Microplastics in the beach sediments around the Ras Rakan Island, Qatar

Faculty and PostDoc, Science and Engineering

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ABSTRACT: The ubiquitous m**icroplastic (MP) pollution is an emerging environmental issue in the marine environment. In this study, historical accumulation trends of MPs in the beach sediments around the Ras Rakan Island of Qatar have been established. The vertical distribution of MPs ranged from 0 to 665 particles/kg with maximum abundance at the surface layer (0–5 cm). Pellets were the dominant type of MPs in the surface sediments, whereas fibers were dominant in the bottom sediments. The polymer composition of MPs was identified using an Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy. Polyethylene (PE), polypropylene (PP), polyamide (PA), polyethylene terephthalate (PET), polyvinyl chloride (PVC) and Polystyrene (EPS) were the abundant polymers present in the sediments. High MP concentrations were found in the western and northern parts of the island. The prevailing winds, waves, tides and currents are the forces responsible for the distribution and transport of MPs from the offshore to the island and further to vertical re-distribution as time progresses. The level of MP pollution along the coast of Ras Rakan Island was higher than that found on the coast of mainland Qatar. This informs that remote islands should also be considered for MP pollution monitoring to assess the risk associated with MP on the biota.**

1. INTRODUCTION

The presence of plastics in different forms in the ocean and on the coast is an emerging global environmental issue. Due to physical, chemical and biological factors, the large size plastic debris breakdown into numerous small plastic fragments. Pastic particles which vary between 1 µm and 5 mm in length are termed as microplastics (MPs). There are two types of MPs - primary MPs (manufactured purposely in small size) and secondary MPs (fragmentation of large plastic debris due to photo-degradation, physical, chemical and biological processes in environments). As the coastal regions of Regional Organization for the Protection of the Marine Environment (ROPME) Sea area is undergoing fast economic and population growth, we can link the distribution and abundance of MPs in the Arabian Gulf with urbanization, recreational activities and levels of waste management infrastructure. The distribution and composition of MPs in the ROPME maritime area is poorly understood. The concentration of MPs in seawater in the east coast of Qatar (Castillo et al.[1]) and intertidal sediments around Qatar mainland (Abayomi et al.[2]) have been studied earlier. However, there is lack of baseline data on the level of MP pollution in the near/remote Islands of Qatar. Keeping this in view, a comprehensive depth-wise study on the MP trend in the Ras Rakan Island of Qatar was taken-up.

2. STUDY AREA AND SAMPLING

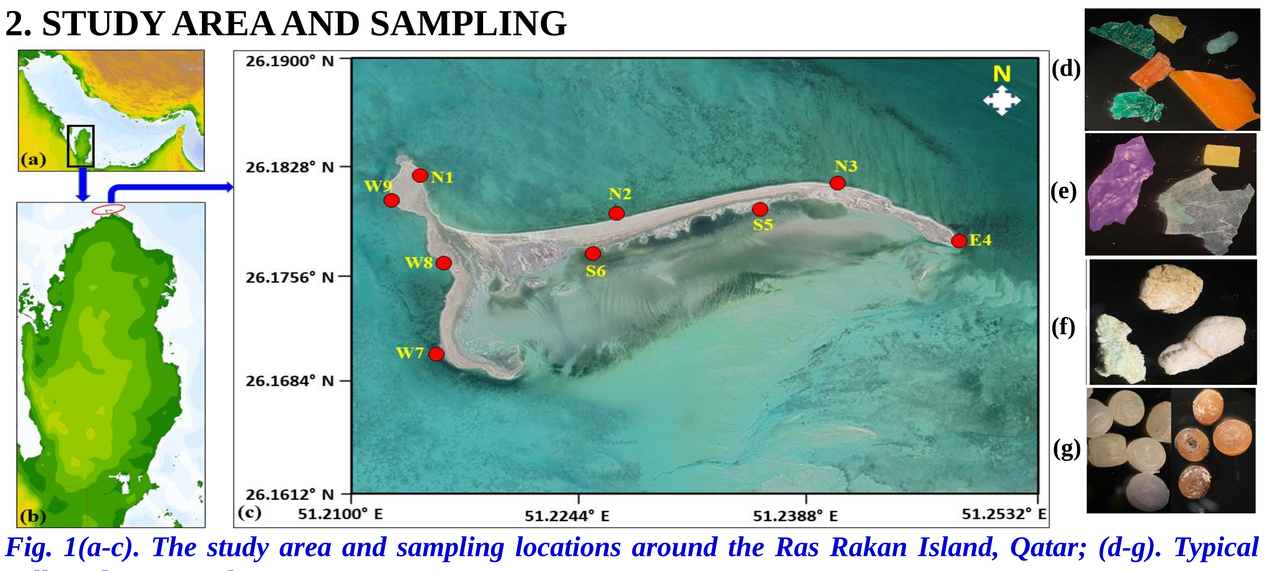

Fig. 1(a-c). The study area and sampling locations around the Ras Rakan Island, Qatar; (d-g). Typical collected MP samples.

Ras Rakan is an uninhibited island situated nearly 2 km off the northern coast of Qatar mainland. It has a length of 3.5 km in the east-west direction and has an extremely narrow width of about 100 m except for a small region on the west side of the island, that is about 400 m wide. It has wetlands, salt marshes and mangrove swamps. It is an important nursing ground for fish, birds and hawksbill turtles.

3. ANALYTICAL METHODS

500 g of dried sediment from each sample was sieved. Density separation method (using NaCl solution) was conducted to extract the less density plastics from other heavier particles. 30% H_2O_2 solution was added to remove the organic content before and after the density separation method. In this study, plastic particles sized between 0.3 and 5 mm were considered as MPs as per the classification of NOAA. The separated MPs were visually examined using an Olympus stereomicroscope. MPs were categorized based on physical characteristics such as fragments, fibers, films, pellets and foams. 50% of representative MPs from each sample were analyzed for polymer identification using Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy. Absorbance spectra were recorded in the mid-infrared region (4000 – 600 cm-1) using 32 scans at 4 cm-1 resolution. The polymer type was identified based on the absorption frequencies for specific chemical bond types present in the relevant polymer samples - by comparing sample FTIR spectra against known spectra from database library.

4. RESULTS AND DISCUSSION

The vertical distribution of MPs in 9 locations around the Ras Rakan Island (Fig. 2a) ranged from 0 to 665 particles/kg. The average MP concentration was 62±141.18 particles/kg. The highest concentration of MPs was obtained at the surface layer (0 – 5 cm) at location W7 (665 particles/kg), which is on the west part of the Island. No MPs could be found below 20 cm depth in any of the locations. The maximum concentration in the surface layer (0–5 cm) sediments (average 320.7 particles/kg) is 25 times higher than those found in the bottom layer (10–15 cm) sediments. It is difficult to compare the concentrations of MPs among different studies because of the lack of standardized/harmonized procedures for sampling, separation, identification and size measurements. However, the values of MP concentrations in the surface sediments found in the Ras Rakan Island are higher than those found in the Qatar mainland (Abayomi et al., 2017) as well as other parts of the Gulf region (Table 1). The average values of different shapes of MPs in all locations showed the following order: Pellets (77%) > Fibers (11%) > Fragments (6%) > Foams (3%) > Films (2%) (Fig. 2b). Various polymer types of MPs, including polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC), polyamide (PA) and polystyrene (PS) were detected in the sediment samples (Fig. 2c).

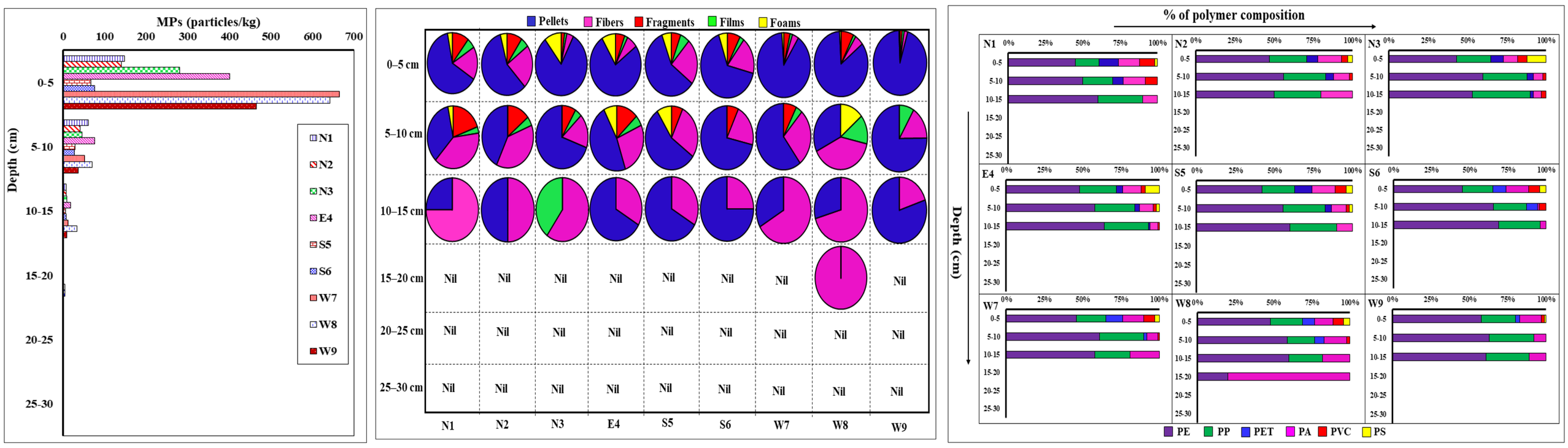

Fig. 2. (a) Vertical distribution, (b) morphology and (c) polymer compositions of MPs in the sediments at each location around the Ras Rakan Island

Table 1. Comparison of MP concentrations in sediments in different locations in the Gulf

Location	Location specifications	Sampling depth	Defined size of MPs	Concentration of MPs (particles/kg)	References
Qatar	8 sandy beaches	0 – 2 cm	1 to 5mm	6 to 38	Abayomi et al.[2]
Strait of Hormuz, Iran	5 low tide littoral zones	1 – 2 cm	< 5mm	2±1 to 1258 ± 291	Naji et al.[3]
Iran	5 intertidal regions	0 – 5 cm	0.82 to 4.6mm	0 to 125 ± 25	Naji et al.[4]
Khark Island, Iran	11 beach sediments around Island	0 – 5 cm	≤100 µm to ≤5000 µm	295 to 1085*	Akhbarizadeh et al.[5]
Qeshm Island, Iran	15 mangrove sediments	0 – 5 cm	10 to 1000µm	19.5 to 34.5	Naji et al.[6]
Ras Rakan Island	9 beach sediments	0 – 5 cm	< 5mm	320.7 ± 234	Present study
Ras Rakan Island	9 beach sediments	5 – 10 cm	< 5mm	49.1 ± 17	Present study
Ras Rakan Island	9 beach sediments	10 – 15 cm	< 5mm	12.7 ± 9	Present study
Ras Rakan Island	9 beach sediments	15 – 20 cm	< 5mm	1 ± 3	Present study
Ras Rakan Island	9 beach sediments	20 – 25 cm	< 5mm	0	Present study
Ras Rakan Island	9 beach sediments	25 – 30 cm	< 5mm	0	Present study

5. CONCLUSION

Pellets were the dominant MPs in the surface layer, whereas fibers were the most frequently observed MPs in the bottom sediments. PE, PP and PA were the most abundant polymer types of MPs in the sediments. The winds, currents, waves and nearshore processes are the main influencing factors for the transportation and deposition of MPs in the Gulf. The results are useful to inform the historical MP pollution trend in the Gulf. The values of MP concentrations in the surface layer of sediments found in the Ras Rakan Island are higher than those found in the Qatar mainland, and other parts of the Gulf region. Therefore, regular MP pollution monitoring programs are needed in all the remote islands in the Gulf to assess the risk associated with MP on the biota.

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7. REFERENCES: [1] Castillo, A.B., Al-Maslamani, I., Obbard, J.P., 2016. Prevalence of microplastics in the marine waters of Qatar. Marine Pollution Bulletin, 111, 260-267. [2] Abayomi, O.A., Range, P., Al-Ghouti, M.A., Obbard, J.P., Almeer, S.H., Ben-Hamadou, R., 2017. Microplastics in coastal environments of the Arabian Gulf. Marine Pollution Bulletin, 124, 181-188. [3] Naji A, Esmaili Z, Mason SA, Vethaak AD (2017b) The occurrence of microplastic contamination in littoral sediments of the Persian Gulf. Iran Environ Sci Pollut Res 24:20459–20468. [4] Naji A, Esmaili Z, Khan FR (2017a) Plastic debris and microplastics along the beaches of the Strait of Hormuz, Persian Gulf. Mar Pollut Bull 114:1057–1062. [5] Akhbarizadeh R, Moore F, Keshavarzi B, Moeinpour A (2017) Microplastics and potentially toxic elements in coastal sediments of Iran's main oil terminal (Khark Island). Environ Pollut 220: 720–731. [6] Naji A, NuriM,Amiri P,Niyogi S (2019) Smallmicroplastic particles (SMPPs) in sediments of mangrove ecosystem on the northern coast of the Persian Gulf. Mar Pollut Bull 146:305–311.