Science of the Total Environment 640–641 (2018) 637–645

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Microplastic pollution in sediments from the Bohai Sea and the Yellow Sea, China

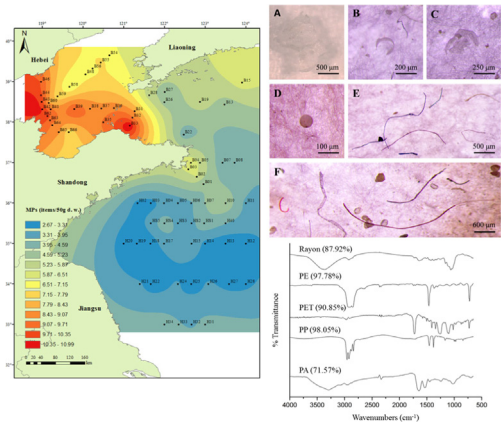
Jianmin Zhao [a], Wen Ran [a,b], Jia Teng [a,b], Yongliang Liu [a], Hui Liu [a], Xiaonan Yin [c], Ruiwen Cao [a,b], Qing Wang [a,*]

[a] Muping Coastal Environment Research Station, Yantai Institute of Coastal Zone Research (YIC), Chinese Academy of Sciences (CAS), Yantai 264003, PR China
[b] University of Chinese Academy of Sciences, Beijing 100049, PR China
[c] Yantai Oil Spill Response Technical Center of Yantai Maritime Safety Administration, Yantai 264000, PR China

HIGHLIGHTS

- The microplastic pollution in sediments from marginal sea of China was reported.
- The abundance was as follows: Bohai Sea > Northern Yellow Sea > Southern Yellow Sea.
- The pollution level was comparable to other countries and other regions in China.
- Our study provides bases for environmental risk evaluation of microplastic in China.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 11 January 2018
Received in revised form 27 May 2018
Accepted 28 May 2018
Available online xxxx

Editor: Kevin V. Thomas

Keywords:
Microplastic
Yellow Sea
Bohai Sea
Sediment

ABSTRACT

Microplastics are one of the most significant pollutants in the marine environment and accumulate in sediments all over the world. To assess the pollution level in the marine environment in China, the distribution and abundance of microplastics in sediments from the Bohai Sea and the Yellow Sea were investigated in this study. The sediment samples were collected from 72 different sites in the Bohai Sea and the Yellow Sea. Microplastics were separated from sediment through density flotation and categorized according to shape and size under a microscope. Additionally, polymer types were identified using Fourier-Transform Infrared Micro-spectroscopy (μ-FT-IR). Our study demonstrated that microplastics were consistently found in all samples, which emphasized their extensive distribution throughout the Bohai Sea and the Yellow Sea. The average microplastic abundance was 171.8, 123.6 and 72.0 items per kg of dry weight sediment for the Bohai Sea, Northern Yellow Sea and Southern Yellow Sea, respectively. Among the sampled microplastics, fiber (93.88%) and small microplastics (<1000 μm) (71.06%) were the most frequent types. Fourier transform infrared microspectroscopy (μ-FT-IR) analysis determined that the main types of microplastics were rayon (RY), polyethylene (PE) and polyethylene terephthalate (PET). Our results highlighted the widespread distribution of microplastics in sediments from the Bohai Sea and the Yellow Sea and provided useful information for evaluating the environmental risks of microplastics in China.

* Corresponding author.
E-mail address: qingwang@yic.ac.cn (Q. Wang).

https://doi.org/10.1016/j.scitotenv.2018.05.346
0048-9697/

1. Introduction

The global production of plastics has increased over a hundredfold from the middle of the twentieth century to the current level of 320 Mt./year (Plastics Europe, 2016). According to recent estimates, >5 trillion plastic debris and at least 250 million tons of plastic are floating in the oceans due to industrial discharge, littering and terrestrial runoff (Eriksen et al., 2014). The occurrence and distribution of large plastic debris in the marine environment has been well documented (Derraik, 2002; Cózar et al., 2014; Van Sebille et al., 2015). Plastics at sea eventually undergo fragmentation via ultra-violet radiation, leading to the formation of microplastics (plastic particulates <5 mm) (Arthur et al., 2009), which are also referred to as secondary microplastics (Wright et al., 2013). Microplastics manufactured in microscopic sizes and typically used in personal care products are called primary microplastics (Carr et al., 2016). As there are different sources, microplastics occur in diverse shapes such as spheres, fibers, and fragments in environmental samples (Frias et al., 2010). Microplastics may become widely dispersed in the marine environment through hydrodynamic processes and ocean currents (Ng and Obbard, 2006). Therefore, microplastic pollution has become a global problem of increasing concern.

Microplastics have already been reported in various marine environments throughout the world, including within the water column, nearshore sediments and deep-sea sediments. In recent years, sediments have become the main focus of studies assessing microplastic abundance because they are generally considered to be sinks for microplastics. Studies have reported that microplastics are widely distributed in sediments in the UK (Thompson et al., 2004), Singapore (Ng and Obbard, 2006), Sweden (Norén, 2007), Belgium (Claessens et al., 2011; Van Cauwenberghe et al., 2013b), Italy (Vianello et al., 2013) and Germany (Dekiff et al., 2014). The concentration of microplastics in sediments varies from 0.3 (Van Cauwenberghe et al., 2015) to 5000 items kg^{-1} (Mathalon and Hill, 2014). Recently, microplastics have even been detected in deep-sea sediments from the Atlantic Ocean, Mediterranean Sea, Northwest Pacific Ocean and Arctic Ocean (Van Cauwenberghe et al., 2013a; Fischer et al., 2015; Bergmann et al., 2017).

As the largest plastic producer and consumer in the world, China accounts for 26% of the world's total plastic production. Thus, microplastics have been reported in sediments from beaches and estuaries (Qiu et al., 2015; Yu et al., 2016; Fok et al., 2017; Peng et al., 2017), as well as surface water from estuaries and seas (Zhao et al., 2014; Zhao et al., 2015; Zhang et al., 2017) in China. However, data on the abundance and distribution of microplastics in sediments from the Bohai Sea and the Yellow Sea are almost completely nonexistent. The Bohai Sea is a semi-enclosed inner sea located in China, and the coastal region is one of the most densely urbanized and industrialized zones in the country. The Yellow Sea is a shallow and flat epicontinental sea bordered by China and the Korean Peninsula.

In this study, the abundance and distribution of microplastics in sediments from the Bohai Sea and the Yellow Sea were investigated. The

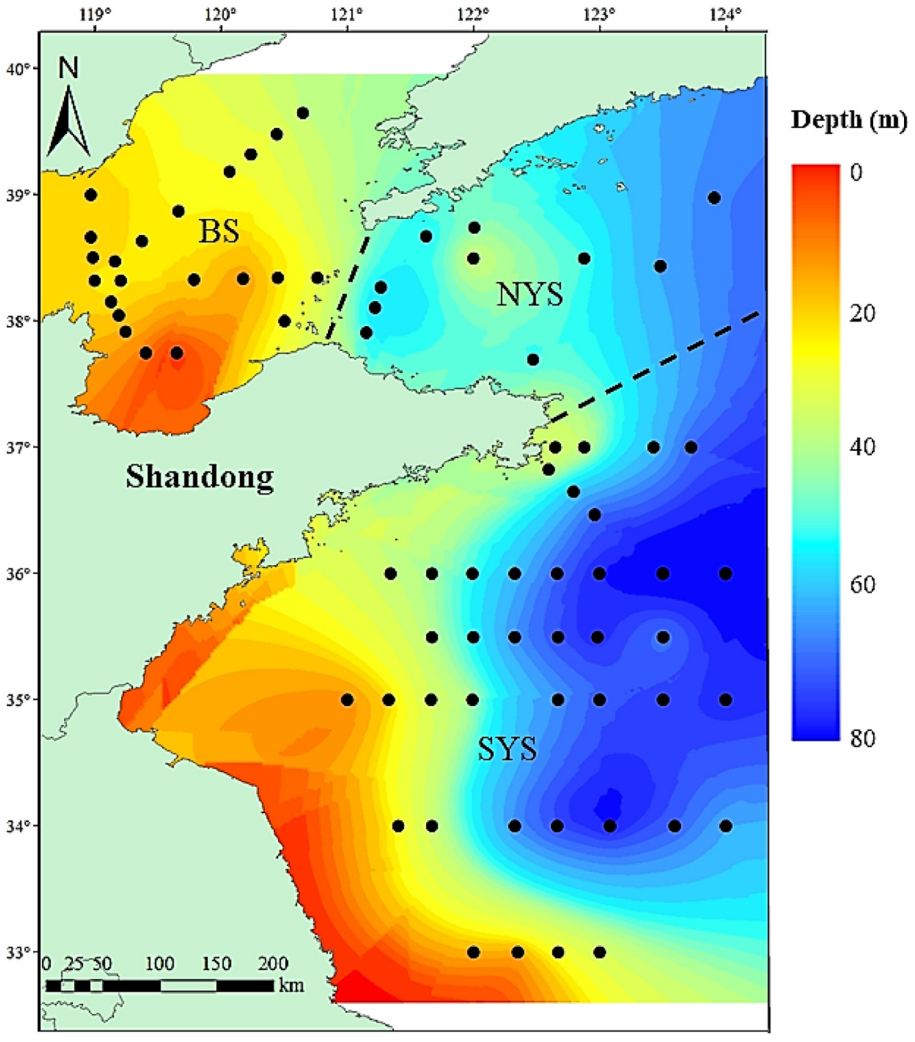


Fig. 1. Sampling sites in the Bohai Sea and the Yellow Sea.