

# Microplastic (MP) Pollution in Sidi Youssef Harbor of the Kerkennah Islands, Sfax (Tunisia)



Khawla Chouchene, Teresa Rocha-Santos, and Mohamed Ksibi

**Abstract** Microplastics (MPs) (<5 mm) are emerging pollutants that have attracted widespread environmental concerns about their negative effects on the marine ecosystems. The harbor area of Sidi Youssef in Kerkennah Islands is threatened by the abandoned plastic fishing gears or their leftovers which affect fish stocks and consequently pose a serious threat to the marine environment. In this study, microplastic pollution in surface sediments from 20 stations was investigated. The average abundance of (MPs) was  $611 \pm 514$  items/m<sup>2</sup>. Fibers and fragments were dominant in most sites (94%), followed by granules, foams, and tubes. MPs < 500  $\mu$ m accounted for more than half of the total MPs while small MPs < 1 mm accounted for 97%. White and transparent MPs were more common with 87.8% than of other colors. Based on the identification by FTIR-ATR, polypropylene (PP) and polyethylene (PE) were the main polymer types found in sediments. These results highlighted the widespread distribution of MPs and will provide our understanding of the environmental risks posed by MPs to marine ecosystems.

**Keywords** Microplastics · Sediments · FTIR-ATR · Polyethylene · Polypropylene

---

K. Chouchene (✉)

Laboratoire de Génie de L'Environnement Et Ecotechnologie, GEET-ENIS, Université de Sfax, Route de Soukra km 4, Box 1173, 3038 PoSfax, Tunisia  
e-mail: [chouchene.khawla23@gmail.com](mailto:chouchene.khawla23@gmail.com)

T. Rocha-Santos

Department of Chemistry and CESAM, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal

M. Ksibi

Higher Institute of Biotechnology of Sfax, Route de Soukra km 4, po. Box 1175, 3038 Sfax, Tunisia

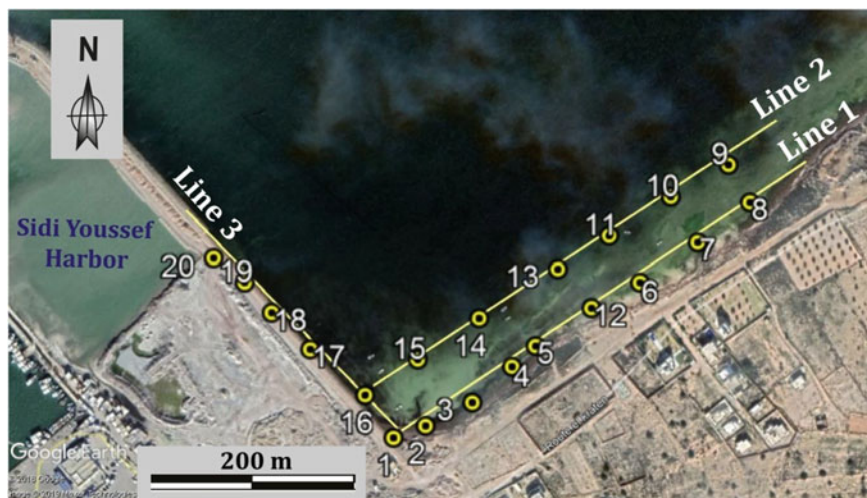
## 1 Introduction

Microplastics (MPs), defined as plastic particles less than 5 mm in length, have been receiving increasing attention as unfortunate major problems for allowing pollutants to cross the ground and affect wildlife and groundwater. MPs occurrence and distribution have been documented in remote areas worldwide including sediments, surface water, island lakes, and estuarine, coast and marine organisms [11]. The Mediterranean sea which has become concerned by this issue is exposed to high anthropogenic pressures by dense habitat, shipping canal, and strong tourism activities and is considered as a sink for MPs accumulation in sediments, in Sweden, Germany, the Netherlands, Belgium, Tunisia, and floating in seawater, in Malta, Italy, Nile deep-sea fan, and Greece [6]. The widespread distribution and occurrence of MPs have been surveyed in sediments as the main focus for the final destination of most MPs categories with diverse sizes [10]. The harbor area of Sidi Youssef in Kerkennah Islands is characterized by specific anthropogenic pressures linked to fishing activities. Abandoned or lost fishing gear affects fish stocks and poses a threat to the marine environment. Indeed, between traditional fishing and illegal fishing, hybrid methods have developed in the Kerkennah Islands. The “gargoulettes” used for catching octopus are now made of concrete, while the plastic traps often replace the palm traps. Plastic waste that is not collected on the earth ends up in the oceans. There, they break down into increasingly tiny fragments and turn into microplastic particles. Only a few investigations have been conducted on the MPs distribution in coastal areas of Tunisia [1–3].

Yet, no data are available on the distribution and occurrence of microplastics pollution in the Kerkennah Islands, Sfax (Tunisia). These islands are one of the most touristic regions and urbanized industrially. In this study, microplastics collected from 20 sampling points at the Sidi Youssef harbor were set up for the first time. This overview of the used method from field sampling to laboratory analysis will provide the preliminary data on abundance, type, and composition of microplastics in Sidi Youssef harbor.

## 2 Materials and Methods

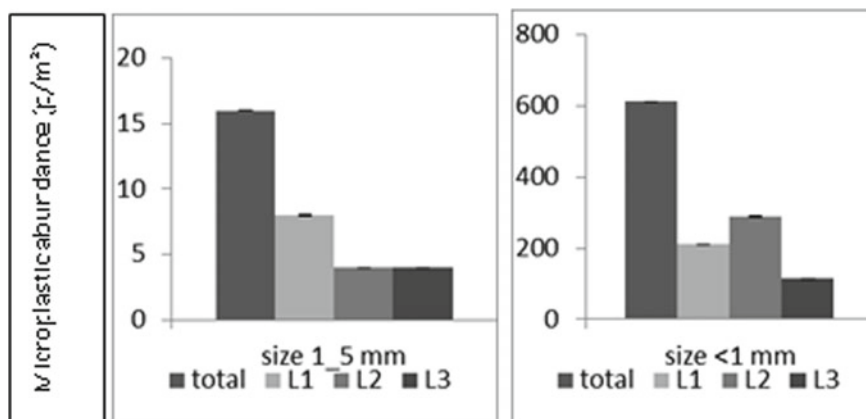
Sediment samples were collected from Sidi Youssef (SY) harbor (34°39′23.56″ N, 10°58′18.31″ E), on March 23rd, 2018, during dredging activities. A total of 20 samples were collected using a 50 m regular grid pattern, resulting in 2 parallel lines and one perpendicular line to the waterline as indicated in Fig. 1. The top of 3–5 cm of sediments was sliced off from 0.25 to 0.25 m<sup>2</sup> using a stainless spatula and scooped in precleaned glass jars (250 g), then transported rapidly to the laboratory, where they were frozen at 4 °C. Sediments were homogenized and dried at 40 °C for 3–5 days. They were fractioned through a cascade of stainless-steel sieves of 5-, 2-, and 1-mm mesh. Because the sediments were between fine and medium sand, they



**Fig. 1** Maps of Sidi Youssef Harbor (Island of Kerkennah, Sfax) showing the sampling sites

were divided into two classes  $< 1$  and  $1-5$  mm. In each class, plastics were excluded from the non-plastics by visual sorting ( $1-5$  mm) and density separation (NaCl). The smallest size class ( $< 1$  mm) was suspended in a high saline concentration of NaCl in order to extract the MPs particles following the method described by Mathalon and Hill [9].

This method consists of dispersed dried sediments in high saline solution ( $120$  g (NaCl)/L  $H_2O$ ). They were vigorously shaken for  $15$  min and settled for  $2$  h. The supernatant with the extracted floating particles from sediments was filtered (Sciences PTFE Membrane Filters  $47$ ,  $0.45$  mm) and then washed with distilled water to remove any remaining salts. These fractions were dried at  $60$  °C for  $2$  h before the digestion process. This was performed using  $10\%$  KOH solution as indicated by Lusher et al. [7]. MPs were rinsed with  $1$  mL of  $80\%$  (v/v) ethanol and visualized under an optical microscope (COFEMO, CFM-7045 B2,) using the Fluorescence staining method described by Maes et al. [8]. The plastic particles were sorted based on morphology: foams, tubes, granules/pellets, fragments, and fibers. Finally, all particles were counted and photographed before identification by FTIR Spectroscopy–Attenuated Total Reflectance (ATR). During all the aforementioned procedures,  $100\%$  cotton lab coats were used, in order to minimize any cross contamination, due to fibers released from clothing.



**Fig. 2** Size distributions of microplastics collected from the harbor of Sidi Youssef in Kerkennah Islands

### 3 Results

In the studied harbor, the sediments were relatively fine and medium sandy and completely full by small shells and other marine impurities. Indeed, it was difficult to conduct the separation of all tiny MPs. Data obtained showed that Sidi Youssef harbor is contaminated by 611 items of plastic debris across 20 sampling points. Around 97% of pieces are recognized to be MPs (<1 mm) with the one of size between 1 and 5 mm represented less than 3% as illustrated in Fig. 2. Within the three lines, the highest MPs concentrations were generally found in the second line “L2” with an average of  $275 \pm 0,896$  items/m<sup>2</sup> followed by the line “L1” with  $218 \pm 0,748$  items/m<sup>2</sup> and then the line of dredging zone “L3” with 118 items/m<sup>2</sup>. It is important to note that a clear increase of small size particles < 1 mm was observed. This is most probably due to the degradation of larger plastic items (1–5 mm). These can occur during inter- and intra-particle collisions [4], due to UV radiation, and mechanical and/or biological degradation processes [5, 13].

With respect to shape, fragments and fibers were the most abundant in all samples. Colored microparticles were dominant among the microplastic particles, followed by transparent items. For all samples, PP and PE were found to be the most components of polymers of plastic marine debris.

### 4 Discussion

Microplastics are known to absorb various harmful pollutants having significant impacts on human health and the environment. However, their distribution, abundance, and the attached organisms along harbors are not well understood. This is the

first report on the presence of microparticle community on MPs in Sfax (Tunisia). From this study, fragment and fiber items were found to be the most abundant type of MPs identified in all sediment samples. The abundance of both pieces was the greatest as the coastal activities which include fishing practices, aqua tourism, and marine industries. These activities are the sources of MPs (mainly composed of PP and PE) pollution in the marine ecosystem. The distribution of MPs has been observed to be dependent on environmental and anthropogenic factors. For instance, wind direction and tidal currents are the main factor forces behind their spatial distribution. Indeed, Zhao et al. [11] postulated that there would be a greater accumulation of MPs at downwind sites. In the present study, the dominant size of MPs is less than 1 mm *increasing the chances* of trophic transfer to marine predators through their *ingestion of low-level food web organisms* [12]. It is therefore essential to assess the risks posed by increasing item numbers of small size MPs in the marine environments. Based on FTIR-ATR identification, PP and PE were found to be the most common floating polymers in the present study. Indeed, PP and PE are the most used polymer types, which are commonly found in consumer products (e.g., plastic traps, fishnet, plastic bags, bottles, caps, films, and containers) and are likely derived from the breakdown of larger debris [12]. Alternatively, these types are also used in personal care and cosmetic products (PCCPs), such as abrasive, for film-forming, viscosity controlling, and as binder for powders [12].

## 5 Conclusion

In the present study, we reported for the first time the MPs pollution in the harbor of Sidi Youssef in the island of Kerkennah. The results revealed that the 20 sampling points are vulnerable to MPs form representing a potential risk for human health that may be entering the food chain through ingested marine organisms. As the abundance of microplastics in the marine environment increases, further studies are planned to quantify their presence in all Tunisian coasts, biota and to assess their toxicological effects.

## References

1. Abidli, S., Toumi, H., Lahbib, Y., Trigui El Menif, N.: The first evaluation of microplastics in sediments from the complex Lagoon-Channel of Bizerte (northern Tunisia). *Water Air Soil Pollut.* **228**, 262 (2017)
2. Abidli, S., Antunes, J.C., Ferreira, J.L., Lahbib, Y., Sobral, P., El Menif, N.T.: Microplastics in sediments from the littoral zone of the north Tunisian coast (Mediterranean Sea). *Estuar., Coast. Shelf Sci.* **205**, 1–9 (2018). <https://doi.org/https://doi.org/10.1016/j.ecss.2018.03.006>
3. Chouchene, K., da Costa, J.P., Wali, A., Girão, A.V., Hentati, O., Durate, A.C., Rocha-Santos, T., Ksibi, M.: Microplastic pollution in the sediments of Sidi Mansour Harbor in Southeast Tunisia. *Mar. Pollut. Bull.* **146**, 92–99 (2019)

4. Cooper, D.A., Corcoran, P.L.: Effects of mechanical and chemical processes on the degradation of plastic beach debris on the island of Kauai, Hawaii. *Mar. Pollut. Bull.* **60**(5), 650–654 (2010). <https://doi.org/https://doi.org/10.1016/j.marpolbul.2009.12.026>.
5. Ding, J., Li, J., Sun, C., Jiang, F., Peng, Ju., Lingyun, Qu., Zheng, Y., He, C.: Detection of microplastics in local marine organisms using a multi-technology system. *Anal. Methods* **11**, 78 (2019)
6. Lusher, A.: Microplastics in the marine environment: distribution, interactions and effects. In: Bergmann, M., Gutow, L., Klages, M. (eds.) *Marine Anthropogenic Litter*, pp. 245–307. Springer International Publishing, Cham (2015)
7. Lusher, A., Welden, N., Sobral, P., Cole, M.: Sampling, isolating and identifying microplastics ingested by fish and invertebrates. *Anal. Methods* **9**, 1346–1360 (2017)
8. Maes, T., et al.: A rapid-screening approach to detect and quantify microplastics based on fluorescent tagging with Nile Red. *Sci. Rep.* **7**, 44501 (2017). <https://doi.org/10.1038/srep44501>
9. Mathalon, A., Hill, P.: Microplastic fibers in the intertidal ecosystem surrounding Halifax Harbor, Nova Scotia. *Mar. Pollut. Bull.* **81**, 69–79 (2014)
10. Wang, j., Wang, M., Ru, S., Liu, X.: High level of microplastic pollution in sediments and benthic organisms of the South Yellow Sea, china. *Sci. Total. Environ.* **651**, 1661–1669 (2019)
11. Zhao, J., Ran, W., Teng, J., Liu, H., Yin, X., Cao, R., Wang, Q.: Microplastic pollution in sediments from the Bohai sea and the Yellow sea. *China. Sci. Total. Environ.* **640–641**, 637–645 (2018)
12. Zhao, S., Zhu, L., Li, D.: Microplastic in three urban estuaries. *China. Environ. Poll.* **206**, 597–604 (2015)
13. Zhu, L., Bai, H., Chen, B., Sun, x., Qu, K., Xia, B.: Microplastic pollution in North Yellow Sea, China: observations on occurrence, distribution and identification. *Sci. Total. Environ.* **636**, 20–29 (2018)