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Microplastics in the seawater from the Beibu Gulf, the northern South China Sea: Occurrence, sources and ecological risk

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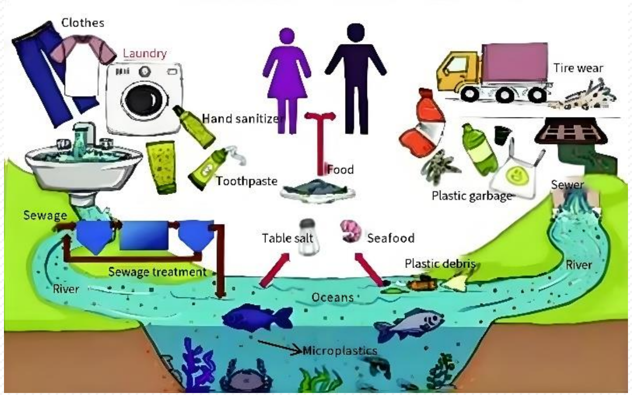
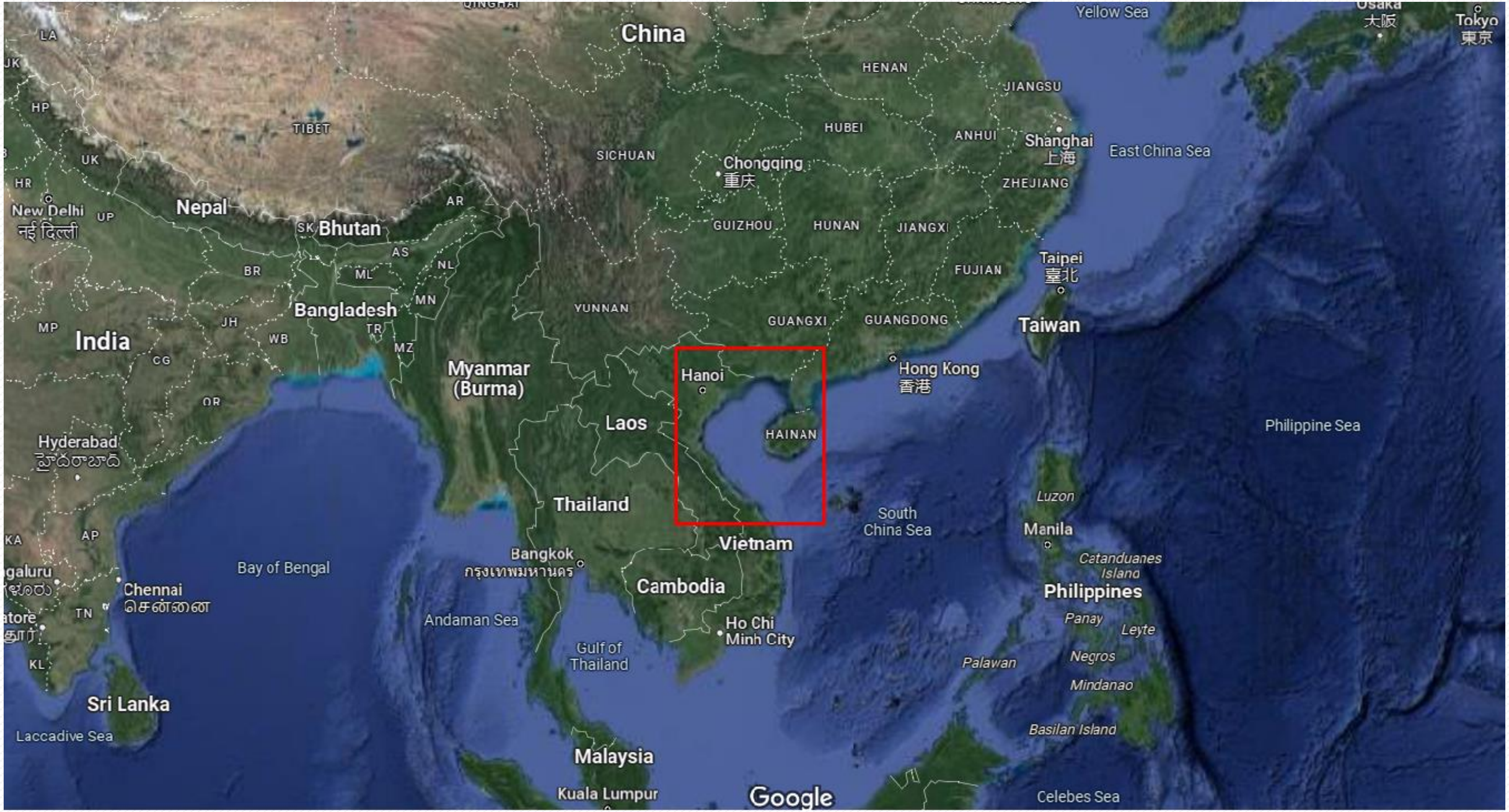
CONTENTS

What and why microplastic

- Microplastics, with a maximum size **not exceeding 5 millimeters.**
- Microplastics have the ability to adsorb large quantities of toxic substances, such as heavy metals and organic pollutants, further **exacerbating the risk of toxicity to marine organisms.**
- Microplastics that enter the marine environment are ingested by marine animals, accumulate in different tissues and subsequently bioaccumulate in the food chain, ultimately **affecting human health.**



Microplastic in the Beibu Gulf



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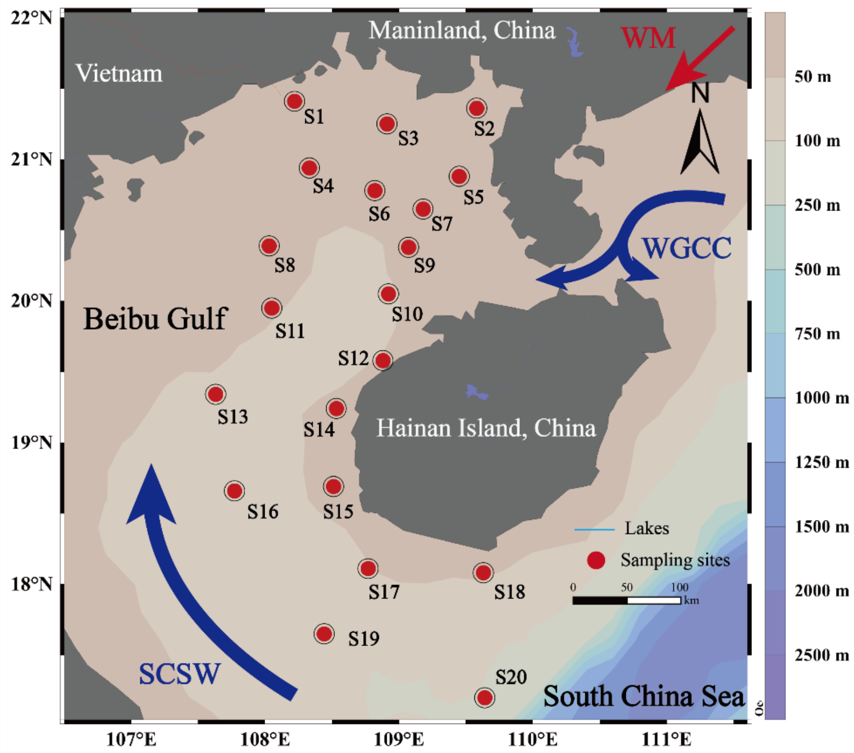


Fig.1 Map showing sampling locations in the Beibu gulf. SCSW: South China Sea water; WGCC: west-Guangdong coastal current; WM: winter monsoon

- The Beibu Gulf is situated in **the northwestern part of the South China Sea**, and represents a semi-enclosed shallow bay shared by China and Vietnam.
- the Beibu Gulf is significantly **impacted by the West Guangdong Coastal Current** (WGCC) throughout the year. One of its branches enters the Beibu Gulf through the Qiongzhou Strait, potentially carrying a substantial amount of **pollutants into the coastal bays** of the northern South China Sea.
- The seawater in the Beibu Gulf is strongly **influenced by the South China Sea (SCS) waters** from the south.

Microplastic in the Beibu Gulf

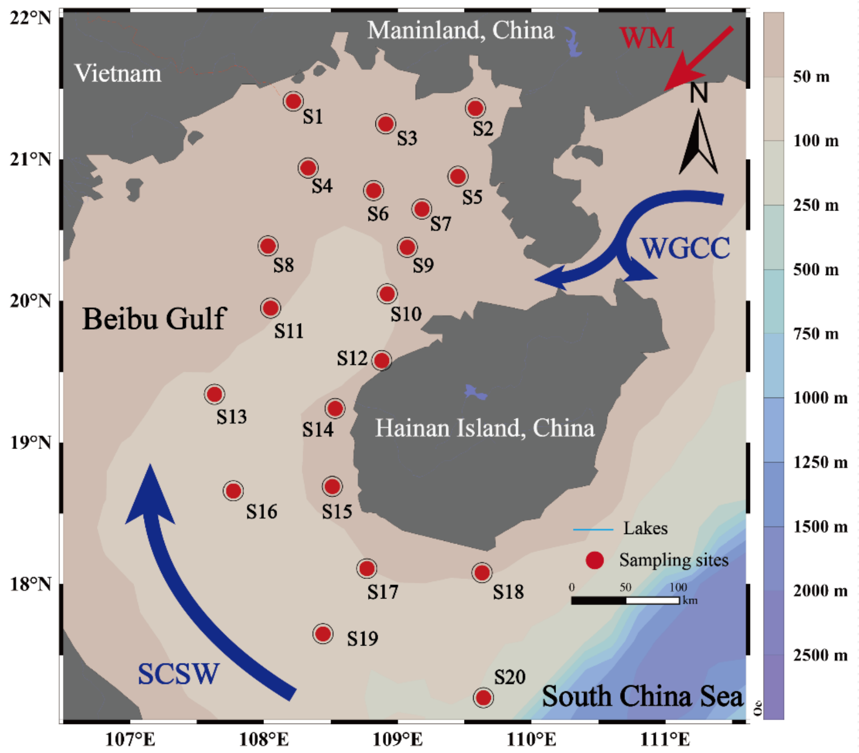


Fig.1 Map showing sampling locations in the Beibu gulf. SCSW: South China Sea water; WGCC: west-Guangdong coastal current; WM: winter monsoon

Microplastic in the Beibu Gulf

Pollution load index (PLI)——commonly used to assess the potential ecological risk of microplastics in aquatic environments

$$PLI_i = \sqrt{C_i / C_0}$$

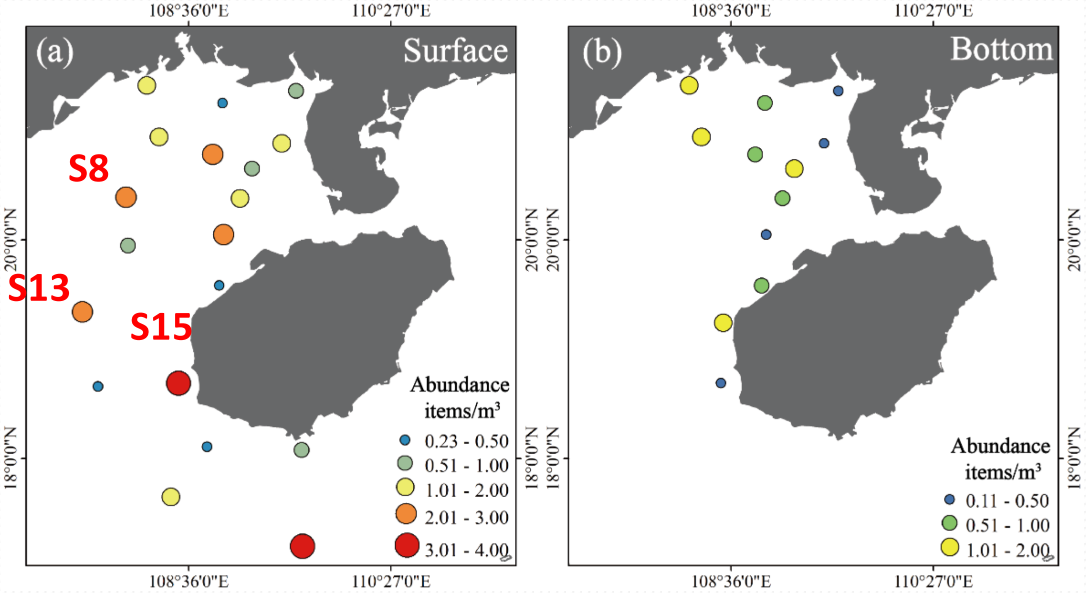
Polymer hazard index (PHI)——evaluation of the risk level of microplastic contamination based on the chemical toxicity of different polymers

$$PHI_i = \sum_{i=1}^{n} (P_i \times S_i)$$

Positive matrix factorization (PMF)——obtaining the optimal factor contribution matrix and source profile characteristics

$$Q = \sum_{i=1}^{n} \sum_{j=1}^{m} \left(\frac{x_{ij} - \sum_{k=1}^{p} g_{ik} f_{kj}}{u_{ij}} \right)^2$$

Microplastic in the Beibu Gulf



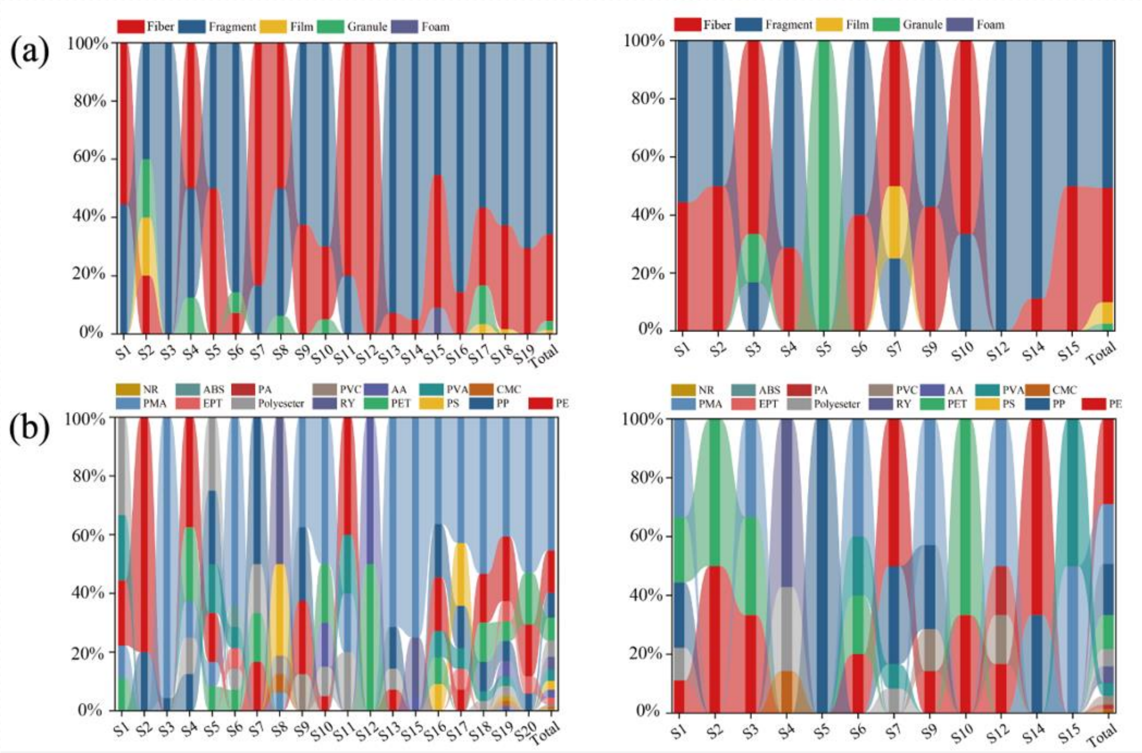
- The sample with **the highest abundance** of microplastics in the surface seawater was located at **S15**. Some high abundance values were also found at **S8 and S13**, which may be related to **the West Guangdong Coastal Current (WGCC).**
- The abundance of microplastics in **bottom seawater** was **lower** than in **surface seawater**. The strong vertical mixing caused by the winter monsoon in the Beibu Gulf can **redistribute pollutants back into** the upper water column.

Microplastic in the Beibu Gulf

Location	Net mesh (µm)	Abundance (items/m³)	Source
Surface seawater			
Sanggou Bay, China	50	0.63 ± 0.37	(Wang et al., 2019a)
North Yellow Sea	30	545 ± 282	(Zhu et al., 2018)
Jade Bay (Southern North Sea)	40	60 ± 194	(Dubaish et al., 2013)
Yangtze Estuary, China	32	4137.3 ± 2461.5	(Zhao et al., 2014)
The western Pacific Ocean	44	0.74 ± 0.33	(Cui et al., 2022)
East China Sea	60	1.02 ± 1.09	(Liu et al., 2019)
Pacific Ocean	60	1.20 ± 0.57	(Li et al., 2020a)
Indian Ocean	60	1.28 ± 0.56	(Li et al., 2020a)
Beibu Gulf, China	60	1.35 ± 0.93	Current study
Bottom seawater			
Rockall Trough (North Atlantic Ocean)	80	70.8	(Courtene-Jones et al., 2017)
Haizhou Bay, China	160	10.20 ± 2.41	(Liang et al., 2023)
Yangtze River Estuary & East China Sea	20	118.91 ± 46.39	(Ge et al., 2023)
Beibu Gulf, China	60	0.79 ± 0.50	Current study

- In the **surface** seawater, the abundance of microplastics in Beibu Gulf was same order of magnitude **with open oceans**.
- In the **bottom** seawater, the abundance of microplastics of the Beibu Gulf was the **lowest**.
- The abundance of microplastics in the **bottom** seawater is significantly **lower than** in the **surface** seawater.

Microplastic in the Beibu Gulf

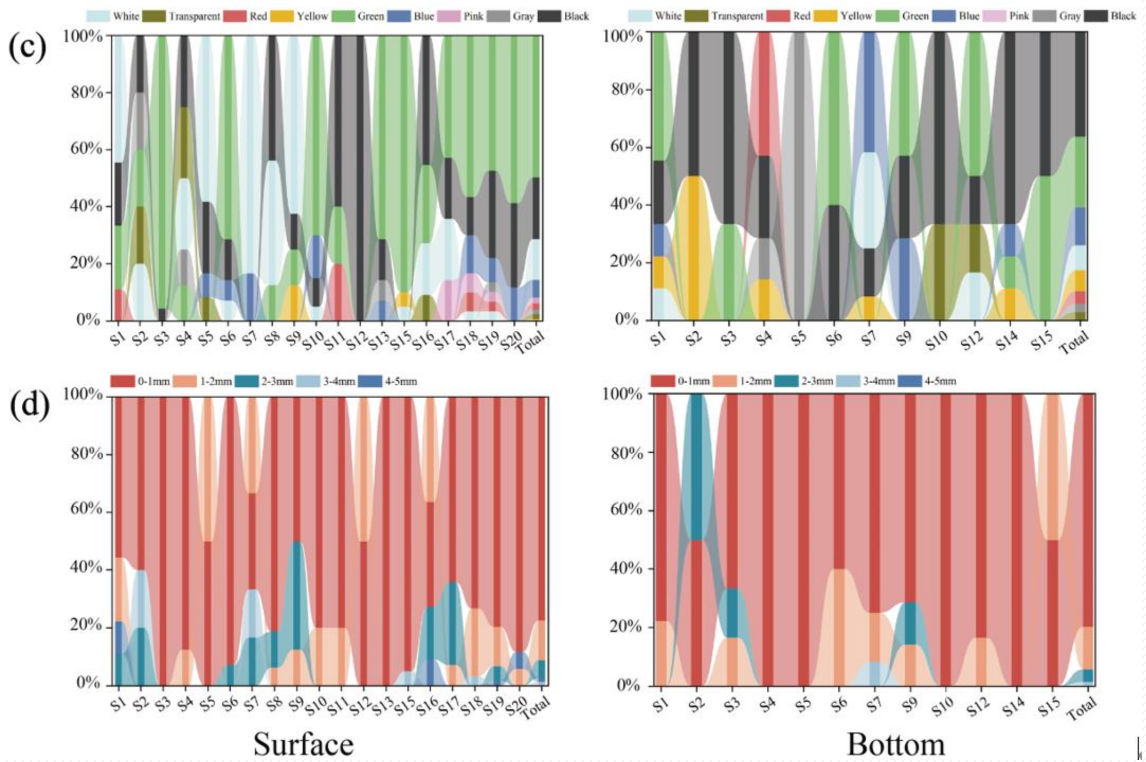


Surface Bottom

- Microplastics in both **surface** and **bottom** seawater samples from the Beibu Gulf were dominated by **fragments and fibers.**

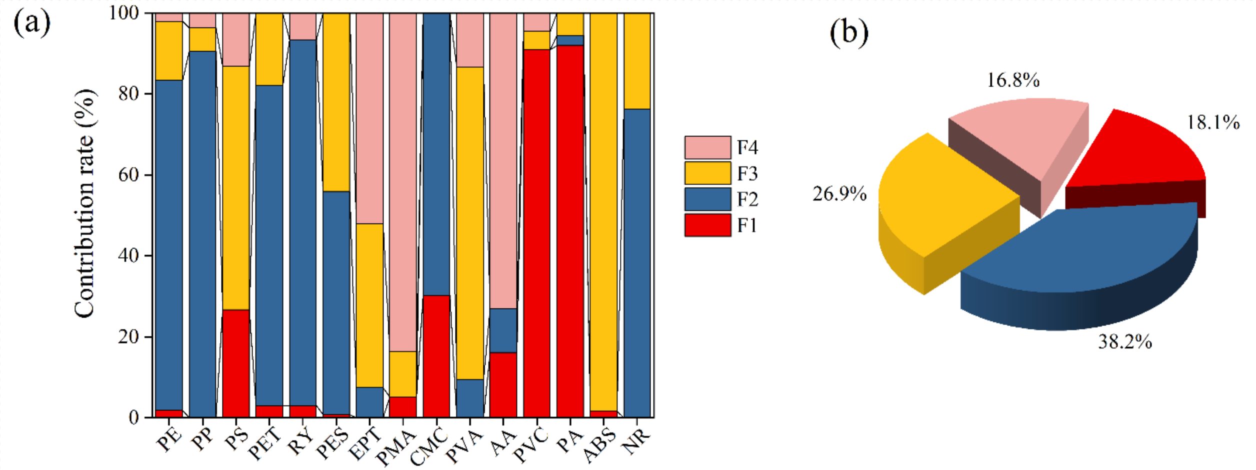
- **15 polymer types** were found in **surface** seawater in the Beibu Gulf, **10 polymer types** were found in **bottom** seawater. The predominant microplastic materials in both **surface and bottom** seawater were **PMA, PE, PP, and PET.**

Microplastic in the Beibu Gulf



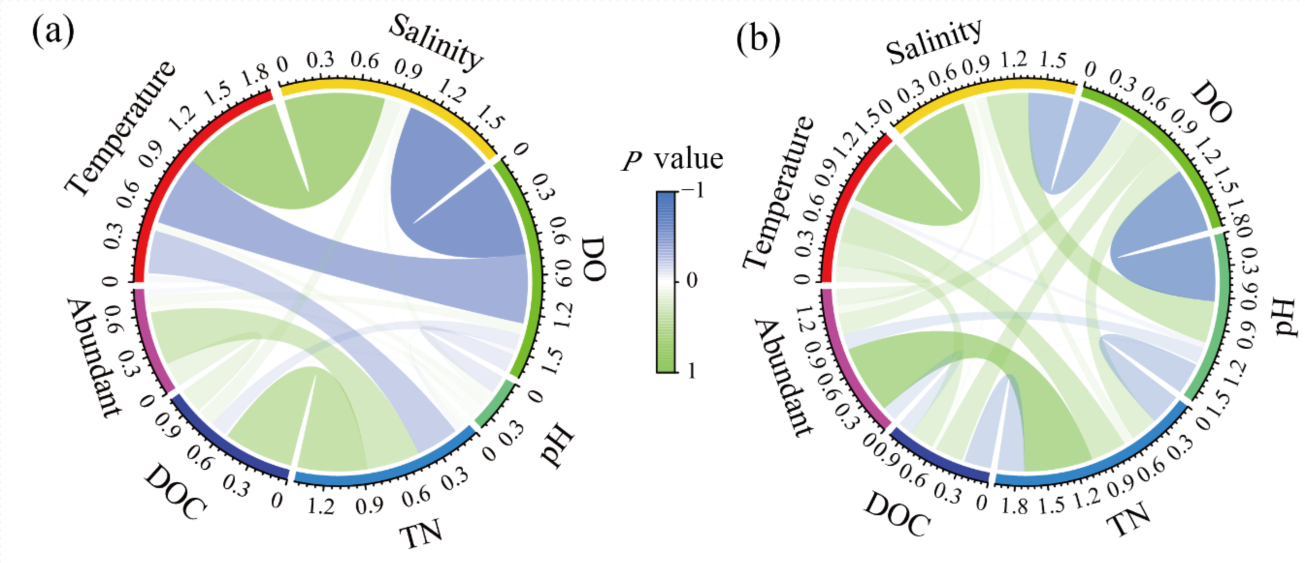
- In the **surface** seawater, **green** microplastics were **the most** predominant, followed by black and white.In the **bottom** layer, **black** microplastics dominated, followed by green, blue, white, yellow and red.
- The color of microplastics can influence the foraging behavior of marine organisms.
- In **surface and bottom** seawater, microplastics are most abundant in the **0.06-1 mm** range.

Microplastic in the Beibu Gulf



- F1 **(18.10%)** of the total variance and was dominated by **PA** (91.90%) and **PVC** (90.90%). F1 represents contributions from **pipe wear and fishing activities.**
- F2 **(38.20%)** of the total variance and was dominated by **PP** (90.95%), **RY** (90.30%), **PE** (81.50%). F2 represents contributions from **plastic waste.**
- F3 **(26.93%)** of the total variance and was dominated by **ABS** (98.40%). F3 represents contributions from **aquaculture and industrial use.**
- F4 **(16.80%)** of the total variance, with **PMA** contributing the most (83.70%). F4 represents contributions from **painting activities.**

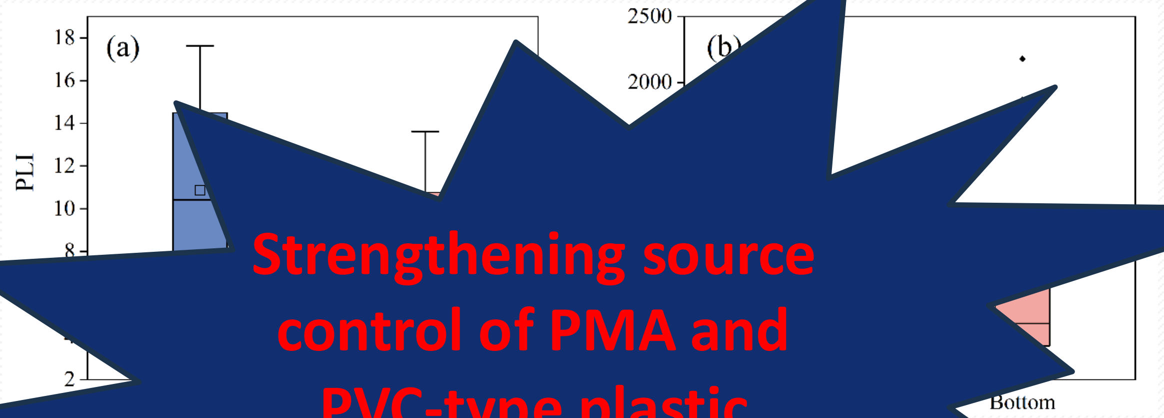
Microplastic in the Beibu Gulf



- Correlation analysis revealed **no significant correlation (P > 0.05)** between environmental factors and microplastic abundance **in surface seawater.**

- There was a **significant positive correlation (P < 0.05)** between total nitrogen (TN) **in bottom seawater** and microplastics. Microplastics can be **adsorbed on the surface of particles**, thus affecting their transport and transformation in the water column; microplastics can also **act as bio-vectors**, which in turn **promote the transformation and release of nitrogen.**

Microplastic in the Beibu Gulf



Strengthening source control of PMA and PVC-type plastic products

- The PLI in surface s moder l of pollution overall. The PLI in bottom seawat k level of pollution overall.
- According to the ce a ttom seawater both is IV.
- It is worth noting that all thes ple sites have PMA as the main contributor to their level IV risk. Due to the high toxicity factor of PMA an the construction activities in the industrial and urban clusters of the Beibu Gulf.
- PVC can release carcinogenic monomers and intrinsic plasticizers. PVC surfaces can easily adsorb persistent organic pollutants, leading to complex ecological toxicological effects.

Summary

- The average abundance of microplastics in surface and bottom waters was 1.35 ± 0.93 items/m^3 and 0.79 ± 0.50 items/m^3, respectively. The composition of microplastics in surface water was PMA, whereas PE in bottom water

- PMF modeling revealed that the primary sources of microplastics were plastic waste disposal, aquaculture, fishing activities.

- PLI indicated that the overall risk of microplastic pollution in the Beibu Gulf was low. Conversely, PHI for microplastics was relatively high, i.e., PMA used in painting activities should be given more concern.

- **Call for international cooperations for microplastic research in bays, seas and open oceans…….**

Zhu et al., Microplastics in the seawater of the Beibu Gulf, the northern South China Sea: occurrence, sources and ecological risk. *Journal of Oceanology and Limnology*. https://doi.org/10.1007/s00343-024-3284-9. *To be published.*

THANKS !

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Cooperations ……