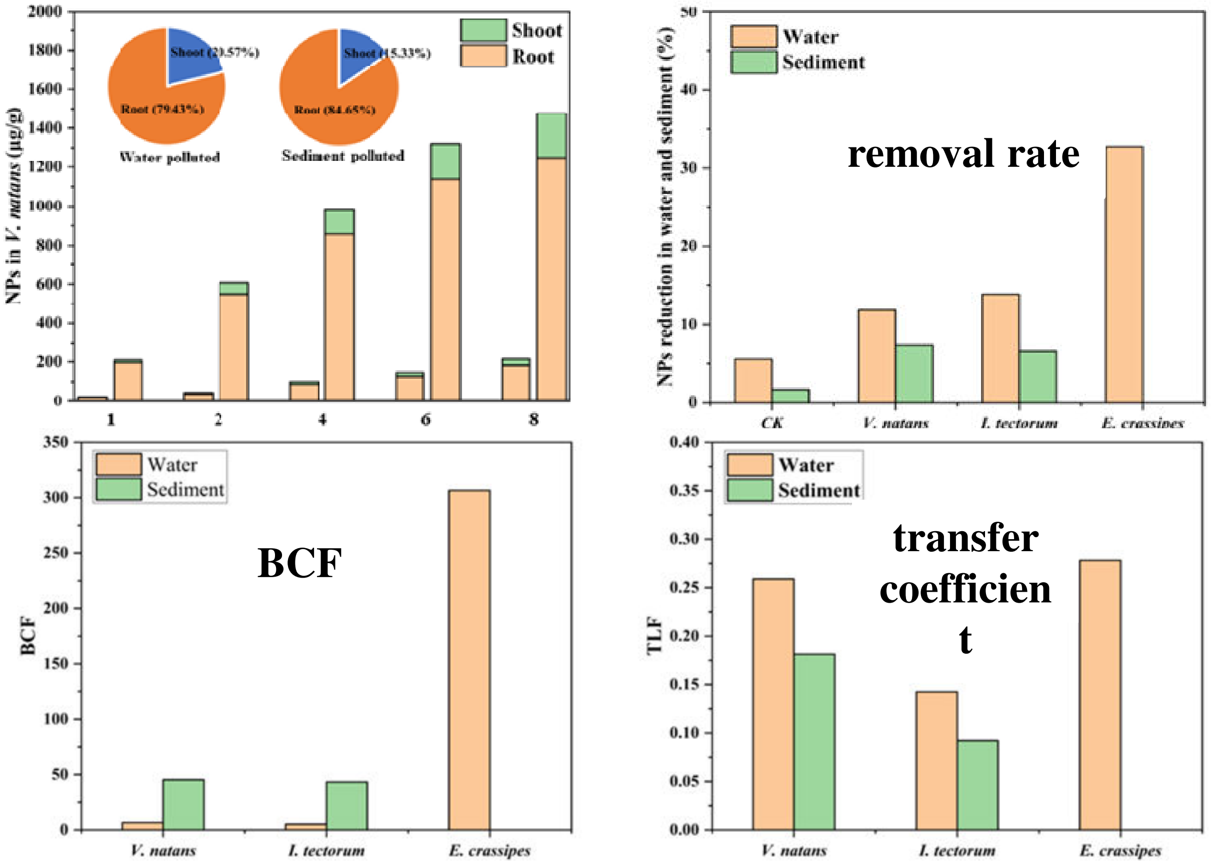
5） **Biomass**: plant length, fresh weight, tillering

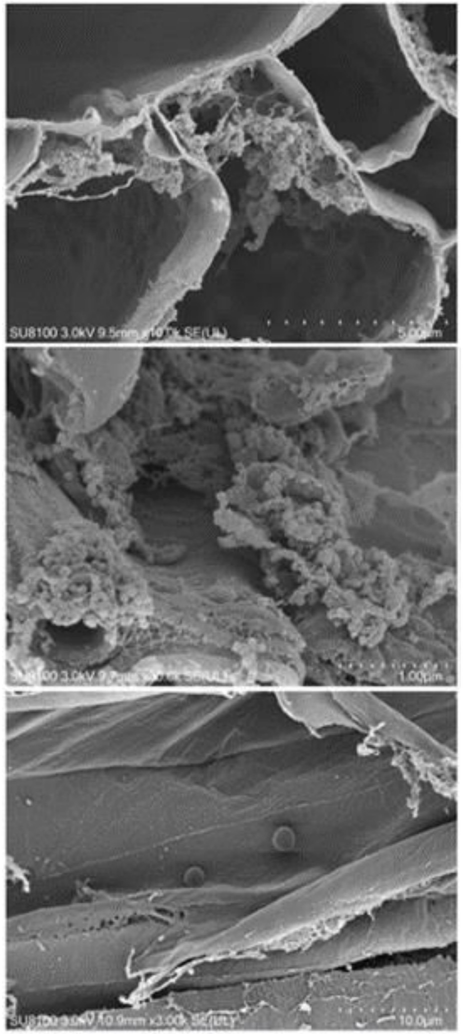
***V.denseserrulata*+Sediments+sMPs** (PS)

3 Effects on Aquatic Plant Growth

3.1 Transport and accumulation of sMPs

- Root is the main organ where sMPs accumulated the most
- 7 to 12 percent of the sMPs consumed by *V.denseserrulata*
- Root of *V. denseserrulata* contained a small number of 100-nm plastic particles but none of 1000-nm plastic particles





100 nm PS root

100 nm PS leaf

1000 nm PS root

V.denseserrulata

3 Effects on Aquatic Plant Growth

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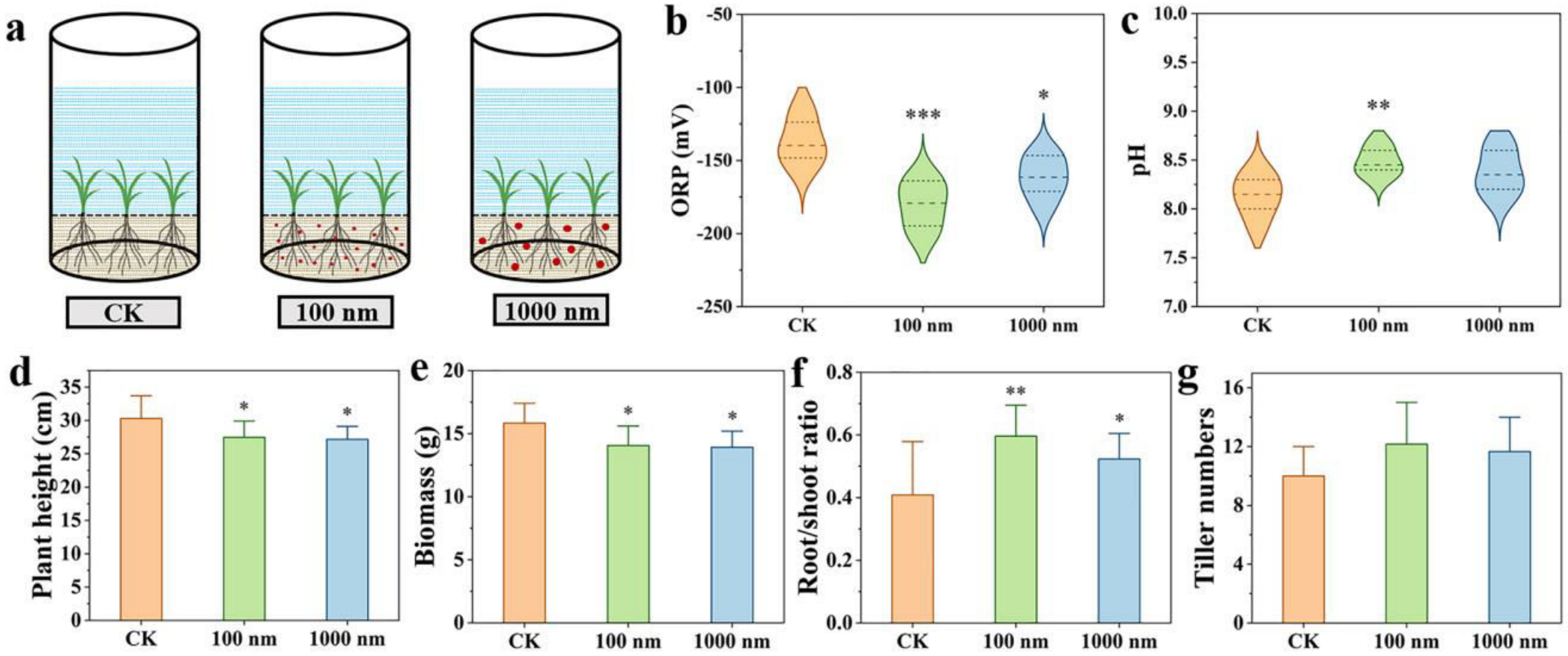
3.2 Effects of sMPs on sediment properties and plant growth



- sMPs (PS) significantly reduced the ORP and increased the pH of sediments. 100-nm particles had a more significant effect on plant growth than 1000-nm particles.
- A dose-response experiment (0-1000 μg/g) showed that the growth of *V.denseserrulata* in wet sediment was not affected until the dose reached 1000 μg/g (i.e.,0.1% w/w).
- The observed effect dosage of 0.1%w/w sMPs significantly suppressed plant height and biomass by 19.2-22.3% and 10.8-15.8%, respectively.

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4 Conclusion and Future Work

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4.1 Conclusion

- **The dam operation increased the microbial diversity of surface sediments. Furthermore, the carbon, nitrogen, phosphorus, and sulphur cycle activity of the microbial flora in the reservoir sediment coarsening and microplastic accumulation areas was relatively low.**
- **Bitter grass could inhale nanoscale PS plastic, which would be more concentrated in the root. It significantly inhibited the height and biomass of bitter grass, decreased sediment ORP values, and increased sediment pH.**

4 Conclusion and Future Work

4.2 Future Work

- It is intended to conduct further study on the occurrence characteristics of microplastics from different sources in the basin and analyze the microplastic sources in the lake and reservoir. .
- to conduct a study on the influence of hydrological changes on MPs' transport behaviour under river damming conditions
- to identify the water ecological and environmental effects of microplastic pollution; and propose countermeasures and measures for controlling such pollution in lakes and reservoirs

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This ends the presentation
Thank you

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