A Summary of the Transporting Mechanism of Microplastics in Marine Food Chain and its Effects to Humans

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Abstract—Microplastics are ubiquitously present in the oceanic environment and, though unrecognizable to the public, pose perilous effects to animals in all trophic levels as well as to human beings. For this study, we emphasized the wide-ranging effects of oceanic microplastics to animals and to humans. The transportation mechanism of microplastics in oceanic food chain was analysed and the negative effects to animals in all trophic levels including humans are specified. Then, two approaches to mitigate the perilous effects are illustrated. Further, by reviewing the previous research, some knowledge gaps appeared. Therefore, four suggestions for future research were proposed. Unlike previous research, this review paper serves as an overview of the perilous effects created by the microplastics from cosmetic products to animals across all trophic levels, including human, and the transporting mechanism of microplastics through the marine food chain was elaborated as well. Hence, this review paper can raise people’s awareness to the microplastic pollution caused by cosmetics and further promote the banning of the microplastics in cosmetic industries and the propagating of potential alternative materials that are more sustainable.

1. Introduction
Plastic, a byproduct of petroleum fractional distillation, is omnipresent in the world, and become an indispensable ingredient in our daily life. However, because plastic is composed of polyethylene (PE) \cite{1}, they are hard to degrade and may exist in the nature for thousands of years. Hence, the destination for many plastic items is the ocean, in which they become a substantial component of the oceanic pollution \cite{2}. Also, among the plastic pollutants in the ocean, the macroplastic debris dominates. However, in the past few years, the menace of microplastic pollution has become more and more severe \cite{2}. To specify, microplastics are synthetic polymer particles that are less than 5 mm in length \cite{3}, and they are the most voluminous type of anthropogenic debris found in the marine environment \cite{4}. Because of their functionality and relatively low cost, these microparticles have deeply entered our daily life. For example, the microplastic, nowadays, is commonly used in cosmetic industries. As a result, the cosmetic industry makes billions of dollars from people’s quest for great skins and has huge potential to expand into a more dominant field of industries. Among these cosmetic products, facial scrub is one of the top selling items. To better clean up the dirt and dead skin on our face, most face cleansers nowadays have additives such as small particulates, commonly known as microplastics \cite{5}. In the past, facial scrubs contained natural exfoliants to increase the friction while washing our faces \cite{2}. However, because of the rising competition of cosmetic companies, the microplastics are introduced into face cleaning products to reduce the cost while maintaining the functionality of the

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natural exfoliants. With the help of these particles, cosmetic companies significantly boost their annual turnovers.

However, due to its small size, the microplastics can easily bypass the filters in artificial sewing systems and enter the river, and ultimately lead into the oceans [3]. As a result, a substantial amount of microplastics can enter the ocean and pollute the marine ecosystem continuously. Unfortunately, these microplastic particles lie in the size range of the food for planktons and larvae [6]. Hence, the planktons and larvae find it hard to distinguish the microplastic particles from their food source, and ingest them accidentally [4]. Also, since these small creatures lie at the bottom of the marine food chain, they become an irreplaceable food source for many fishes in higher level in the food chain. Consequently, these fishes accumulate microplastic debris inside their body due to their preying behavior. Such process is called the trophic transfer [4]. However, these mid-trophic level fishes are also preys for the predators in higher trophic levels, and, thus, these predators also accumulate microplastic due to preying microplastic contaminated animals. Ultimately, human beings, as one of the top predators in the food chain, consume a number of commercial fishes and mussels to maintain their daily protein intake. Therefore, through trophic transfer, the perilous microplastic particles can ultimately come back into human’s body with great dosages.

In this paper, we aim to review previous research to find how microplastic particles in commercial face scrubs come and migrate in the oceanic food chains and food webs, and how they ultimately come back into human body through trophic transfer. In this review, we divided the animals in the food chain into 4 trophic levels, with the primary producer, microalgae, at the bottom level, the microorganisms in the lower trophic level, fishes in mid-trophic level, and marine mammals and humans as top predators. The negative effects on creatures in all trophic levels are analyzed. Furthermore, the strategies on how to mitigate the perilous effects are reviewed and analyzed. In previous researches, the trophic transfer of microplastics in oceanic environment and the negative effects were studied, while few researches have been reviewed in detail about the transporting mechanism as well as its negative effects caused by commercial facial scrubs. Furthermore, some ways to mitigate the perilous effects of microplastics in marine system are proposed. Last but not least, some recommendations for future studies are provided. This review can raise people’s awareness of how the environment and our health can be negatively impacted by the microplastics from cosmetic products and, further, finding ways to protect our earth and people around us.

2. How Microplastic Come into the Food Chain

While washing our faces, the sandy texture particles inside the face scrubs are applied to increase the friction, so that the dirt and dead skins on our face can be removed more efficiently. Unfortunately, nowadays, these microparticles inside the face scrub are microplastics, which is a kind of perilous oceanic pollutants. To specify, the concentration of microplastics in facial scrubs could be up to 50391 particles per gram, and every time we use the facial scrub, 10,000 to 100,000 particles will be released into the domestic sewing systems [7]. So, as we clean up the face scrub on our face, these microplastic particulates will flow down the drain into the sewing system. Because of their small size, the microplastics can bypass the filters of the sewing system and easily get into the ocean and pollute the marine ecosystem. To specify, a team of oceanographers led by Kyushu University estimated that there were 24.4 trillion pieces and a combined weight of 82,000 to 578,000 tons of microplastics in the upper layer of the oceanic system [8]. Though this sounds to be a striking amount, the team claims that this is still a conservative estimate, because gridded data in Western Indian Ocean and South China are mostly absent [8]. Due to its high population density in Southeast Asia and China, this region generated 68% of the global mismanaged plastic waste. Hence, the amount of aquatic microplastic content may be even higher. Also, the microplastic debris appears in every ocean. For example, in Atlantic Ocean, the abundance of microplastic is $1.15 \pm 1.45$ items/m$^3$. Even worse, the microplastic abundance in North and South Atlantic Ocean is reported as 0–8.5 items/m$^3$ [9]. Due to the oceanic commuting system like wave currents, tides, cyclones, wind factor, etc. [9], these microplastics can transform at a very fast rate. In fact, according to Dr Florian Pohl, a single oceanic avalanche can
rapidly transport microplastic contaminated sediment to hundreds of kilometers away [10]. All in all, the microplastic is ubiquitous in the ocean system, including surface water, water column of different depth, underneath the sedimentation, and even polar ice cores [7].

Similar to the microplastics, the micro-organisms, as the basis for the oceanic food web [11], are also widely distributed throughout the ocean. In fact, these microbes are found in all portions of the water column, the sediment surface and the sediment themselves [12]. Because of the concentration of plastic polymers, most of the microplastic also lies in the ocean floor or within the sediment [10]. Plus, aside from lying under the ocean, inside the aquatic environments, some of the microplastics will float in the water just like the microorganisms does. Hence, the place where microplastic is concentrated highly coincides with that of the habitable zones for microorganisms. Also, as these microplastics are similar in size for the food for microalgae (such as zooplankton) and larvae [6], these small oceanic creatures cannot differentiate their food source from them. Hence, microalgae and larvae will consider floating microplastic debris as food and accidentally ingest them [4]. For example, zooplanktons, a common type of microalgae widely distributed through the oceans and as one of the bases for the entire marine food web, prey phytoplanktons, an autotrophic microorganism that produce energies through photosynthetic procedures [13], to fulfill their nutritious intake [11]. Because the size of phytoplanktons ranges from 2 µm to 200 µm [13], they lie in the size range of the microplastics. Plus, these microplastics will float just like the phytoplanktons do. So, zooplanktons may regard the floating plastic debris as food, and accidentally ingest them [4]. Due to this accidental ingestion, the microplastic successfully comes into the marine food web and started to migrate inside food chains [6].

3. How Microplastic Migrate in the Food Chain

3.1. Bottom Level Microalgae
Microalgae (like phytoplanktons), with a diameter equal to or less than 1µm [6], lay at the bottom of the oceanic food chains. Consequently, they are one of the primary producers for the entire food-web and are responsible for 50% of the primary net production [14]. So, as the entire aquatic food web depends heavily on these small creatures, the microalgae lay a solid foundation for the oceanic food web [11]. Hence, the health of these phytoplanktons is important for the thrive of the aquatic ecosystem. Once these small microalgae got harmed, everything inside the marine ecosystem will not be spared. Plus, they are the main food source for microorganism such as zooplanktons and larvae. So, unlike zooplanktons and larvae, in which they maintain their nutritious intake by preying behaviors, microalgae obtain energies through the photosynthetic effects [15]. So, they will not contain microplastic debris inside their body through accidental ingestion. Even though, the existence of marine microplastics still pose negative effects on these small creatures. For example, the existence of microplastics may induce growth inhibition [16] and shading effects [14]. Also, microplastics can lead to a decrease in chlorophyll content [16] and photosynthetic activities [14]. Because they are the primary producer for aquatic ecosystem, the reduction in photosynthetic activities will dramatically reduce the total energy content for the entire marine food web. In other words, the reduction in energy content for microalgae will reduce the energy intake efficiency for microorganisms in lower trophic levels. So, to gain equal amount of energy, microorganisms such as zooplanktons and larvae will prey more microalgae, and thus dramatically increase the time of predatory activities.

3.2. Lower-trophic Level Microorganisms
Lying in the lower end of the marine food chain, microorganisms such as zoo- planktons and larvae consider microalgae as their primary food source [15]. However, with a diameter equal to or less than 1 µm, the phytoplanktons are similar to the size of the microplastics [6]. Also, since the habitable zone for the microorganisms highly coincided with the locations where microplastics are concentrated, the accidental ingestion of microplastics by zooplanktons and algae frequently take place everywhere in the ocean [4]. Plus, due to their small size, the resistance to toxic particles is lower compared to larger species. So, the zoo- planktons and larvae are highly susceptible to the toxicity of microplastics [14].
A number of laboratory and field studies have indicated that many species of zooplanktons readily ingest microplastics in many regions in the world [17] and will pose negative effects on these small creatures from both the toxicity of the microplastic [14] as well as the reduction in nutritious intake [4]. Since the microplastics are mostly composed of polyethylene (PE) [3], they are hardly degradable. So, once the zooplanktons accidentally ingest these toxic particles, they will stay inside their body for a long time and the toxicity of microplastics will continuously harm the health of zooplanktons. On the other hand, from the nutritious intake perspective, the microplastics also pose perilous effects. Unlike microalgae, microplastics doesn’t contain any nutritious content, and thus cannot support the energy intake for zooplanktons. Consequently, even though zooplankton thought they are full, they indeed don’t consume enough energy to support their activities. This deficiency in energy intake will also pose negative effects on the health of the zooplanktons [17].

Moreover, for larvae, recent studies have not indicated significant effect on their feeding capacity, but have major effect on their energy intake efficiency [17]. Similar to zooplanktons, the accidental consumption of microplastics will cause the energy deficiency for larvae. This will cause negative effects in many life stages for larvae. Firstly, the energy deficiency may negatively affect the reproduction [17]. The reproduction process is energetically demanding, and, thus, the intake of microplastics can affect the fecundity of larvae. For example, several reports have shown that the decrease in nutrition can lead to the decrease in egg production in copepods [17]. Moreover, for larvae in early larval stages, the lack of energy will strongly influence the growth and stages to adulthood [17]. For example, a study of Tigriopus japonicus, a type of copepods, reveals that an increase in the length of nauplius phase from accidental ingestion of microplastics [18]. Last but not least, the microplastic ingestion may reduce the lifespan for many larvae species such as copepodites and nauplii [18]. The decrease in lifespan will affect the total population of larvae, and thus have negative effects on the food availability for many mid-trophic level fishes.

3.3. Mid-trophic Level Fishes

The mid-trophic level contains many secondary consumers that prey zooplanktons and larvae for food [17]. As these microorganisms are in the lower end of the food chain, many mid-trophic level fishes consider zooplanktons as indispensable nutritional supplement [4]. One of such examples is Menidia Beryllina, a common type of euryhaline fish in North and Gulf coasts. As a mid-trophic level fish, they ingest various prey items including protozoan zooplankton, and are a prime food source for species in higher trophic levels [4]. When Menidia Beryllina consumes microplastic contaminated protozoan zooplanktons for food, they will also accumulate the microplastic debris in their body. Through this method, the microplastics come into the food chain and will migrate into higher levels through preying behaviors, denoted as trophic transfers [4]. Since predators will continuously prey microplastic contaminated species for food, the microplastic debris will accumulate inside their body in higher dosages compared to their preys.

Aside from accumulating microplastics from their preys, some larger microplastics also lies in the food range of these mid-trophic level fishes [6,19,20]. So, the ingestion of microplastic by the mid-trophic level fishes commonly occurs in ocean systems and may cause health problems to them [7]. After the accidental ingestion, the microplastics will retained mostly inside the digestive system of fishes (including stomach and intestine) and may transfer to other organs and skins [7]. Although, for hundreds of thousands of years, fishes constantly ingest indigestible like sandy materials or partially digestible particles such as wood and shells, and have developed some mechanisms to cope with these unwanted particles, it’s not the case for the oceanic microplastics [20]. As a byproduct of fossil fuel combustion, the plastic was invented due to the increasing demand of energy after industrial revolution, and thus the microplastic only appears in the aquatic environment for less than 100 years ago. So, the oceanic lives have not yet developed mechanisms to deal with this novel toxin. Thus, there are negative effects to the fishes. To start with, as the microplastics may confuse fishes from their preying items, the existence of microplastics will cause a reduction in predatory performances [20]. Also, to maintain the protein and energy intake, fishes living in microplastic contaminated
regions must double their preying time to gain 95% of the intake requirement compared to microplastic free regions [20]. The microplastics will also pose threat to the health of the oceanic fishes. Laboratory experiment have indicated that the mortality rate for microplastic contaminated fish have greatly increased compared to the control group (fishes without microplastic contamination) [19]. For example, most of the microplastic particles are not perfectly rounded and contain sharp edges. Hence, when ingesting these particles, the sharp edges can penetrate the intestinal lining of these mid-trophic level fishes and cause mechanical injuries and ulceration [20].

Because they are in the mid-trophic level, many high-level animals require them to sustain the protein intake. Due to the increasing mortality rate for microplastic contaminated zone, the availability for these fishes decreases dramatically. From this perspective, the mid-to-high trophic level fishes will consume more time in predatory activities. Also, researches indicated that the microplastic debris commonly left inside the digestive system of these fishes [7], the higher-level creatures will also accumulate these debris inside their body from secondary sources. Consequently, the negative effect of microplastics will migrate into mid-to-high trophic levels.

3.4. Top Predators – Marine Mammals
Moreover, as higher trophic level predators will prey these mid-trophic level fish for food, the microplastic continues to migrate into higher trophic levels through this predator and prey relationship. Animals in the mid-to-high trophic level, such as marine mammals, are larger in size and have relatively fewer natural predators. So, the direct negative effect of plastic materials to these marine mammals is entanglement and potential habitat degradation [21]. Hence, the relationship between microplastic pollution and marine mammals are poorly studied. Indeed, the microplastics in aquatic environment pose serious impact to these larger species. Because of their large size, a good amount of protein is required to maintain their daily activities. So, in microplastic contaminated regions, their preys would be contaminated by microplastics. In other words, the marine mammals, through trophic transfer [4], will indirectly collect microplastics in their body from consuming contaminated prey [21]. On the other hand, the microplastics, with a diameter of less than 5 µm, don’t lie in the food range of these marine mammals, so that they will not consider floating microplastics as their food. Even though, the direct ingestion of microplastic materials happen in marine mammals. When marine mammals are preying for food, a great volume of sea water are also ingested into their body [21]. In microplastic contaminated zone, the microplastic ubiquitously present in every section of the water column [9]. So, marine mammals will unconsciously ingest microplastic particles into their body. In general, even though marine mammals lie in the upper trophic level, the microplastic debris still get inside their body both directly and indirectly.

Undoubtedly, due to the large size, the marine mammals are more resistive to the toxins of microplastics. But the gigantic bodies also require good amount of energy to support their daily activities. So, they must continuously hunt for microplastic contaminated prey for survival, and thus will accumulate higher dosages of microplastics. Hence, the microplastics does pose negative health effects to marine mammals.

3.5. Top Predator – Human Beings
Ultimately, human beings, as one of the top predators in the food web, will constantly consume seafoods to maintain the protein intake. In fact, commercial fishes, mussels, etc., provides up to 15% of the animal protein requirement for 4.3 billion people and 20% of the total animal protein intake for 3 billion people across the world [22]. Past researches have shown that the commercial fishes, just like many other fishes in the mid-trophic level, will accumulate microplastic particles inside their digestive tract [20] or even leaching onto their skin [22]. So, those hazardous microplastics ultimately come back into our body in dietary tract through bio-accumulation with great dosages [6]. So, the contamination of microplastic by human beings is no longer a micro issue [22]. Though many specific health effects from microplastic contamination to human beings are left unknown, the microplastic indeed pose perilous effects to us. Firstly, evidence have shown that the rate of nondegradable
microplastic influxes into human body is approximately 40 mg/person/day. Because these microparticles resist chemical degradation and mechanical clearance, the non-degradable microplastics will embedded inside our body for an extended period [22]. Moreover, though the effect of microplastic is poorly studied inside human bodies, several studies suggested that the uptake and toxicity of polymeric microplastics will pose negative health effects in some similar mammalian systems [22]. More specifically, the microplastic can translocate across living cells to the lymphatic and/or circulatory system and potentially harm the immune system [22]. So, the same effect may also pose in human bodies. Lastly, past researches consider eating seafood as a less perilous route of microplastics accumulation because people only eat the skin instead of internal organs of these commercial fishes. However, this is not always the case. Unlike some developed countries like United States and United Kingdom, many developing countries have limited access to seafood items, and thus include the internal organs of commercial fishes in their dietary routine. For example, in the past, China have limited access to commercial fishes, and, thus, the internal organs of these fishes will not be discarded and turned into delicious feasts. In my hometown, Hunan, China, the fish bubbles (lungs) and fish intestines are commonly placed inside the hot pot, in which they contain greater dosages of microplastic compared to the dosages leaching into fishes’ skins. Hence, the effect of accumulation of microplastic through dietary route may be underestimated in current studies.

4. How to Mitigate the Perilous Effects

Based on the previous analysis, there are approximately 24.4 trillion pieces of microplastics in the upper layer of the ocean [8]. Hence, the microplastic pollution commonly exist everywhere in the ocean, and pose danger to oceanic ecosystem and animals in every trophic levels. Even worse, as a top predator, the negative effects of microplastic cannot be spared for us human beings. So, we should start finding ways to mitigate these perilous effects.

4.1. Regulations and Legislations

Because microplastics commonly composed of polyethylene (PE) [1], they are hard to degrade. So, the first thing we should do is to address the source of microplastic pollution [23]. To specify, governments should publish regulations to ban the use of microplastic in commercial goods to avoid addition of microplastics into aquatic environments. Legislations have successfully passed in US and UK to ban the use of microplastics in rinsed-off consumer products (including cosmetic products like face scrubs and non-prescription drugs such as tooth-pastes) [24]. However, a single regulation of banning microplastics in consumer goods is not enough to fully regulate the microplastics into aquatic environment: more precise and detailed regulations are needed. The microplastics don’t solely produced from the industrial usage in rinsed-off consumer products, there are many other sources. One of such examples is the production of secondary microplastics like the fragments from larger plastic items. Take commercial facial scrubs as an example: although the previous laws have banned the use of microplastics inside the scrub, no regulation appears in confining the production of microplastic from the packaging of the facial scrubs. So, even if the source of direct microplastic have been cut off from the direct use of microplastic inside the facial scrubs, the use of plastic in the packaging of the facial scrubs may also lead to the addition of oceanic microplastics. To sum up, there are a lack of regulation to control the source of these secondary source production [25]. So, more detailed and thorough regulations are needed to better control the sources of pollution.

Aside from banning the production of microplastics, governments should also encourage the use of possible alternatives of microplastics in the industries or even enact legislations to further support the research and industrialization of microplastic alternatives. Such alternatives include recycle materials and biologically degradable ingredients [23]. There are several challenges confronted: (1) what are the possible alternatives that can bring into the market in the near-term; (2) what is the cost of these alternative materials; (3) will there be health and environmental concerns for these alternative materials [24]. In other words, the legislation in supporting the use of alternatives must effectively balance the environmental and health concerns as well as whether they make sense economically.
Undoubtedly, the promotion of alternative materials of microplastics will be a long and complicated procedure. But, for better protecting our only planet and the well-being of mankind, the legislation is a must.

4.2. **Microorganisms**

The next way of controlling the microplastic pollution is by affecting its transmission mechanism [23]. Although microplastics can stay in the environment for hundreds of years, researchers have found that some organisms may help accelerate the degradation of the oceanic microplastics. Studies have shown that the bacteria can effectively and rapidly colonize the surface of oceanic microplastics and form microbial biofilms [26]. Lab experiments have shown that fungi, bacteria, and biofilms can effectively degrade microplastic of various polymer types [27]. More specifically, the hydrophobic surface of the microplastics provide an ideal location for microbial colonization and biofilm colonization. Among these microorganisms, the most abundant genus is Vibrio [26]. Fortunately, field studies revealed that Vibrio spp. were present on the floating microplastic from the North and Baltic Sea, so that these microplastics can served as vectors for the dispersal of such pathogens [26]. Therefore, theoretically, this method can be a possible way of dealing with the microplastic pollution. However, little evidence is known for whether these bacterias, fungi and biofilms can degrade the floating microplastics in the field (oceans) [26] other than laboratories. Also, there are no evidence to show whether the introduction of these microorganisms into the ocean may lead to additional environmental concerns. Consequently, more field studies on the microbial degradation of oceanic microplastics are needed.

5. **Recommendations for Future Studies**

To get deeper understanding about the transporting mechanism and its negative effects on the environment and human beings, we made several recommendations for future research and studies.

5.1. **More Field Studies Required**

As mentioned in previous sections, many studies we reviewed are literature based or lab based, while the field studies are always poorly conducted. For example, in the case of microorganisms, lab studies have revealed that fungi, bacteria and biofilms can effectively acceleration of the degradation of microplastics [27]. However, no field studies are conducted to further prove the effects of these microorganisms in real world. Therefore, the studies may not be as plausible since confusions remained. Also, without field studies, researchers cannot know if these microorganisms would cause additional environmental hazards and toxicity. Finally, without field studies, regional variation of the effects in accelerating the degradation of microplastics are undefined. Hence, more field studies are required to add the plausibility on how microorganisms can acceleration of microplastic degradation.

5.2. **More Studies on the Negative Effects to Marine Mammals Required**

Marine mammals, as an essential part in the oceanic food web, will accumulate microplastics inside their body through both accidental ingestion and bioaccumulation through trophic transfer. However, few studies have gathered enough research and field studies on these large creatures. So, little information on how microplastics will negatively affect the health of marine mammals is known. Indeed, lying near the top of the trophic level, these large animals are under great risk of exposing in high dosage of microplastics in microplastic contaminated regions. Thus, in order to gain deeper understanding of the trophic transfer and bioaccumulation of microplastics in oceanic food web, more studies on how microplastics will negatively affect the health of marine mammals is required.

5.3. **More Studies on Negative Effects on Human Health is Required**

People, as one of the top predators in the food web, will constantly consume commercial seafood to sustain protein intake. Since microplastic is widely distributed everywhere in the ocean, the seafood we consume often contain microplastics in their body. So, these toxic particles ultimately come back into our body through trophic transfer. Even though, few studies have conducted in analyzing the
specific health effects of the microplastics to human beings, especially chronic effects. Microplastic pollution is a growing global issue and requires more attention by the general public. So, more studies are required on the negative effects of microplastics to human beings, in that these studies will raise people’s awareness on how these dangerous particles will negatively affect our daily life and people around us.

5.4. Toxic Effects Associated with Microplastics

Relatively more studies have conducted in the bioaccumulation of microplastics through accidental ingestion and trophic transfers, while there remains a knowledge gap on specific toxins inside microplastic particles that may negatively impact the health of animals in all trophic levels and of human beings. Previous lab experiments have indicated that some chemicals in microplastics may leached out and into other part of the body. However, knowledge on the specific chemicals leached and its corresponding toxic effects to animals in all trophic level is unknown. So, more studies on the toxic effects associated with microplastics is required.

6. Conclusions

In this study, we highlighted the wide-ranging impact of oceanic microplastics produced by commercial face scrubs to the animals in all trophic levels, marine ecosystems, as well as to human beings. This review includes the route of microplastics entering the oceanic ecosystem and the ways microplastics migrate in the oceanic food chains. Negative effects on animals in all trophic levels and human beings are analyzed. Once these microplastic particles enters the aquatic environment, they exist ubiquitously inside the marine ecosystem. Similarly, microorganisms such as zooplanktons and larvae also commonly appear in every section of the ocean. Thus, this coincidence provides adequate prerequisite for accidental ingestion [4].

For the migration of microplastics in marine food chains, it all starts from the accidental ingestion by microorganisms. Microorganisms’ primary food source is floating microalgae. Because of the similar size of microplastics compared to microalgae, microorganisms can hardly distinguish the former from the latter. Hence, accidental ingestion occurs frequently and commonly for microorganisms in microplastic contaminated regions. Through this method, the microplastics enter marine food chain, and started to migrate into higher levels. Because microorganisms are food sources to mid-trophic level fishes, they will also accumulate the microplastics through their preying behaviors. This process is called trophic transfer [4]. Aside from getting microplastics from their preys, they may also directly ingest microplastics. Then, as top predators, marine mammals and humans require great amount of seafoods to maintain their protein intake. So, when consuming mid-trophic level fishes from microplastic contaminated regions, they would indirectly collect microplastics. Also, for large marine mammals, some research indicated that they will also ingest microplastic particles nearby when swallowing the fishes. However, few studies have systematically analyzed the direct ingestion of microplastics by large marine mammals– further studies are required.

In terms of the negative effects produced by oceanic microplastics, not even the microalgae will be spared. Although microalgae, such as phytoplankton, obtain their energies from photosynthetic activities and doesn’t require preying behaviors to support themselves, the microplastics still negatively affect them through growth inhibition and shading effects [14,16]. As the primary producer in the ocean, the existence of microplastics will also lead to a reduction in the chlorophyll content inside microalgae and will thus lead to a decrease in the total energy content inside the marine environments. Then, for microorganisms in lower trophic levels, microplastics will negatively affect them from the feeding capacity and energy intake efficiency [14,17]. Plus, the negative effects are perpetual in all life stage of microorganisms including to growth in childhood and adulthood as well as the reproduction process [18]. Moreover, for fishes in mid-trophic levels, the appearance of microplastics will reduce their predatory performances [7] and, thus, the mortality rate will increase. Furthermore, for animals who prey mid-trophic level fishes for food, marine mammals are under great risk of accumulating great dosage of microplastics. However, the effect of microplastics to marine
mammals are poorly studied and required further field works to fill the knowledge gap. Similarly, evidence indicated that humans continuously ingest oceanic microplastics, and these particles will embed inside our body for an extended period [22]. Still, the specific chronic effect of microplastics to human is poorly studied, further research is required. Plus, the specific toxins of microplastics to animals and humans are poorly studied. Therefore, future studies should dive further into the toxic effect of microplastics to marine animals and human beings to better understand the perilous effect of microplastics.

Lastly, to mitigate the perilous effects, two ways are proposed. Firstly, more detailed regulation and legislation are required to cut the addition of microplastics into marine ecosystems as well as to encourage the industrialization of microplastic alternatives. Also, as some organisms can help accelerate the degradation of microplastics in oceanic food chains, these particles can act as vectors for the dispersal of such pathogens [27].

There is great amount of microplastics commonly exist in the ocean, and the microplastic pollution have no longer been a micro issue. However, relatively few people have noticed the perilous effect of marine microplastics, and thus will not even know the fact that washing our face using face scrubs containing microplastics can further damage our mother planet. Hence, in order to raise people’s awareness, in this review paper we analyzed the perilous effect of microplastics produced from face scrubs to the oceanic animals and environment as well as to human beings. This review also inferred that, to quest for great skins, people do not need to use facial scrubs with microplastics. Some alternative materials can be applied to cut the microplastic pollution. Further, this paper may help banning the use of microplastics in cosmetic industries and boosting the introduction of alternative materials.

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