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POLLUTION BY MACRO- AND MICROPLASTIC OF LARGE LACUSTRINE ECOSYSTEMS IN EASTERN ASIA

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ABSTRACT

Pollution of aquatic ecosystems by microplastic is an increasingly urgent problem. Despite significant interest from the scientific community, many large and unique water bodies remain under-investigated. In our study, we compared, on the one hand, the content of macroplastic of the lakes shore and on the other hand the content of the microplastic in the adjacent aquatic area nearby touristic villages situated on the shore of two large water bodies, Lake Baikal (Russia) and Lake Hovsgol (Mongolia). In both cases, we discovered that the microplastic particles were of secondary origin, and fragments and fibers were the predominant forms. The concentration of microplastic particles in the water opposite to the village on the lake Baikal shore was 4-times larger than the concentration of microplastic opposite to the village on the Lake Hovsgol shore. Mass tourism (not the aboriginal population) is likely the main driver of the water pollution by microplastic particles nearby villages with underdeveloped wastewater treatment facilities and idle systems of garbage collection and utilization.

KEY WORD : Lake Baikal, Lake Hovsgol, Plastic pollution, Microplastic.

INTRODUCTION

There is a growing body of literature regarding the contamination of aquatic ecosystems by microplastic (Andrady, 2011; Cole *et al*., 2011; Vandermeersch *et al*., 2015; Wan *et al*., 2018). However, most of these studies address the highly populated marine offshore areas (Andrady, 2011; Machado *et al*., 2018) or industrialized lake ecosystems (Driedger *et al*., 2015; Pozdnyakov and Ivanova, 2018). There is a lack of data concerning microplastic contamination of large lacustrine ecosystems in the sparsely populated areas. For instance, there is only one report about lake Hovsgol (Free *et al*., 2014) situated in Mongolia (~5 million years old) (Goulden *et al*., 2006) and none regarding the more ancient lake Baikal (~25-30 million years old) that is also a UNESCO Heritage Site. However, both lakes have a growing anthropogenic load because of the increasing number of tourists.

Both lakes with corresponding flora and fauna are remarkable sites to study such types of pollution. Lake Baikal and Hovsgol have both almost pristine offshore areas and areas that are heavily affected by human activity that is worsened by the underdeveloped wastewater treatment facilities or its absence. The goal of the study was to assess the macroplastic pollution of the shore and microplastic pollution of the adjacent lake waters. Such a comparison of those two lakes was conducted for the first time.

MATERIALS AND METHODS

Two touristic villages were chosen for the study: the village Bolshiye Koty (population is less than 100) on the lake Baikal shore and the village Hankh (population is about 3000 inhabitants) on the lake Hovsgol shore (Fig. 1). However, despite the small size, the largest tourist flow is in Bolshiye Koty. In

both cases, there is no wastewater treatment facilities and system of garbage collection, transport, and utilization is underdeveloped.

The collection of microplastic in the water over lake littoral was conducted by tugging neuston net (it is a standard microplastic collection method for water body surfaces (Wan *et al*., 2018) following by the fixation of the samples. In the laboratory, collected samples were filtered through several metal sieves, while the count of microplastic particles was conducted under a light microscope (Masura *et al*., 2015).

Macroplastic registration on the shore was done by a total collection of the plastic garbage in the area with the following dimensions: 50 m long and 4 m width. Later all microplastic was sorted and weighed.

RESULTS AND DISCUSSION

Conversion of the sample processing results for volume units (km^3) resulted in the following values: Lake Baikal, 1,065 billion particles per km^3; Lake Hovsgol, 294 million particles per km^3 (almost 4-times less than Lake Baikal). In terms of the morphology of the microplastic particles in both lakes, fragments (predominate in Lake Hovsgol, 43.39% of collected particles) and fibers (predominate in Lake Baikal, 53.08%) were ranked in the top two positions (Fig. 1). Also, films and foam particles were found. In both cases, foam particles are about a similar portion of all collected microplastic (7.56% in Lake Hovsgol and 6.19% in Lake Baikal). It should be noted that the concentration of the microplastic particles in the sub-surface layer of the water might be affected by various factors, for example, mixing during a storm. Besides, it is likely that mass daily vertical migrations of the hydrobionts (Houghton *et al*., 2018) might also affect the concentration, which is especially relevant for Lake Baikal (Karnaukhov *et al*., 2016; Takhteev *et al*., 2019).

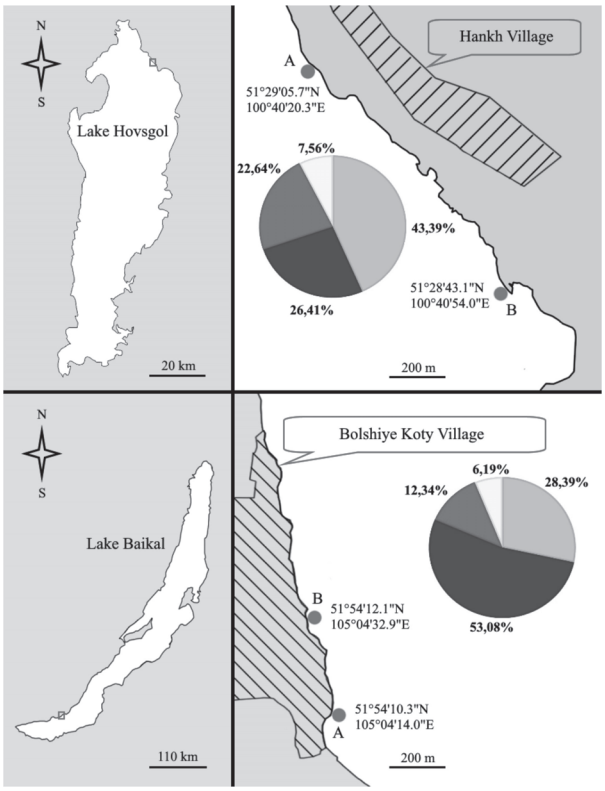

Fig. 1. Map and scheme of the collection sites (A – the start of tugging, B – end of tugging) and percentage of the microplastic particles with different morphology (brown – fibers, red – films, orange – fragments, yellow – foam).

Analysis of the collection on the lakeshore microplastic showed the following results (Table 1). It is worth noting that the weight of the plastic garbage on the shore of Lake Hovsgol near village Hankh is slightly less than the weight of the garbage collected nearby Bolshiye Koty village. However,

Table 1. Plastic garbage content along the lakes shore.

[1]	Type	Location			
		Bolshiye Koty		Hankh	
		Quantity, units	Weight, g	Quantity, units	Weight, g
1	Plasticbottles	5	131	2	90
2	Syntheticclothes /fishingnets	2	30	4	200
3	Cellophanebags	1	6	3	65
4	Packingmaterial	7	59	2	90
5	Plasticcanisters	2	166	-	-
6	Plasticplatesanddishes	2	7	-	-
7	Otherplastic	5	118	1	5
	Intotal	24	517	12	450

plastic garbage in the latter is more diverse. The top groups of the plastic garbage on the shore are plastic bottles, synthetic clothes/ropes/fishing nets, cellophane bags, and packing material.

Such plastic garbage found on the shore is the source of different types of microplastic particles in the water; the collected microplastic particles are of secondary origin. Primary microplastic particles, for example, that are used in cosmetics, were not found at either site.

CONCLUSION

The present study is the first step of our project. However, we can already conclude that, in the case of similar and relatively weak levels of touristic infrastructure development, the largest pollution burden of the shoreline areas by macroplastic, as well as adjacent water areas of the lakes by microplastic, is present at the sites with the highest touristic load, while the aboriginal population has no significant effect. It is probable that this conclusion is transferable only for areas that are similar to those we have studied (i.e., villages without wastewater facilities and lack of garbage collection and utilization sites).

Data regarding microplastic particles in the water showed a relatively high level of pollution in two studied sites. However, it should be noted that considering that many factors might affect particle concentration in the subsurface layer, future studies are needed to collect samples during different day times and at different depths.

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