Occurrence of microplastic resin pellets from Chennai and Tinnakkara Island: Towards the establishment of background level for plastic pollution

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Plastic resin pellets collected from the metropolitan city Chennai (east coast of India) and remote Island Tinnakkara (west coast of India) were characterised by colour and their surface oxidation features. The most abundant pellets were yellow in Chennai and white pellets were plentiful in Tinnakkara Island. Surface oxidation features of pellet samples in the Chennai coast were cracks, material loss, erosion, adhesion and colour change. This is congruent with a long residence time in the marine environment associated with more pollutants. In Tinnakkara Island, white pellets were most abundant with less oxidation, which confirmed that short residence time in the marine environment and likely nearby sources.

[Keywords: Resin pellets, pollution, occurrence, Chennai, Tinnakkara Island]

Introduction

Marine debris from natural and anthropogenic sources has increased substantially. Two types of microplastics have been extensively examined in the literature: (1) pieces of plastic that have been broken off of larger, manufactured plastic products, and (2) pellets composed of plastic resin that represent the raw materials from which plastic products are manufactured1.

In India, few research articles related to the occurrence of plastic resin pellets on beaches have been published2,3. All these research papers are extensively studied the occurrence of plastic pellets in metropolitan beaches only. In this study, we have analysed pellet samples from beaches on Chennai (metropolitan city in east coast of India) Tinnakkara Island, Lakshadweep archipelago, India (remote island) to establish the background level of occurrence of plastic resin pellets in beaches around India.

Materials and Methods

Plastic resin pellets were collected from two coastal areas (Chennai beach and Tinnakkara island) in November 2014 (Fig. 1). Chennai metropolitan city is the fifth largest one in India and the extended urban and metropolitan population is 8.24 million according to the 2011 census data. The climate of this region is tropical, characterized by high temperatures (mean 27 - 30°C) and moderate rainfall (900 mm yr\(^{-1}\)). Two rivers meander through Chennai, the Cooum River (or Kuvam) through the centre and the Adayar River to the south. The city is served by two major ports, Chennai Port, one of the largest artificial ports, and Ennore Port4. The Lakshadweep islands (36 islands, 10 inhabited) situated off the Kerala coast are made up of coral reefs of Holocene age. Tinnakkara island is one of the ten uninhabited islands of Lakshadweep archipelago. The normal rainfall is 143.48 cm, of which 111.34 cm is contributed by southwest monsoons (June–September)5.

Fig. 1—The sampling locations in Chennai coast and Tinnakkara island.
We have followed a general protocol for collected pellets, which has been described by several authors6,7,3&8. Samples included only microplastic resin pellets. Collected pellets were individually classified according to colour, based on recommendations in the literature9; www.pelletwatch.org). Once classified, pellets were weighed using an analytical balance, and their sizes were measured using a caliper. Final storage was in separate glass containers, by colour. Subsamples of collected pellets were used to characterise major oxidation features on the pellet surface. This was accomplished using a NIKON Stereoscopic microscope SMZ1500 coupled with a digital camera.

Results
Total number of pellets collected from Chennai and Tinnakkara were 201 and 603 respectively. The number of pellets found in Tinnakkara island was three-fold more than those from the Chennai coast. Though Tinnakkara island is located relatively remote oceanic areas and no plastic manufacturing activities found nearby, it is very closest to the international tanker route across the Arabian Sea. Therefore, the abundance of plastic resin pellets in Tinnakkara Island could be derived from international tanker route ship accident and/or unintentional release and deposited by hydrodynamics.

![Fig. 2](image)

Fig. 2—Frequency distribution of pellets based on colour in (a) Chennai coast and (b) Tinnakkara island.

White, yellow and other plastic pellets were obtained from the Chennai coast, whereas in Tinnakkara island five different coloured pellets such as white, black, yellow, gray and blue were found (Fig. 2a,b). In generally white and yellow pellets were common (In Chennai, 47% yellow and 44% white; In Tinnakkara, 15% yellow 36%

Discussion
Large number of resin pellet was collected at Chennai coastal area. Pellets from Chennai were more yellowed, meaning that they were relatively more weathered and had absorbed more pollutants especially persistent organic pollutants (POPs) from the environment. This is due to significant industrial and harbour activities along Chennai coast, which may release POPs near the beaches of collection2,4,10. Moreover, the yellow colours appear as a result of photo-oxidative damage and indicate longevity in the marine environment. Phenolic antioxidants quench free radicals generated by exposure to UV light, high-temperature polymerization, and nitrogen oxides in the air (among other factors), thereby preventing oxidation. Overall photochemical reaction generates phenolic compounds that posses quinoidal structures, causing yellowing of the polymer8.

Surface oxidation features of pellets revealed that samples from Chennai coast were more weathered than Tinnakkara island samples. The most observed features of Chennai pellets were cracked surface, adhesion, material loss, erosion and change in colour, whereas Tinnakkara island samples were presenting virgin surfaces, with few signs of oxidation (Fig. 3 and 4). This is congruent with a short residence time in the marine environment and primary sources possibly due to ship accident.

![Fig. 3](image)

Fig. 3—The distribution of plastic resin pellets along Chennai coast, Bay of Bengal, India.
Our results give tentative background level of occurrence of plastic resin pellets along Indian beaches. Because the studied islands are located in relatively remote oceanic areas and have little plastic manufacturing activities nearby, the majority of the pellets on the beaches likely come from sources outside of these islands. For example, the pellets on the shores of Tinnakkara island were likely from the international tanker routes and deposited by oceanic currents and winds within the Indian Ocean, primarily northern Indian Ocean.

Conclusion

Yellow pellets with significant surface oxidation features were plentiful in Chennai coast, which indicates high photo-oxidative damage and longevity in the marine environment. In Tinnakkara island, white pellets were most abundant with less oxidation, which confirmed that short residence time in the marine environment and likely nearby sources.

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References


