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Study on microplastics in the gut content of selective fin and shell fishes

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Abstract

Microplastics are the smaller size of the original or disintegrated plastic. These plastics are available in the aquatic column in large which became a concern with reference to health issues. So, it is essential to understand what extent these microplastics are consumed by the high order animals and its bioaccumulation. In this study an attempt was made to understand the same by the way of commercially important fin fish and shell fish samples. The gut content was estimated for the availability of microplastics and the exerted data was interpreted to understand the microplastics consumption and its distribution in this marine ecosystem. Statistically it stated that 50% of the studied mackerel specimens were found containing microplastics of which 33% contained high amounts of microplastics and 36% of the shrimp specimen contained microplastics but in lesser concentration. Moreover, no correlation was found with reference to feeding intensity and availability of microplastics in the gut content. Further studies are essential to correlate and understand the impact of fishing gears and other land based anthropogenic activities.

Keywords: *plastics, environmental impact, wild life, fish, gut content*

Introduction

The microplastics are classified as primary and secondary microplastics based on their origin. The primary microplastics mainly originated from the manufacture of plastics, pharmaceuticals and cosmetic products as pellets or granules. The secondary microplastics are the plastic products that degraded and converted in to smaller size as pellet or granule or fibre or filament.

Since these microplastics are also concentrated in the soil, it will accumulate in the pore spaces of the soil and reduce the water percolation capacity in turn, reducing the recharge of the ground water, nutrient recycle in the soil and thermal profile of the soil. If the same available in the water column, due to its less dense nature, it will float in the system and develop turbidity in the water column. Hence, it affects light passing capacity in the water column. The consumption of these suspended particles by marine biota leads to bioaccumulation in the food web and hazard to the higher animals. Over and above, these microplastics also absorb toxic elements on its surface and also lead to concentration of potential harmful elements in the biota.

So, it is essential to understand to what extent these microplastics are consumed by the high order animals and are concentrated in it system by its bioaccumulation. These higher order animals will be consumed by the humans, which lead to harmful effects. The studies on these aspects, with reference to fishes, are very minimal, that also in India very few studies are available. So, an attempt was made to understand the same.

The existing literature states that Cole et al., (2011) reviewed the literature and discussed about the properties, nomenclature and sources of micro plastics and its routes to enter the marine environment. Further, this article also discussed about the analytical methods and the spatial and temporal trends of abundance in different environments. Andrady (2011) discussed the microplastics ability to concentrate organic pollutants in the marine environment and its impact on the biota. Browne et al., (2013) reported worm's consumption of microplastics and its toxicological effects. Zhao et al., (2014) studied the Yangtze estuary in east China Sea and established that rivers were transport larger amount of microplastics to the sea.

The different methods for analysing and reporting technique on microplastics were established by Masura et al., (2015). Anderson et al., (2016) reviewed the Canadian aquatic ecosystems for the presence of microplastics, especially Arctic regions. The global modelling was developed for the microplastics quantification till 2050 by Seigfried et al., (2017). MSPGB (2018), Loder and Gerdts, (2019) and Vollerstein (2019) discussed the different methodology for the study of microplastics in different environments. The microplastics concentration was analysed for captive grey seals (*Halichoerus grypus*) and Atlantic mackerel (*Scombers combrus*) for its abundance in their digestive tracks (Nelms et al., 2018). Carlos de Sa et al., (2018) compared the marine faunal microplastics ingestion and its adverse effect. Malakar et al., (2019) reported plastic pen occurrence in the guts of yellow fin tuna *Thunnus albacores*. Indian marine waters do not show any significant dedicated research on the marine biota with reference to microplastics.

Material and Methods

Selection of Species

Two species which are normally consumed by the population of Andaman and Nicobar Islands were selected. The feeding behaviours of the fishes are also considered for the selection of commercialy important species. Accordingly, the fin fish species *Rastreilleger kanagurta* and shell fish *Metapenaeus monoceros* were selected for this study.

Collection of Samples

Freshly caught specimens of both the species were bought from the Junglighat landing centre, Port Blair on the 28th January, 2019. The details like the fishing ground, time of collection and the craft and gear used were recorded. Both the species were collected from Diglipur coast and the effort was made during the day and night. The craft was mechanised dhinghi and the purse seine net was used as a gear.

Storage of the Samples

The iced specimens of both the species were collected from the craft in icebox and brought to the laboratory and stored in 10% formaldehyde. Care was taken to ensure that all the specimens were completely submerged in the formaldehyde. The formaldehyde was changed as and when, it became excessively turbid due to its preservation process.

Dissecting the Samples

Prior to dissection, the specimens were placed in distilled water for few hours, to flush the formaldehyde and reduce its vapours. After that, the gender was identified as well the basic biometric such as length and weight were measured. Latter, the dissection was made to remove the gut content. The gut weight also measured. However, the shrimp gut was not weighed due to its small size. Once the above formalities were over, the contents of guts were collected in a vial with 10% formaldehyde for the preservation.

Observation under Microscope

The collected gut contents were placed in a petri dish and the clumps were gently broken down using a forceps and a needle. A jet of distilled water was used to further separate the clumps of organic matter into smaller masses. These contents were then viewed under the stereo-binocular microscope.

Identifying and Isolating the Microplastics

Microplastics were quite prominent and easily identifiable when considered the following points:

- Microplastics are almost always brilliantly coloured unless they are transparent. This makes them highly visible. The colour of the most microplastics will not fade hence this was an easy task.
- The shapes of the microplastics need to be kept in mind, i.e., granules, film, sheets, fibre or filaments. Microplastics, which are usually used in cosmetics and air blasting media will always have a regular shape usually spherical in nature.
- To confirm whether the object is truly a microplastics it was pressed with needle. If it breaks easily, then it was considered non plastics and if comparatively strong then it was identified as microplastics.

The identified microplastics can then be extracted using a suitable micropipette and placed in a smaller vial along with small amounts of distilled water to facilitate its removal, when it is needed for further confirmation and counting.

Results and Discussion

The studied fin and shell fish specimens revealed the following results. It was observed that 24 out of 48 mackerel specimen (Table 1) contained microplastics. Out of this, 8 specimens contained microplastics in excessive amounts (greater than 4 nos.). The shrimp specimens (Table 2) represented 16 out of 45 microplastics in their digestive tracts.

Statistically it stated that 50% of the studied mackerel specimens were found containing microplastics of which 33% contained high amounts of microplastics and 36% of the shrimp specimen contained microplastics but in lesser concentration.

Table 1. The results of the gut content analysis of the *Rastreilleger kanagurta* species
+ Presence, 4 or less than 4 Nos. of microplastics and organisms
++ More than 4 Nos. of microplastics and organisms; * Absent

Sample No.	Status of Gut	Microplastics	Organisms identified in the Gut
F1	Fresh	+ +	++copepods
F2	Digested	++	++None identifiable
F3	Digested	+	++None identifiable
F4	Semi digested	*	Copepods
F5	Semi digested	*	Copepods
F6	Semi digested	+	+ copepods ,unknown-4 ,
F7	Semi digested	*	ND
F8	Semi digested	*	ND
F9	Semi digested	+	+ copepods , jelly ball
F10	Semi digested	*	ND
F11	Semi digested	*	ND
F12	Undigested	*	ND
F13	Digested	+	+
F14	Semi digested	*	ND
F15	Semi digested	*	ND
F16	Large, sparse	++	++ copepods
F17	Digested	+	++ copepods
F18	Digested	*	++ copepods
F19	Semi digested	*	++ copepods , unknown-2
F20	Semi digested	*	++ copepods
F21	Undigested	++	ND
F22	Digested	++	++ copepods , 1 worm, 2 jelly balls
F23	Semi digested	++	++Copepods , worms
F24	Semi digested	++	++1 worm,
F25	Digested	+	+
F26	Semi digested	+	Unknown -1

F27	Semi digested	*	ND
F28	Semi digested	+	+Copepods,
F29	Semi digested	*	ND
F30	Digested	*	ND
F31	Semi digested	*	ND
F32	Semi digested	*	ND
F33	Semi digested	+	+
F34	Semi digested	*	ND
F35	Semi digested	*	ND
F36	Semi digested	+	+copepods
F37	Digested	*	ND
F38	Digested	*	Copepods
F39	Semi digested	*	ND
F40	Semi digested	*	ND
F41	Digested	+	+ copepods
F42	Digested	+	Copepods , unknown -3
F43	Digested	++	+ copepods
F44	Digested	+	ND
F45	Digested	*	ND
F46	Digested	+	+ copepods
F47	Digested	+	ND
F48	Semi digested	+	+ copepods

Table 2. The results of the Gut content analysis of the *Metapenaeus monoceros* species. + Presence; ND- Absence

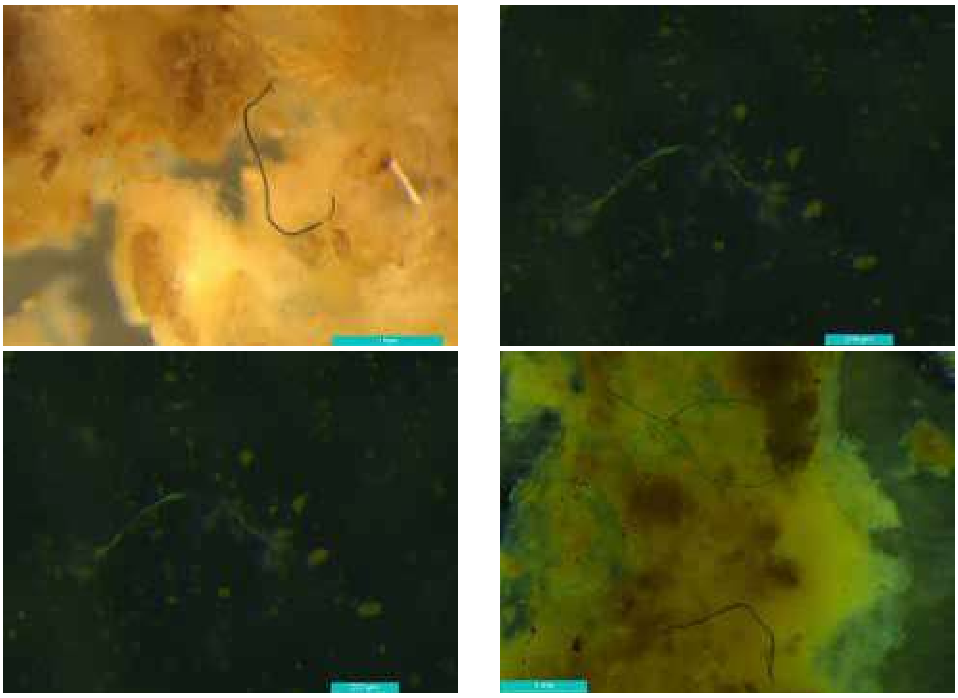
Sample No.	Microplastics	Sample No.	Microplastics
P1	ND	P24	ND
P2	ND	P25	+
P3	+	P26	ND
P4	ND	P27	+
P5	ND	P28	ND
P6	+	P29	+
P7	ND	P30	+
P8	ND	P31	ND
P9	+	P32	ND
P10	ND	P33	+
P11	ND	P34	ND
P12	ND	P35	ND
P13	ND	P36	+

P14	+	P37	+
P15	+	P38	ND
P16	ND	P39	ND
P17	ND	P40	ND
P18	+	P41	ND
P19	+	P42	ND
P20	ND	P43	ND
P21	ND	P44	+
P22	ND	P45	+
P23	ND		

The study revealed that the size of the microplastics available in mackerel *Rastreilleger kanagurta* specimen's gut content was larger, i.e., 1000µm to 2000µm in size (Fig.1). However, the microplastics in gut content of *Metapenaeus monoceros* was around 500µm size. This may be related to their feeding behaviour as well as due to the availability of microplastics, i.e., the mackerel moves in the pelagic waters and consume these plastic, so it may be in larger in size. Whereas, the shrimp *Metapenaeus monoceros* are mainly detritus feeders and mostly available in the bottom of the ocean, so, the settlement of fibres to the bottom may be less or disintegrated before its settlement to the smaller fractions.

Further, it may also infer that the selecting feeding habit of shrimp will reduce the intake of microplastics. When the content of mackerel specimen analysed, the F2 specimen exhibited the granular form of microplastics and the remaining forms are in fibre or lines (Plate 1 and 2). This shape also imparts greater buoyancy to the microplastics, which in turn must have been in suspension for longer time period and provide more opportunity to be fed by the pelagic fishes.

Plate 1. Microplastics observed from the Gut of *Rastreilleger kanagurta*



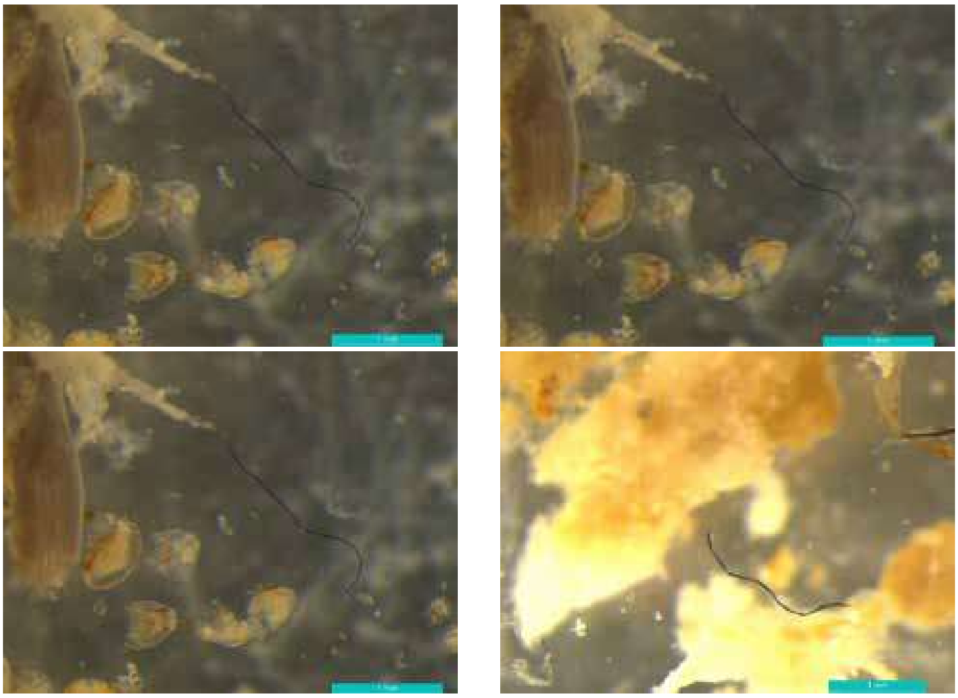
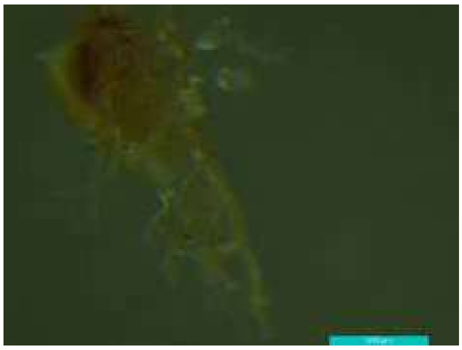


Plate 2. Plankton content from the gut of *Rastreilleger kanagurta*

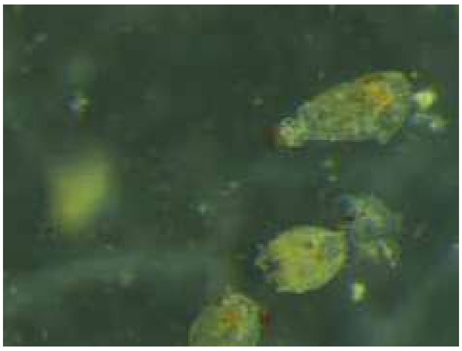
Veliger larvae

Broken part of a sea weed

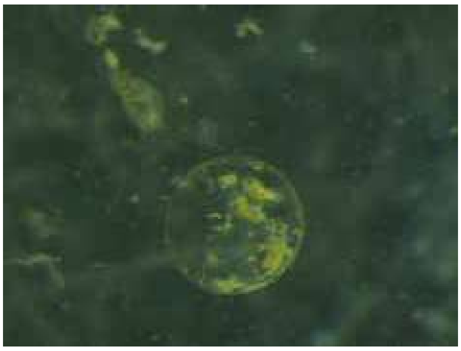
Round worm



Exoskeleton of a shrimp



Copepod exoskeletons



Digestive Particles

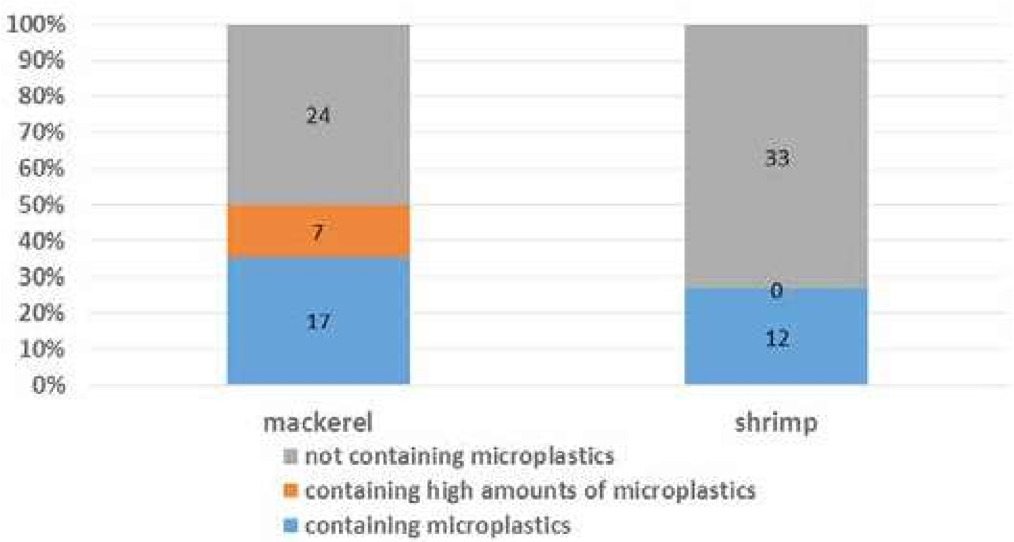


Fig.1 Percentage break-up of the micro plastic abundance in the analysed fish and shrimp specimen

The prevalence of fibres as microplastics in the gut content of the fish indicated that this may be due to the fishing activities, which may have been originated from the disintegration of fishing gears such as fishing nets, long line wires and related activities. The colour of the microplastics which was observed during this study was blue. This colour also support that the origin of this plastic may be fishing related activities. Addition to that, the microplastics of transparent, green, brown and red colours were also encountered during this study.

Further, no correlation was found with reference to feeding intensity and availability of microplastics through the gut content analysis suggested that this may be due to the accidental entry to this gut content and not intentional. However, the amount of availability in the gut content inferred that this fishing ground infested with good amount of microplastics concentration floating in the pelagic waters and also deposited in the sediment.

Conclusion

The two species such as *Rastreilleger kanagurta* and *Metapenaeus monoceros*, respectively, representing fin and shell fish of pelagic and benthic community gut content stated that 50% of the studied mackerel specimens were containing microplastics of which 33% were exhibit high amounts. The shrimp specimen contain 36% of the microplastics but in lesser concentration. There were no correlation was found with reference to feeding intensity and availability of microplastics through the gut content analysis suggested that this may be due to the accidental entry to this gut content and not intentional. A systematic study is essential to understand bioaccumulation of the same to the humans.

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