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Microplastics in Taihu Lake, China☆

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ABSTRACT

In comparison with marine environments, the occurrence of microplastics in freshwater environments is less understood. In the present study, we investigated microplastic pollution levels during 2015 in Taihu Lake, the third largest Chinese lake located in one of the most developed areas of China. The abundance of microplastics reached 0.01 × 10^6–6.8 × 10^6 items/km^2 in plankton net samples, 3.4–25.8 items/L in surface water, 11.0–234.6 items/kg dw in sediments and 0.2–12.5 items/g ww in Asian clams (*Corbicula fluminea*). The average abundance of microplastics was the highest in plankton net samples from the southeast area of the lake and in the sediments from the northwest area of the lake. The northwest area of the lake was the most heavily contaminated area of the lake, as indicated by chlorophyll-α and total phosphorus. The microplastics were dominated by fiber, 100–1000 μm in size and cellophane in composition. To our best knowledge, the microplastic levels measured in plankton net samples collected from Taihu Lake were the highest found in freshwater lakes worldwide. The ratio of the microplastics in clams to each sediment sample ranged from 38 to 3810 and was negatively correlated to the microplastic level in sediments. In brief, our results strongly suggest that high levels of microplastics occurred not only in water but also in organisms in Taihu Lake.

1. Introduction

Widespread use of synthetic polymers, so-called plastic, has changed our ways of life. However, the huge production of plastic has resulted in serious environmental concerns (Cózar et al., 2014; Rocha-Santos and Duarte, 2015). In particular, the small-sized plastic particles that originate from manufacturing (primary sources) and the degradation of large items (secondary sources) are prone to accumulate in the environment and may pose an unpredictable influence on the ecosystem (Cole et al., 2011; Wright et al., 2013). The small particles (<5 mm) are defined as microplastic (Thompson et al., 2004). Concerns about microplastic and its associated environmental issues have arisen worldwide (Barboza and Gimenez, 2015).

Because of their ubiquitous presence and morphological features, microplastics are likely to threaten the life and development of biota via direct and indirect pathways, including contact, uptake and digestion (Farrell and Nelson, 2013; Desforges et al., 2015; Long et al., 2015). Microplastics provide substratum sorption of various persistent organic pollutants (POPs). Microplastics may pose a potential risk to the ambient environment because of their tendency to release certain contaminants (Bakir et al., 2014; Napper et al., 2015). Microplastics also have potential risks for human health because of their ability to persist through the food chain (Brennecke et al., 2015). Therefore, it is very important to understand the fate and behavior of microplastics in the environment.

To date, microplastics have been well documented in marine environments worldwide (Thompson et al., 2004; Cózar et al., 2014; Law and Tompson, 2014). Microplastics have even been found in abiotic sea products such as sea salts (Yang et al., 2015). However, the occurrence of microplastics in freshwater environments is less understood (Driedger et al., 2015; Eerkes-Medrano et al., 2015). Freshwater systems have several important functions, such as the use as providing sources of drinking water and fisheries. Some freshwater systems are surrounded by a high population density, and such intensive anthropogenic activity can introduce various contaminants, including microplastics, into the

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body of water (Floehr et al., 2013; Ismail et al., 2014; Driedger et al., 2015). In recent years, the occurrence of microplastics has been documented in several lakes and rivers (Eriksen et al., 2013; Castaneda et al., 2014; Yonkos et al., 2014). To date, however, field studies have only reported microplastic burden in limited freshwater organisms (Faure et al., 2015; Peters and Bratton, 2016).

Taihu Lake is the third largest fresh water lake in China. It is located in one of the most developed areas of China, the Yangtze River Delta. Taihu Lake is also well known for its fisheries and tourism. However, with the development of the local economy and industry, Taihu Lake has become one of the most severely polluted lakes in China (Liu et al., 2009; Yan et al., 2014). In the present study, we investigated microplastic pollution levels in water, sediments and an organism of Taihu Lake. Our purpose is to determine the extent of microplastic pollution in a lake located in an area with intensive anthropogenic activities. We found high levels of microplastic pollution in Taihu Lake and propose that the Asian clam (*Corbicula fluminea*) could be used in the biomonitoring of microplastic pollution in this freshwater system.

2. Material and method

2.1. Research area and sampling sites

Taihu Lake has a surface area of approximately 2000 km^2 and a mean depth of 1.9 m (Hu et al., 2006). Three rivers (Yincungang River, Wujingang River and Zhihugang River) are connected to the northern bay of Taihu Lake and account for 1/3 of the total inflow to Taihu Lake (Fig. 1). The Taipu River is connected to the southern region of Taihu Lake and accounts for 2/3 of the total outflow from Taihu Lake. There are three waste water treatment plants that have a treatment capacity of larger than 5×10^4 m^3/day. Taihu Lake represents a critical drinking water source for local population of approximately 20 million people. The industry and agriculture in the Taihu Basin provide 14% of China's gross domestic product (Wang et al., 2015). Therefore, Taihu Lake plays an important role in the regional economy and social development.

In August 2015, samples were collected from 11 locations, which were chosen for prospective pollution level and geographic region (Fig. 1). These sites represent three different areas of Taihu Lake. Sites 1–4 were located at the northwest area of the lake and close to cities and rural areas. These sites were believed to be affected by intense levels of anthropogenic activity. Sites 5–8 were located in the central area of the lake. Sites 9–11 were located in the southeast area of the lake, where there is less anthropogenic pollution coming from the surrounding land. Two other farmed sites (F1-2) were added to the sample collection in November 2015.

2.2. Sample collection

In August 2015, water, sediment and organism samples were collected. The dissolved oxygen (DO), pH, chlorophyll-α (Chl-α) and ammonia nitrogen (NH_4^+) were also measured *in situ* using a multi-parameter probe system. One liter of surface water was sampled at each site and sealed in glass bottles for further analysis of total phosphorus (TP) and total nitrogen (TN). The wind condition was measured using a Kestrel 4500 shooter's weather meter.

Prior to sampling, all sampling containers and tools were

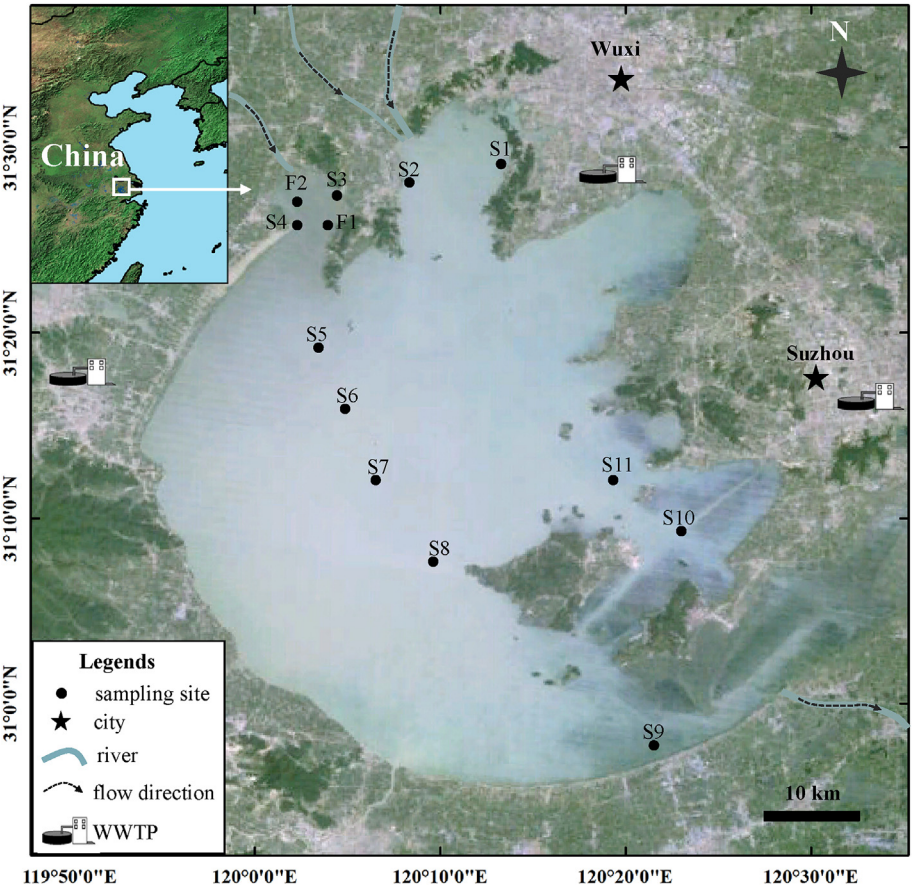

Fig. 1. Geographic position of sample sites and the distribution of cities around Taihu Lake.