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Note

Evidence of microbeads from personal care product contaminating the sea

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ABSTRACT

Plastic microbeads in personal care products have been identified as a source of marine pollution. Yet, their existence in the environment is rarely reported. During two surface manta trawls in the coastal waters of Hong Kong, eleven blue, spherical microbeads were captured. Their sizes (in diameters) ranged from 0.332 to 1.015 mm. These microbeads possessed similar characteristics in terms of colour, shape and size with those identified and extracted from a facial scrub available in the local market. The FT-IR spectrum of the captured microbeads also matched those from the facial scrub. It was likely that the floating microbeads at the sea surface originated from a facial scrub and they have bypassed or escaped the sewage treatment system in Hong Kong. Timely voluntary or legislative actions are required to prevent more microbeads from entering the aquatic environment.

1. Shorter research notes

Plastic microbeads are often used as a scrubbing agent in personal care and cosmetic products (PCCPs), such as facial cleanser, shower gel and toothpaste (Leslie, 2014). Their sizes can vary from a few microns to a thousand micron (1 mm). Because of their small size, they can easily pass through preliminary wastewater treatment plants (WWTPs) in which only coarse screens (>6 mm) or fine screens (1.5–6 mm) are used to remove solids in wastewater (Vesilind, 2003) and enter the sea with the effluent. In fact, plastic microbeads in PCCPs were first recognised by Zitko and Hanlon (1991) as a source of pollution but they were considered as an issue of low priority in the last century because of their low input to the marine environment (0.2 t/yr for New Zealand; Gregory, 1996). Nevertheless, plastic microbeads can now be found in various PCCPs and have replaced natural materials such as pumice and walnut husks as scrubbing agents (Fendall and Sewell, 2009). Public attention over the pollution of microbeads has risen in recent years as scientists have reported numerous microplastic ingestion cases by different marine organisms and expressed concerns over the potential for toxic chemicals to bioaccumulate and transfer in the food webs through microplastic ingestion (see review by Rochman, 2015). However, little is known about the existence or distribution of microbeads in the marine environment because the mesh sizes of sampling nets in marine surveys were often larger than 300 μm (Hidalgo-Ruz et al., 2012) which cannot capture most of the microbeads that generally exist in particle size of smaller than 100 μm (Fendall and Sewell, 2009) or a mean size ranging between 164 and 327 μm (Napper et al., 2015). Here we report a case of microbeads sampled from the coastal waters of Hong Kong with their size, colour, shape and polymer composition matched the microbeads found in a PCCP which is widely available for sales in local supermarkets.

Ten blue, spherical microbeads (see Fig. 1a for one of them) were captured in a 20-minute surface manta trawl off the south coast of Lantau Island on 26th Feb 2015 and one was captured near Kat O in another trawl on 20th Jul 2015 (Fig. 2). The trawls were performed using a manta neuston net system (model: NQS45; Ocean Instruments) with a 335 μm net fitted in a rectangular steel frame (opening: 87 cm wide and 16 cm high). The planar areas of the eleven microbeads were measured using ImageJ 1.49 (http://rsb.info.nih.gov/ij/index.html) and their diameters could be calculated because they were almost perfectly spherical. Their sizes (in diameters) ranged from 0.332 to 1.015 mm with a mean and a median size of 0.632 mm and 0.653 mm respectively. The polymer composition of the microbeads was identified by comparing the spectra obtained from a FT-IR spectrometer (PerkinEmler Frontier) equipped with a UATR sampling accessory for the samples, to the standard spectra in the NICODOM IR Polymers library (Fig. 3a and b). The library search suggested that all eleven microbeads were wax. Although wax could be derived from naturally occurring minerals, its organic structure allows it to sorb and accumulate chemical pollutants from the ambient sea water as synthetic plastic polymers do and therefore it can also be a transport medium of chemical pollutants.

The blue microbeads collected from the sea surface were surprisingly similar to the microbeads commonly found in PCCPs and warranted further investigation on the possibility of them sourcing from one of the PCCPs available in Hong Kong. An unnamed facial scrub was subsequently purchased from a local supermarket. Approximately 3 g of the product was dissolved in boiling water before it was allowed to pass through a Whatman Grade 1 filter (pore size: 11 μm) under vacuum. The microbeads were oven-dried at 50 °C and three discernible kinds

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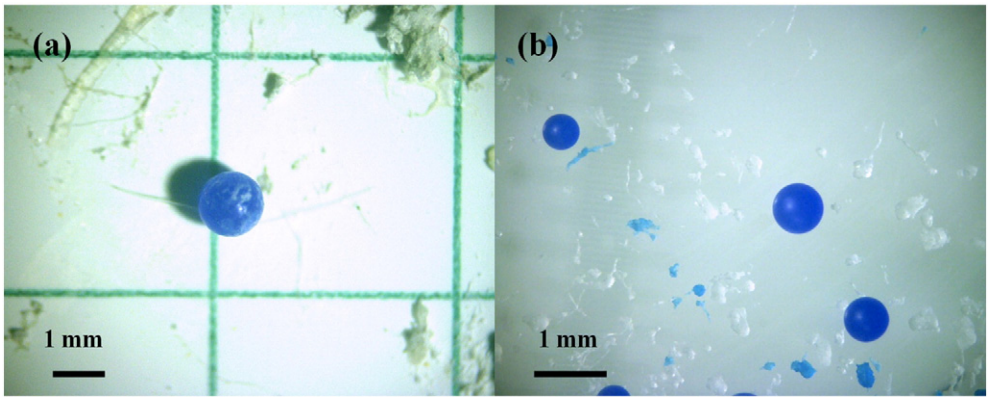

Fig. 1. Photomicrographs of (a) a microbead sample from the sea surface off Lantau Island, Hong Kong and (b) microbeads extracted from a facial scrub.

of microbeads were recovered, namely the spherical blue, irregular blue and irregular white ones (Fig. 1b). The spherical blue ones were visually very similar to those collected from the sea surface, despite that the latter ones were less shiny (Fig. 1a). FT-IR analysis suggested that these blue, spherical microbeads were also wax ($N = 10$; Fig. 3c), the same material as those microbeads found at the sea surface. This material was included in the ingredient label as 'synthetic wax'. The sizes of 36 randomly selected microbeads of this kind were again obtained using the same method with ImageJ. Their sizes (diameters) ranged from 0.363 to 0.945 mm with a mean and median size of 0.663 mm and 0.652 mm respectively, which closely resembled those microbeads collected from the sea surface. Thus, it is very likely that the eleven microbeads floating on the sea surface off Lantau Island and near Kat O were microbeads originated from a PCCP and they have bypassed or escaped from the sewage treatment system in Hong Kong. Nonetheless, the other two kinds of microbeads found in the same product, namely the irregular blue ones (polyethylene) and irregular white ones (low density polyethylene), were absent from same trawl sample probably due to their smaller sizes. At this point, we must emphasise that our search for this kind of blue, spherical microbeads was not exhaustive for all PCCPs available in Hong Kong and therefore it is unfair to conclude that the eleven microbeads found on the sea surface must be from one specific PCCP.

The existence of microbeads in the coastal waters of Hong Kong implied that the microbeads have found their way into the sea, either escaped from the local sewage treatment system or being directly washed into the waterways without treatment. Given that the two sample locations are over 50 km apart and separated by main landmass of Hong Kong, it is likely that they had different origins and this implies that the pollution of microbeads is not constrained to a particular area. On Lantau Island, there are over ten sewage treatment works (Fig. 2) that may represent point sources of microplastics to the south western waters of Hong Kong. Remote villages scattered on Lantau Island may also be a diffused source of microplastics as about 7% of the population

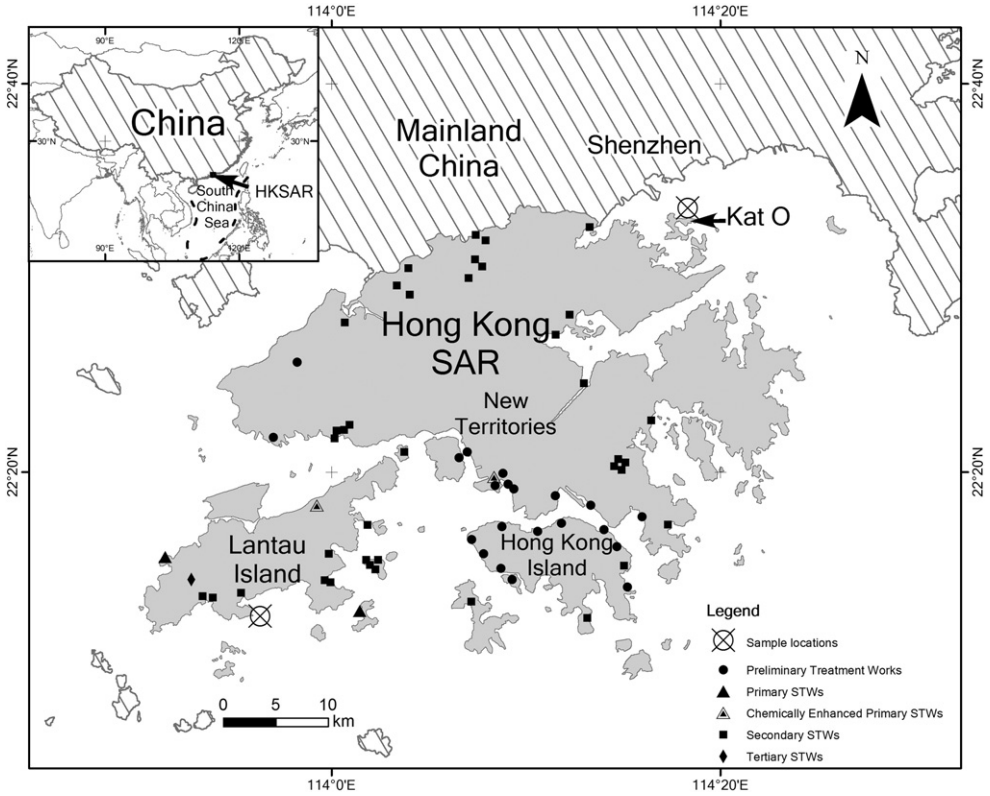

Fig. 2. Sample collection location and the distribution of the sewage treatment works (STWs) in Hong Kong.