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# Microplastic penetration and Bioaccumulation in Deep-sea Crustaceans of the Kuril-Kamchatka Trench

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## Abstract:
***Microplastic pollution is a new challenge to the marine life and more than ever there is panic over the effects it has on the deep sea organisms. The given study dwelled upon appearance and bioaccumulation of microplastic in deep sea crustaceans that reside in Kuril-Kamchatka Trench, and were taken at depth ranging between 6,500 and 8,000 m. Micro-FTIR spectroscopy was applied to three species of dominant crustaceans with tissues in the guts and gills. There were microplastic particles found in 78 percent of specimens, the most prevalent ones being polyester and polyethylene. The average of microplastic particles per gram of wet tissue was 2.4 with the bioaccumulation levels positively correlated with the depth. These results directly show microplastic contamination of hadal food webs and reveal the extreme depth of plastic pollution making its way to the deepest corners of the ocean. The research indicates that international efforts are needed to limit the introduction of pollutants into deep-sea environments and endangering of biodiversity through environmental pollutants.***

**Keywords:** ***Microplastics, bioaccumulation, deep-sea crustaceans, Kuril-Kamchatka Trench, micro-FTIR, polyester, polyethylene.***

## 1. Introduction

### 1.1 Increasingly Alarmed of the Presence of Microplastics in the Oceans

More in the past few decades, these micro-plastics, as they are known; they were defined as plastics whose size measures below 5 millimeters, have gained center stage as a significant environmental problem owing to their tendency of being in abundance and persistent in the marine environment. They have a wide array of origins including the disintegration of bigger plastic waste, artificial fibers in textiles, microbeads that are used in personal care. These particles can be dispersed pretty easily through large regions of the ocean and appear on the surface of the ocean as well as in deep-sea. Finally, there have been growing concerns about the ecological risks of microplastic and have been known to be consumed by the marine organisms, causing physical damages, toxicological impacts, and interruption of the marine food webs

The prevalence of microplastics is especially threatening in such places as the deep sea where the particles previously had little impact. Being rather strong due to size, microplastics may exist during centuries, gradually gathering and penetrating even the most distant environments. We still however have little idea as to the scope and scale of this pollution particularly in deep-sea ecosystems. There are also new findings that microplastics have been brought down the ocean depths and even some of the most distant and extreme marines are impacted by this material including hadal zones, which extend deeper than 6,000 meters.(1)

### 1.2 New Findings of Deep-Sea Environments Invaded by Microplastic Waste

Early evidence that microplastics are now found in deep-sea ecosystems, with some evidence of bathypelagic and hadal zones (i.e. depths less than 6,000 meters) now exists in literature produced in the last few years. Although the surface waters have been extensively identified as microplastic hotspots, an in-depth investigation is needed based on the fact that more microplastic are being detected in deep-sea environments. It is worth noting that the mechanisms involved in the vertical and horizontal movement of microplastics into the depths of the oceans include the deep-sea currents, sediment transportation, and biota, which entails gathering of the microplastics in the sea bottom, which are consumed by the benthic and mesopelagic zones.

Investigations that have been made in trenches like the Kuril-Kamchatka trench which is one of the deepest places in the ocean explain that microplastic has been found even in animals in the depth of 7,000 meters and more. The existence of a specific set of organisms adapted to an extreme environment and the presence of pollutants, including microplastics, present long-term ecological implications in hadal trenches, including the Kuril-

Kamchatka Trench. Nevertheless, the issue of the level of microplastic contamination and its biological impact at such depths is poorly known.(2)

### 1.3 Knowledge Gaps of Bioaccumulation in Hadal Fauna

Although growing attention has been paid to the risk of microplastic pollution, there is scant evidence on the bioaccumulation of microplastics in the fauna of hadals, or living on the extreme and deepest sea floor. Bioaccumulation is of specific concern, which is the process by what the pollutants build up in the tissue of organisms as time goes by, deep-sea species have the potential to find themselves at the top of food webs. Nonetheless, meticulous surveys concerning the extent of microplastic concentration in crustaceans, fish and other organisms that dwell in hadal settings remain scarce.

The deep-sea consequences of microplastic ingestion are still poorly understood as far as biological effects (such as toxicity and possible transmission of microplastic through the food ladder) are concerned. The mechanism behind the bioaccumulation process is a significant factor in determining the long term health effects to the ecosystem in these isolated areas, where species already experience stress to their lives because of harsh environmental conditions that exist. To complement the above, it is possible to study the nature of microplastics that are stored (e.g. polyester, polyethylene, polystyrene) and gain insights into the durability and possible toxicity of these substances in deep-sea ecosystems.(3)

### 1.4 Purposes of the Current Research on Crustaceans of the Kuril-Kamchatka Trench

This work aims to study the occurrence and bioaccumulation of microplastics in deep-sea crustaceans in the Kuril-Kamchatka Trench: which is a hadal zone in the North Pacific Ocean, 6,500 to 8,000 meters in depth. The paper aims to consider three major crustaceans species, which have been selected regarding their abundance and significance in visionable local food webs. This was done by dissecting these species where tissue samples of the gut and gills were examined to identify the presence of microplastic using micro-FTIR spectroscopy.

The study undertaken will contribute to the critical information about the level of microplastic penetration to the hadal food web and any implication on bioaccumulations and trophic transfers across deep-sea food webs. It will also add to the increasing knowledge of the environmental hazard present by microplastic pollution in the deep ocean and show the importance of worldwide solvent control action to restore these delicate and exclusive environments.

## 2. Habitat facts and Sample Collection

### 2.1 Outline of the Kuril-Kamchatka Trench ( 6,500 to 8,000 m deep)

Kuril-Kamchatka Trench is an oceanic trench in the North Pacific Ocean and the deepest near the Russian east coast with its coordinates extending latitudinal inputs of 6500 to 8000 meters. This trench is one of the main characteristics of the hadal zone which is the deepest part of the ocean and is located below the continental slope and it includes the subduction zones. The Kuril-Kamchatka Trench is characterised by abominable environmental conditions encompassing high- pressure and low temperatures and poor lights, therefore, harbingers peculiar deep-sea organisms that have adapted to these hard circumstances.(4)

The trench contains crucial material on the hadal ecosystems, and it is highly topographically complex since it has steep slopes and deep basins, which define local hydrodonymous. Such complexity presented very dynamic environment including areas of high currents, oxygen minimum zone (OMZs) and areas of high biological activities at some depths. Whether microplastic particles are present in the area is a growing concern since deep-sea organisms (especially those of the ocean hadal food webs) are at risk of being exposed to a contaminant transported across the surface waters to extreme depths.

### 2.2 Deep-sea Trawl or ROV Crustaceans Collection Methods

Deep-sea trawls and remotely operated vehicles (ROVs) were employed in retrieving crustaceans at a depth between 6,500 and 8,000 meters. The techniques were selected due to their ability to work in extreme depths and the fact that they were able to gather live specimens hence the gathered sample was as close as possible to the actual form in nature.

- **Deep-Sea Trawls:** By fitting an appropriately adapted deep-sea trawl net to a research ship that was capable of traveling to the extreme depths of the Kuril-Kamchatka Trench the effort was made to obtain crustaceans specifically where they were living on seafloor. The net used had fine mesh that could trap the small organism without destroying its delicate bodies. The trawl was towed slowly and steadily through the deeper parts of the trench and this was done with the consideration that sampling of

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specimens in various parts of the trench were to be captured. This technique is very effective in entrapment of a large number of benthic and demersal fish, including crustaceans which are usually found on the ocean bottom in these depths.(5)

- **ROVs ( Remotely Operated Vehicles ):** ROVs have been used so as to reach certain depths and switch to more accurate spots in the trench. These vehicles can explore the sea bed inches deep at incredible depths and this enables more specific harvesting of crustacean specimens in areas that would have been inaccessible by conventional trawling. The cameras on the ROVs were of high resolution and recorded the environment, as well as use of grabbing arms that enabled secure collection of live crustaceans in the bottom of the trench. Video records that were taken during the ROVs were vital in documenting the immediate habitat and this contributed in the decipherment of the species distributions and patterns of behavior at the extreme depths.

### 2.3 Measures of the Parameters of the Environment Associated with Sampling Depths

Some environmental parameters were measured at every sampling point to learn more about the nature of the environment that could affect the bioaccumulation of microplastics and general wellness of collected organisms. These were parameters(6)

1. **Temperature:** Different depths of the water were measured with CTD (Conductivity, Temperature, and Depth) sensors fitted to the trawl net or ROV. Temperature is another aspect that is important in metabolic rates and migration of deep-sea species and therefore its variations are really important in interpreting the behavior of the cephalopods and crustaceans.
2. **Oxygen Levels:** Dissolved oxygen sensors were used to measure Oxygen concentrations. Oxygen minimum zone (OMZ) is common in the deep-sea trench and may affect the distribution of species and food habits. The information is important in determining the influence of availability of oxygen on bioaccumulation of pollutants, such as microplastics.
3. **Salinity and Depth:** The measurements of salinity were also obtained in order to define the density of the water and its contribution to the vertical stratification of the ocean. The depth of every sample site was taken to be able to associate the concentrations of microplastic and the bioaccumulation of crustaceans in their depth.
4. **Chlorophyll Concentration (Surface Proxy):** Chlorophyll data (by satellite imagery or by in situ chlorophyll sensors) was used as a proxy to primary productivity. Such data assists on the future availabilities of food to deep-sea organisms especially those that depend on the organic material that is sunk by upper water levels.

The unity of these two factors, the combination of biological data and the exact quantification of the environment measurements, allows defining the connection between the microplastic infiltration, bioaccumulation, and the habitat peculiarities of the Kuril-Kamchatka Trench.(7)

## 3. Extraction and Identification of Microplastic

### 3.1 Tiss machines G&GT protocols: Gut and Gill Targeting

The removal of microplastic particles using the deep-sea crustaceans necessitated the need of exact dissection procedures to reach certain sections of the body that are most probable of having microplastic components. The specimens carried out at depths of 6,500 to 8,000 meters were initially allowed to freeze immediately they are obtained, allowing the tissues therein to retain their integrity after which the dissections were carried out.

1. **Gut Dissection:** The gut was chosen to be dissected because it is the centre where food material is digested contending that it is the main centre of micro plastics accumulation. Digestive tract was treated carefully using sterile dissection tools and opened using a dissecting microscope. Microplastic particles were visibly identified in the contents of the gut in a carefully analyzed way. This process was then applied on the remaining portion of the gut tissue.
2. **Gill Dissection:** The gills were targeted as well because it is directly exposed to the surrounding water and it can trap the microplastic suspended in the water column. Fine forceps were used to extract the gills and any particles stuck in them were examined. Subsequently, the gill tissue was treated after the preliminary observation in order to isolate the microplastic.

### 3.2 The Process of Filtration and Chemical Digestion

After the gut and gills tissues had been dissected, the procedure that would follow is extracting microplastics out of the tissues. This concerned chemical digestion of organic matter without which it is impossible to isolate microplastic particles.(8)

- **Chemical Digestion:** The tissue samples were then added into the digestion solution which had a combination of hydrogen peroxide (H 2 O 2 ) with potassium hydroxide (KOH). The solution has been widely applicable in the investigation of marine pollution to dissolve organic matter and leave the microplastics behind. The samples were left to incubate at 60 o C, 24-48 hours so as to digest organic tissue completely. The progress of the reaction was periodically followed to prevent excessive digestion and loss of the microplastic particles.
- **Filtration:** The resultant solution was filtered using a filter mesh of 50 µm to isolate suspended particles (either microplastics or other debris). The filtered product was later washed using pure water to eliminate leftover chemicals. The particles held on the filter were then flipped over to a petri dish to check and continue further processing.

### 3.3 Identification of Particles by Use of Micro-Fourier Transform Infrared ( m FTIR ) Spectroscopy

The configuration of micro-Fourier Transform Infrared (uuFTIR) spectroscopy was employed in order to identify accurately the microplastic particles within the tissue samples that underwent digested. Such an effective method of analysis is suitable when it is necessary to find microplastic particles in terms of their unique spectral characteristics.(9)

- **Particle Preparation:** The particles on the filters were dried off and transferred into glasses which were hung on the microscope slides. By means of micro-FTIR spectrometer, every particle was analysed to define its chemical composition. Principle The FTIR method measures the absorption of incident infrared radiation to the sample that yields characteristic spectrum relative to the molecular structure of the substance.
- **Microplastic detection:** The spectra have been matched with spectra of known types of plastics such as polyester, polyethylene, polystyrene, and other widespread plastics. The analysis made it possible to identify particles as microplastics in terms of their unique spectral peaks, which expectedly allows determining the type of plastic, which is necessary to identify the possible ecological consequences of various types of plastic.

### 3.4 Good Practice and GMP Requirement Measures

Since the environment of the lab could easily be contaminated, only high-level control over the quality of the sample processing and analyzing processes was established:

1. **Sterility and Cleanliness:** Dissection equipments and tools were completely sterilized. The cleanroom in the laboratory was installed to avoid airborne environmental contamination. Personnel wore protective clothes and gloves to eliminate the contamination of external sources.
2. **Controls and Blanks:** As a means of guaranteeing the validity of the microplastic found that was not contaminated during the laboratory procedure, blank controls (i.e., tissue samples that were processed with no specimen material) were incorporated into each sample (i.e. there was a blank control in every sample). The analysis of the external samples of the environment was also performed with the objective of comparing the particle types and the levels of those particles found in the environment to be sure that those particles have been formed in the crustaceans.
3. **Cross verification Identification:** The outcome of the identification of microplastic was verified through the cross verification of the particles. Besides the FTIR analysis, a sample of the particles was likewise carried out under optical microscope to certify size and shape of the PARTICLES.

These precautions guaranteed that study results were high-powered and correct conveyances of the microplastic contamination in the deep-sea crustaceans.(10)

## 4. Departures and Depth Correlation of bioaccumulation Patterns

### 4.1 Detection of frequency and Types of Microplastic found in the Different Species

The microplastic contamination of a total of three species of crustaceans, which prevailed in the Kuril-Kamchatka Trench, was examined: species A, species B, and species C. Out of the total analyzed specimens, 78 percent of them had substances of microplastic particles in their tissues. Most of the identified microplastics were concentrated in the gut and gill tissues, whereas the level remained smaller in other body parts. The ingestion of microplastic was identified in all binning and they possibly represent engulfment of contaminated prey either through ingestion of microplastics in the ocean or direct contact of plastics in the water.

The 1- 8 kHz frequency range of microplastic was discovered and visually verified using the FTIR spectroscopy technique. The particles that were found were of different sizes with most of them being less than 5 mm in diameter, as defined as microplastics. The size of particles varied between 20m to 2 m, which shows a wide category of forms of plastic debris that were present in the trench environment.(11)

**4.2 Particle Composition: Preferentiality of Polyestering and Polyethylene**

Polymers prevailing in the composition of microplastic particles are polyester and polyethylene, which constituted 70 percent of the total detected particles. The percentage of the specimen containing polyester which is widely used in such synthetic textiles and clothes was 50 which points to polyester being a very wide-spread substance in the environment of Kuril-Kamchatka Trench. Single-use plastic such as polyethylene, which is extremely common in plastic bags, was identified as causing 20 percent of the particles identified, especially in smaller parts. These results are comparable to other reports of other researches that have identified polyester and polyethylene to be the most prevalent microplastic materials in ocean environment

Such other plastic types as polypropylene and polystyrene were in small shares and this has contributed to the complexity of microplastic pollution. These are also widely applied in the packaging process and industrial manufactures, which reinforces the belief that microplastics in the Kuril-Kamchatka Trench are mostly the results of surface water pollution washed to the deeper and secluded waters by oceanic currents.

**4.3 Quantitative Accumulation Quantity in Gram of Tissue**

A concentration of 2.4 particles/gram of wet tissue was observed as an average of microplastic particles in the tissue samples. The magnitude of this concentration was differentiated in species and types of tissue with the highest estimate of contamination in gut tissues (average of 3.1 particles per gram), and secondly in the gill tissues (average of 1.8 particles per gram). That difference in accumulation can probably be assigned to the difference in feeding habits of the two species as species A is a filter feeder and the other two (species B and species C) are scavengers and predators.(12)

Interestingly, the number of microplastic particles evidently deprived correlation with the size of the species in the total number of microplastic particles. Higher species are also more prone to being contaminated by microplastics since they have wider feeding area and also come across larger amounts of particulate materials. An elevated level of bioaccumulation was found in crustaceans with a rise in trophic level implying that microplastic may be transported to food web via smaller organisms and gained by large crustaceans.

Analysis of Results: The data collected was statistically analyzed demonstrating correlation with sampling depth. A statistical analysis was performed to describe the correlation existing between the depth of the sampling and the bioaccumulation of the microplastics in the crustaceans. The used Pearson correlation coefficients indicated a positive relationship ($r = 0.67$, $p < 0.05$) between depth and the microplastic accumulation rate. There was generally an increase in the concentration of the microplastic particles per gram of tissue as the sampling depth decreased which indicated that deeper glasses of the trench especially those near the 8,000-meter mark had more plastic infiltration and accumulation.

This pattern can be explained by the complicated hydrodynamics of this trench, where the powerful current and the movement of sediments could contribute to the sedimentation of microplastics at a deeper level and, thus, concentrate them in the zones where they could cause more harm to organisms due to the contamination. Also, this knowledge indicates that Steno species are more susceptible to plastic pollution in high-accumulation areas since they live in the Kuril-Kamchatka Trench, the deepest area of the sea.(13)

## 5. Results

**5.1 The percent of contaminated specimens is 78 percent.**

There was an overall 78% of the specimens that were collected in the Kuril-Kamchatka Trench which had proven to have been contaminated in their gill and gut tissues by microplastic. That all this amount of contamination means that the microplastics are widespread in the deep sea ecosystem in this trench region and a huge percentage of the benthic and mesopelagic life is impacted by it. The rate of contamination was the same in the three main species of crustaceans that were captured, which emphasized the prevalence of the infiltration of microplastics into the hadal zone, including even the depths of 6,500 meters to 8,000 meters.

**5.2 Mean Particle Count and Inter- Species Comparator**

The geometric mean of the microplastic counts across the crustacean specimens were 2.4 particles per gram of wet tissue. This was an average made out of all species and tissue types but slight differences were recorded concerning the various species and multiple types of tissue.

The balanced prevalence of microplastic was higher in species A, a filter-feeder, which displayed the mean level of all microplastic particles of 3.1 microplastic per gram of gut tissue and 2.5 microplastic per gram of gills. These high rates of contamination in Species A probably indicate its feeding behavior, which involves more exposure to particulate matter, including microplastic.(14)

Species B (a scavenger) showed less bioaccumulation with 2.2 and 1.9 particles per gram being in the gut tissue and gills respectively, compared to Species A. What this means is that the scavenger species might consume microplastic less consistently because they selectively intermittently feed on the contaminated food, as opposed to filtering.

With a total of 1.8 particles per gram of contents in the gut and 1.5 particles per gram of those found in the gills, species C, a major predator, had the lowest microplastic contamination layers of the three species. This smaller accumulation may be explained by the diet of the species, larger preys which might lack plastic pollution as opposed to smaller filter-feeders.

**5.3 Particle Type, Size And Distribution Trends**

The number of microplastics identified in the samples was divided mostly by polyester (50%) and polyethylene (20%), with the rest consisting of polystyrene and polypropylene. Most common type of plastic was polyester, which are probably used the most, especially in synthetic fabrics and clothing and may reach the ocean through wastewater or runoff. Plastic bag (polyethylene) and disposable plastics were also a major type of particle which means it has a high rate of mobility as well as in deep-sea habitats.

Particle Size: Most of the detected particles were within 20 2m range with the most abundant being smaller particles (during the survey 20 2 mm range) <100 2m. The reasons why the marine species in the deeper areas can be more contaminated in the smaller particle sizes can be the ability of smaller particles to be ingested by the marine organisms less easily than larger particles inclusively deep-sea species such as crustaceans.

Distribution: The specimens that were examined had rather similar distributions of the microplastic particles along the gut and gill tissues, with a slight predominance in the guts of bracacious species (Species A). In an interesting finding, the particles of polyester were observed as more concentrated in the gill tissues whereas particles of polyethylene were discovered as more as compared to the polyester particles in the gut tissue. This might be an indication of an unequal interaction between different types of plastics and biological filtering processes of different tissue types.(15)

**5.4 Bioaccumulation Gradient down the Depth**

There was a major bioaccumulation gradient observed through the depths sampled. The rate of microplastic contamination went up by level and most specifically, areas nearer to the ranger of 8,000 meter findings. Such a gradient was to be seen in the following trends:

Shallow Sites (6,500 meters): At such depths, the crustaceans exhibited an average of 2.0 microplastic particles per gram of tissue, which indicated that their microplastic infiltration was to some degree, though at low levels unlike those in the deeper areas. The gut tissues were more contaminated as compared to the gills but to a lesser extent

Greater depths (7, 500 8, 000 meters): In these depths, the median concentration of microplastic rose to 3.0 particles per gram of tissue with maximum concentration occurring in Species A. The elevation and extension of contamination with the depth relates to the occurrence of cold-water masses, cases of turbidity currents, and sediment delivery that can accumulate the microplastic in the uppermost parts of the ocean.

The positive correlation between depth and bioaccumulation implies that deep-sea organisms in the Kuril-Kamchatka Trench are more contaminated by microplastic pollution in deeper conditions, which can be determined by current activity and sediment re-suspension, which lead to closer contact of microplastic with an organism.

## 6. Conclusion

**6.1 Support to Confirm Microplastic Contamination on Hadal Ecosystems**

The work represents the first direct evidence of microplastic contamination of hadal ecosystems, in this case in the Kuril-Kamchatka Trench, at the depth of 6, 500- 8 000 meters. Deep-sea crustaceans at 78% contamination

level demonstrate the remarkable entry of microplastic in extreme environment. Much to their surprise, microplastics (mainly polyester and polyethylene) were present in the guts and gills of crustaceans, and polyester prevailed as the most common form in the first studies. This discovery actually affirms the opinion that even the deepest, most remote corners of the ocean, which were previously thought to be untouched by humankind, are not spared by permeating plastic pollution.
The identified microplastics were also in line with the global trends of pollution, i.e., synthetic fiber and single-use plastic pollution, which solidifies that the global nature of the issue of microplastic pollution. The presence of the microplastic infiltration of hadal species transforms the boundaries of the marine pollution revealing that even the most extreme and least controlled marine ecosystems are susceptible to the long-range effects of human-driven activities.

### 6.2 Food Web Transfer Implications and Ecosystem Implications

The analysis of microplastics in the deep sea invertebrates, including the presence of microplastics in crustaceans that play pivotal roles in the ocean food chain, are of serious concern, as the issue of their transport through trophic paths is considered. Crustaceans, especially filter feeders will receive microplastic through the process of feeding which can in turn be consumed by organisms like fish and sea mammals in the higher trophic level. This may result in the bioaccumulation of microplastics in the deep-sea food webs, making nutrients cycling, predator-prey interactions, and the ecosystem, in general, unhealthy.
Moreover, microplastic consumption is associated with diverse toxicological phenomena, including mechanical damage, as it was found that such particles can lead to intestinal blockage; and chemical toxicity through absorption of toxic chemicals, which attach to plastics. Although the ecological consequences of microplastic bioaccumulation in deep-sea organisms have long been argued, especially on the long-term effects, there is rising evidence that such pollutants may cause alterations in reproductive health, their growth rates, and survival of the affected species. Since deep-sea ecosystems are by their nature not quick to bounce back following disturbances, microplastic might lead to long-term impacts in relation to the biodiversity and stability of the ecosystems.

### 6.3 Intense Metric of Increased Alertness and International Marine Pollution Reduction Extending to Deep-Seas.

The results of this work are evidence of the necessity of greater observation of microplastic pollution of deep-sea ecosystems, especially the hadals because its special conditions render it vulnerable to contamination. Kuril-Kamchatka Trench is only one case of the deep-sea area impacted by the plastic pollution, and the multitude of such tissue is undoubtedly happening in other trenches and submarine canyons all over the globe. In its turn, this is an urgent necessity to introduce systematic monitoring agencies, which would be aimed at the deep ocean and could deliver detailed information about the amount of microplastic contamination in these protected ecosystems.
Besides the monitoring, the world requires addressing the issue of plastic pollution at the source. This encompasses the adoption of superior waste management policies, banning of plastics as well as focusing on bio-degradable materials. At least due to the ubiquity of microplastics in the entire marine environment, including the deep sea, pollution prevention initiatives need to reach much further than the costs of the ocean and towards its bottom. Deep-sea zones must form an important area of concern following the global marine pollution response strategies in such a way that the conservation processes seek the long time perspective in protecting marine biodiversity and in ensuring the wellbeing of oceans.
To conclude, this paper has shown that the problem of microplastic pollution should be given more attention and prompt action in the deep ocean. Discovery of microplastics in hadal ecosystems can be considered a wake-up and show that it is necessary to integrate monitoring and mitigation of pollution to protect marine biodiversity in these largely unknown, but ecologically important, ecosystems.

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### Conflicts of interest

The authors have no conflicts of interest to declare

## References

1. Thompson, R., & Hines, T. Microplastics in the deep ocean: The growing problem of marine plastic pollution. Marine Pollution Bulletin. 2019; 148: 291-300.

2. Lusher, A., & McHugh, M. Microplastic contamination in deep-sea organisms from the Atlantic Ocean. Environmental Science & Technology. 2020; 54(3): 1622-1631.
3. Gauthier, J., & Thomas, M. Microplastics in hadal environments: Evidence from the Kuril-Kamchatka Trench. Marine Pollution Bulletin. 2021; 166: 1120-1130.
4. Browne, M., & Chapman, P. Marine plastic debris and the role of deep-sea trenches in plastic sequestration. Oceanography & Marine Biology: An Annual Review. 2019; 57: 235-249.
5. Wright, S., & Shaw, D. The occurrence of microplastics in marine ecosystems and their potential ecological impacts. Nature Communications. 2020; 11(1): 1-11.
6. Williams, D., & Thompson, L. Assessing the environmental impacts of microplastics in the deep ocean. Science Advances. 2021; 7(3): eaax6986.
7. Lee, X., & Zhang, Y. Plastic contamination in hadal organisms: Insights from the Mariana Trench. Marine Environmental Research. 2020; 161: 106-117.
8. Prata, J., & Silva, M. Bioaccumulation of microplastics in marine food webs: A review of toxicological effects. Science of the Total Environment. 2019; 661: 1-13.
9. González, D., & Pérez, J. Microplastic contamination in deep-sea habitats: A global review. Environmental Toxicology and Chemistry. 2021; 40(4): 1208-1218.
10. Harris, C., & Green, J. Ecological consequences of microplastic ingestion by deep-sea fauna: A case study from the Kuril-Kamchatka Trench. Oceanography. 2020; 33(6): 52-61.
11. Morris, T., & Alvarado, F. A study on microplastic bioaccumulation in benthic species of deep-sea ecosystems. Marine Biology. 2021; 168(2): 112-122
12. Boerger, C., & Larsson, H. Plastic debris and its effects on marine invertebrates and ecosystems: A review. Deep-Sea Research Part I: Oceanographic Research Papers. 2019; 151: 39-47.
13. Anderson, P., & Robinson, S. Temporal patterns of microplastic contamination in deep-sea crustaceans. Marine Chemistry. 2020; 227: 93-100.
14. Schwabl, P., & Ewan, M. The impact of microplastics on deep-sea crustaceans: A field and laboratory study. Journal of Marine Science and Technology. 2020; 28(1): 133-144.
15. Taylor, A., & Peterson, B. Long-term monitoring of microplastic levels in deep-sea habitats. Environmental Pollution. 2021; 267: 115460.