GLOBAL IMPACT OF MICROPLASTICS IN THE MARINE ENVIRONMENT

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1. INTRODUCTION

OBJECTIVES: Identify characteristics, sources and interactions of microplastics in the marine environment at a global level. Determine the translocation pathways of microplastics, the sea products that represent a greatest risk, the implications derived from the presence of microplastics in marine foods and how these affect the food safety and food security.

Figure 1: Microplastics. FAO

MICROPLASTICS: Plastic pieces less than 5 mm in their longest dimension. (Nanoplastics: < 100 nm).
1ry: Manufactured to be certain size. Pellets, powders or microbeads in cosmetics, cleaning products & industrial abrasives.
2ry: From the fragmentation of macroplastics. E.g., 1 piece of clothes > 1.900 fibres per wash.

Figure 2: Browne et al. 2011

2. SOURCES, RESERVOIRS & PROCESSES

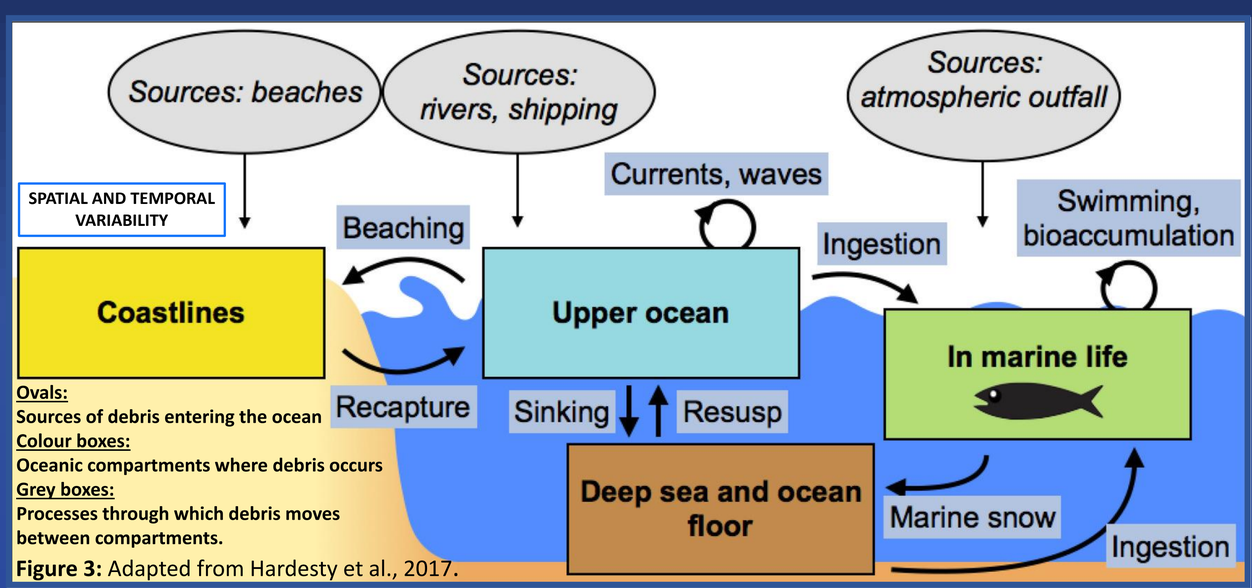


Figure 3: Adapted from Hardesty et al., 2017.

Hotspots: North Pacific Ocean, Mediterranean Sea, ocean gyres (GPGP), river mouths, areas with high anthropogenic activity & next to wastewater treatment plants (WWTP).

3. INTERACTION WITH POLLUTANTS & TOXIC EFFECTS

The fugacity gradient between ingested plastic and lipids in tissues of marine organisms, will determine if chemicals move from the plastic to the animal, from the animal to the plastic or if they are not transferred.

DIRECT BIOACCUMULATION	INDIRECT BIOACCUMULATION	
PLASTIC → BIOTA	PLASTIC → WATER → BIOTA	PLASTIC → PREY → PREDATOR

SURFACE / WATER / SEDIMENT

Figure 4: Adapted from GESAMP

TOXIC EFFECTS
1. **Plastic particles:** immune response with associated inflammation.
2. **Leaching of additives:** endocrine and reproductive alterations. Mutagenicity.
3. **Release of POPs:** changes in feeding behavior, movement and growth.

4. DEGRADATION & INTERACTION WITH MICROORGANISMS

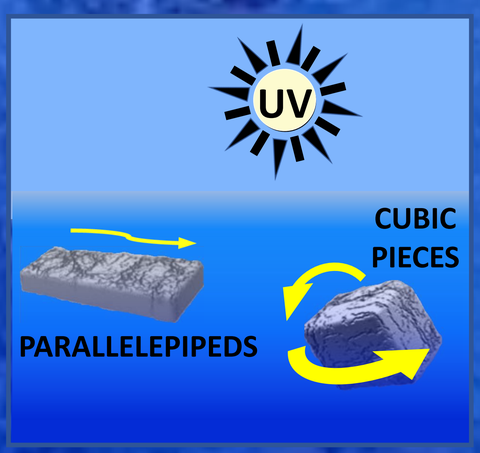


Figure 5: Adapted from Ter Halle et al. 2016.

Figure 6: Adapted from Rummel et al. 2017.

Abiotic degradation precedes biodegradation. Intra and extracellular microbial enzymes degrade plastic. Plastic particles can modify the biological behavior of some species and due to their ubiquity, they can also transport invasive species.

5. FISHERIES & AQUACULTURE

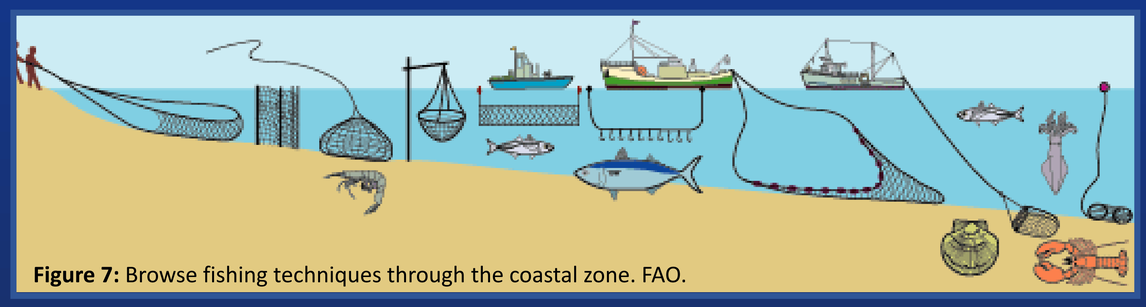
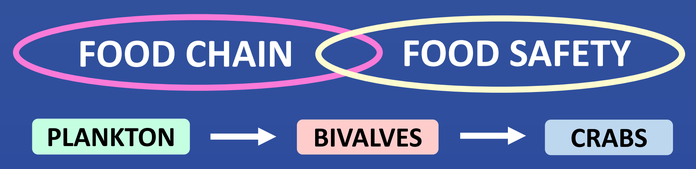


Figure 7: Browse fishing techniques through the coastal zone. FAO.

One of the sources of microplastics are the elements used in fisheries and aquaculture. Microplastics are released to the marine environment through degradation of fishing nets, facilities cleaning, removal of biofouling organisms or from perforating forms of isopod crustaceans that excavate plastic elements.

6. FOOD SAFETY & FOOD SECURITY

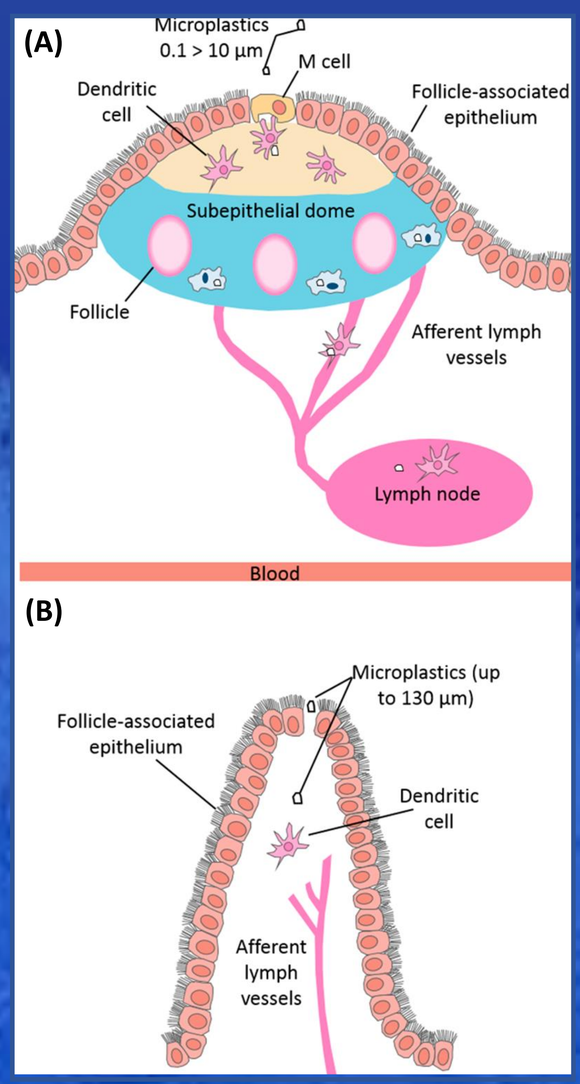
Sea products consumed with their own digestive tract such as bivalves, filtering organisms and small fish, are the main potential sources of microplastics for humans from marine foods. Fishmeal and fish oil from small fishes such as sardines and anchovies contain microplastics. Carnivorous species of fish that require fishmeal may be exposed through their food. Sea salt also contains microplastics.



Bivalve depuration: Faecal bacteria, biotoxins and pollutants removal.

Diagram 1: Microplastics are present in plankton, organisms at the base of the food chain. Trophic transfer occurs in the Green crab (*Carcinus maenas*) from the ingestion of mussels (*Mytilus edulis*).

7. PREDICTIVE MODELS OF TRANSLOCATION



Predicted pathways of microplastic uptake from GIT lumen:

(A) Via endocytosis by the M cells of the Peyer's patches.
M cells capture and transport microplastics and particles from the intestinal lumen to the mucosal lymphoid tissues.

(B) Via paracellular persorption.
Microplastics and non-degradable particles can cross the junctions of the epithelial layer. Dendritic cells are able to phagocytose this particles, moving them to the underlying lymphatic vessels and veins, in such a way that they can reach secondary tissues.

Figure 8: Wright and Kelly 2017.

8. CONCLUSIONS

Microplastics, especially nanoplastics which can cross cell membranes, can cause toxic effects on organisms. Sea products polluted with microplastics could represent a problem of food safety and public health. Seafood consumed with its own digestive tract is the main source of concern although bivalve depuration is not currently focused on the removal of microplastics. It is necessary to determine with more accuracy the sources of microplastics and implement a better control of the emissions. The interactions of microplastics with the environment and all living organisms must be better understood.

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