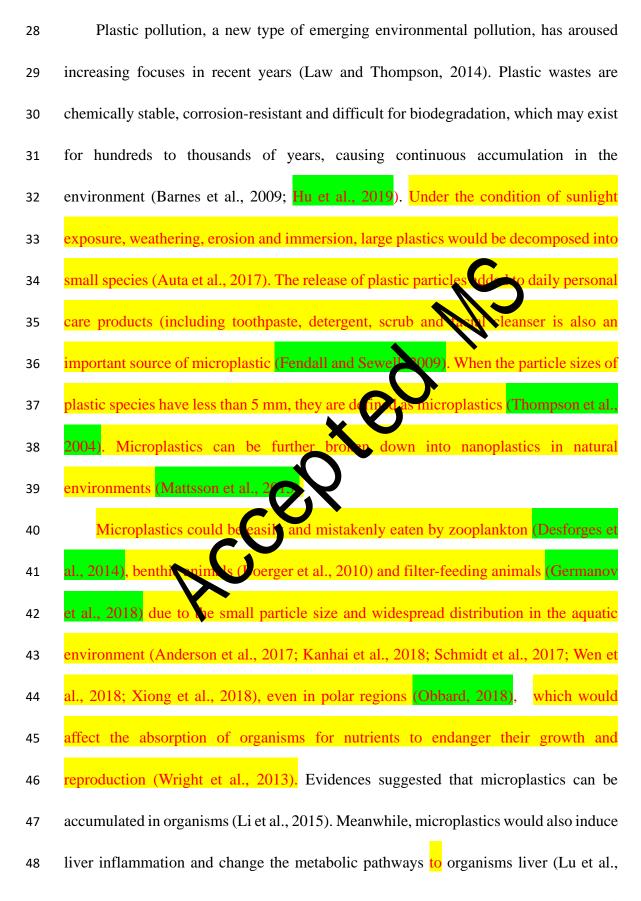
1	Micro(nano)plastics: Unignorable vectors for organisms
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12 Abstract

Micro(nano)plastics, as emerging contaminants, have attracted worldwide 13 14 attention. Nowadays, the environmental distribution, sources, and analysis methods and technologies of micro(nano)plastics have been well studied and recognized. 15 Nevertheless, the role of micro(nano)plastic particles as vectors for attaching organisms 16 is not fully understood. In this paper, the role of micro(nano)plastics as vectors, and 17 their potential effects on the ecology are introduced. Micro(nano)plastics could 1) 18 19 accelerate the diffusion of organisms in the environment, whe lt in biological 20 invasion; 2) increase the gene exchange between atta communities 21 causing the transfer of pathogenic and antibiotic re nce genes; 3) enhance the rate of energy, material and information flow in the 22 nent. Accordingly, the role of microplastics as vectors for organisms should be further evaluated in the future research. 23 Kevwords: Micro(nano)plastic vector; Aggregation; Diffusion; Gene 24 exchange; Energy flow 25 26

27 1. Introduction



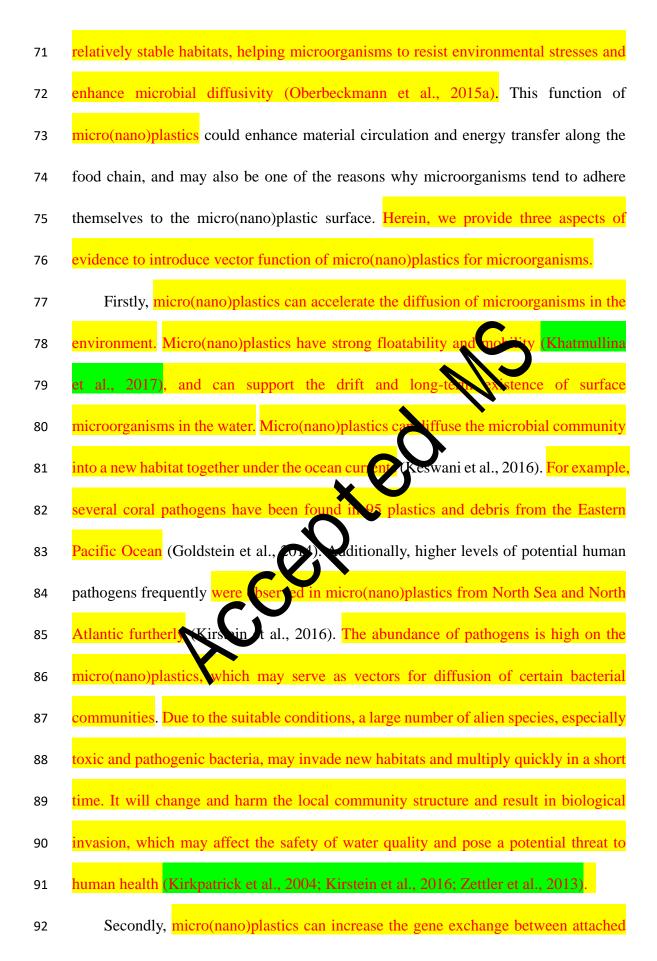
2016). When the size of microplastics reaches to the nanometer level, forming
nanoplastics, its ability to invade the organism is further enhanced. Evidence showed
that nanoplastics could penetrate the blood-brain barrier and eventually enter the brain
groups (Chen et al., 2017; Kashiwada, 2006), which may have profound potential
impacts on organisms.

Micro(nano)plastics, as a kind of particulate matter, can provide an attachment 54 substrate for microorganisms, zooplankton, phytoplankton and protozoans to form a 55 microbial community (Curren and Leong, 2018; Miao et al., sides, due to the 56 widespread distribution and constant drifting along with 57 water, the microbial community may cause serious marine ecological effects such as the spread of 58 pathogenic bacteria and resistant genes, biolog ca asion and the production of new 59 60 species. As vectors of organisms, micr lastics are gradually being concerned to global scientists. The co-ecolog f micro(nano)plastics and biology should be 61 a hot issue in the further of nicro nano)plastic study. The main objective of this paper 62 f different function of micro(nano)plastics as vectors and their 63 is to provide a submary potential co-ecological effects of the micro(nano)plastics and biology on the 64 environment, including aggregation, diffusion, and biological invasion. 65

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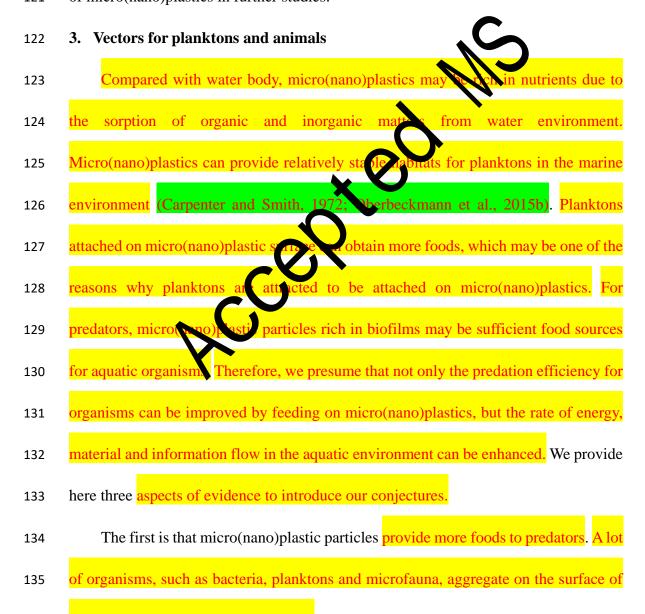
2. Vectors for microorganisms

Micro(nano)plastics can adsorb organic and inorganic nutrients from water
environment to attract the bacteria, viruses and other microorganisms to adhere on their
surfaces (Frere et al., 2018). Microorganisms aggregate here to obtain more nutrients
to improve the ability of bacterial energy. Micro(nano)plastics can also provide

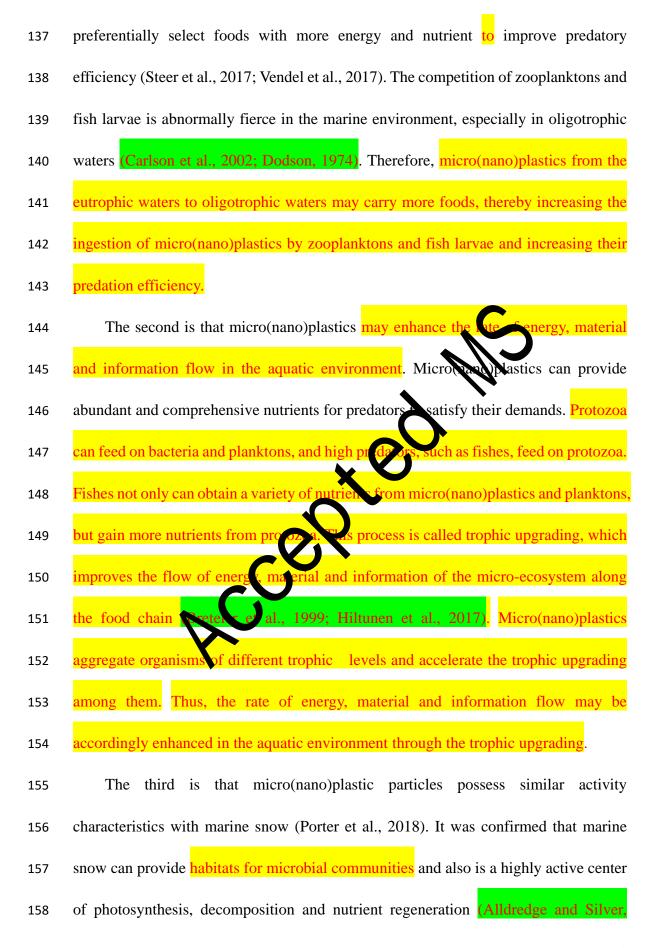


93	between biofilm communities, or between communities on biofilms and surrounding
94	environment (Arias-Andres et al., 2018). As a result of the strong variability of bacterial
95	genes, gene exchange between microorganism communities can occur through
96	horizontal gene transfer in the environment (Broszat and Grohmann, 2014; Madsen et
97	al., 2012; Molin and Tolkernielsen, 2003). Accordingly, new bacteria may be produced
98	during the gene exchange. In particular, pathogenic and antibiotic resistance bacteria
99	contain abundant pathogenic and antibiotic resistance genes, which may be transferred
100	by multi pathways between communities on biofilms. It will use outbreak of
101	pathogenic and antibiotic resistant genes and lead to large-state injection events in the
102	environment.
103	Thirdly, micro(nano)plastics may speed to the spread of the antibiotic resistance
104	genes and bacteria in the environment. Resistant gene and bacteria are often found in
105	downstream waters of medical wayer der treatment plants (Karkman et al., 2017).
106	Once a large number of resistance genes and bacteria enter the ocean system, it may
107	induce the horizontal crancier of resistance genes between communities or the
108	surrounding environment. The existence of micro(nano)plastics may enhance the
109	transportation of antibiotic resistance genes and bacteria due to the strong floatability
110	and mobility of micro(nano)plastics. Antibiotic resistance genes and bacteria may be
111	transferred to different areas. The exchange of antibiotic resistance genes between
112	communities or the surrounding environment and the existence of antibiotic resistance
113	bacteria may cause huge uncontrollable disasters (Bloom et al., 2017; Long et al., 2015).
114	Overall, micro(nano)plastics can provide an attachment substrate for

microorganisms to form a microbial community. Micro(nano)plastics not only act as
vectors of microorganisms diffusion, but as vectors of gene exchange and transfer.
However, the ecological effects of microplastics as microorganism vectors are not yet
fully unknown. Therefore, it is necessary to investigate the abundance and species of
microorganisms in micro(nano)plastics, to explore the diffusion mechanism of
micro(nano)plastics as vectors, and to evaluate the ecological and environmental risks
of micro(nano)plastics in further studies.



136 micro(nano)plastics to form biofilms. Under the natural conditions, predators would



159	1988). Many communities of zooplankton have been found in marine snow in sea
160	waters (Bochdansky et al., 2016; Ivancic et al., 2018; Porter et al., 2018). Organisms
161	tend to gather on marine snow because marine snow can provide abundant nutrients for
162	them (Montgomery et al., 2016; Tansel, 2017). Owing to similar characteristics with
163	marine snow (Porter et al., 2018), there is an inference that biofilms on
164	micro(nano)plastics can also attract organisms to adhere, improve the predatory
165	efficiency and enhance the rate of energy, material and information flow in the aquatic
166	environment.
167	In short, micro(nano)plastic particles may have great potential to enhance the
168	predation efficiency. However, toxic and harrial organisms may exist on
169	micro(nano)plastic surface (Oberbeckmann et al. 2015a). These organisms and
170	micro(nano)plastics themselves have advere effects on the survival, growth and
171	reproduction to organisms (Boerner); a 2010; Cedervall et al., 2012). When predators
172	emerge different degrees of amage causing energy intake reduction, they need to ingest
173	more particles. Such a prenemenon might result in great damage to marine ecosystem.
174	However, it is not yet fully understood that whether micro(nano)plastics rich in biofilms
175	are preferentially eaten by marine predators. Consequently, relevant researches should
176	be performed to understand and explore the relationship between the intake rate and the
177	abundant existence of micro(nano)plastics and nutrient types.
178	4. Conclusion and recommendation
179	Micro(nano)plastics as organism vectors may accelerate the diffusion of
180	organisms, improve the gene exchange among different species, speed up the migration

- 181 of resistant bacteria and genes, inducing uncontrollable transmission of resistant
- 182 bacteria and genes in the environment. Micro(nano)plastics may also cause biological
- 183 invasion and serious ecological disasters due to the spread of harmful algae and
- 184 pathogenic bacteria. Additionally, micro(nano)plastics may enhance the rate of energy,
- 185 material and information flow of the aquatic ecosystem, but may result in damage to
- 186 aquatic ecosystem. The research of micro(nano)plastics as vectors for organisms is a
- 187 new topic. Many conclusions are still in the speculative stage, and there are barely
- 188 scientific and sufficient information to confirm. Consequently, some experiments and
- 189 studies should be carried out in the future:
- 190 (1) Identifying the main microbial communities, species composition in different water
- 191 environments, and effects of microbial habitat on Aicro(nano)plastics.
- 192 (2) Exploring the adsorption mechanism of reanisms on micro(nano)plastic vectors,
- 193 the probability of gene exchange arong species, the advantages of biological 194 community structure and function, and the diffusion mechanism of pathogenic
- 195 organisms attaching on view (nano)plastics.

(3) Analyzing the mpact of community accumulation in micro(nano)plastics on
predators, and the selectivity of predators to foods at different environmental conditions.
(4) Establishing the ecological health risk assessment system of micro(nano)plastic
pollution.

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