MICROPLASTICS IN THE OCEANS

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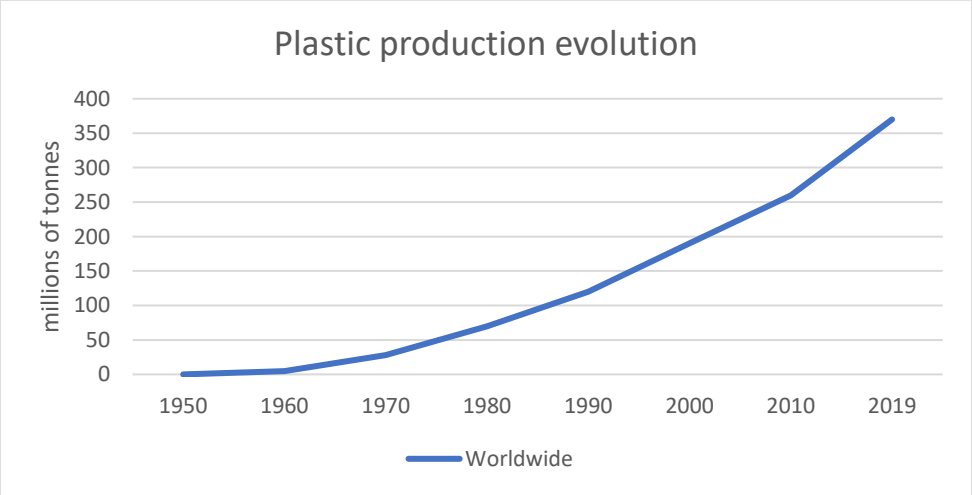
Introduction

Since the invention of plastic and his numerous benefits the numbers of production has been increasing until forming today five continents of plastics being 3 times bigger than France. The disintegration of this plastics lead to microplastics becoming invisible for humans and living organisms in general and stand out being one of the bigger threat for these animals reverberating on us, humans. How can we prevent and apprehend this danger becoming more and more big each year?

The impact of the use of plastic on the oceans

How plastic has evolved in our life

Since 1950, the use of plastics has increased once for the low price of the fabrication but also the practicality: light, mouldable, transparent, coloured. Basically, everything is possible with plastic. [1] Furthermore, with the pandemic occurring since 2019, personnel protective equipment such as mask composed principally by plastic became a substantial threat for our environment and oceans. [2] According to scientist, approximately every individual on Earth generates 4.8 kg of plastics that will end up in the oceans. On a larger point of view, these numbers result to 36.8 million tons of plastic from 368 million of tons produced in 2019 will land in the oceans. [1]



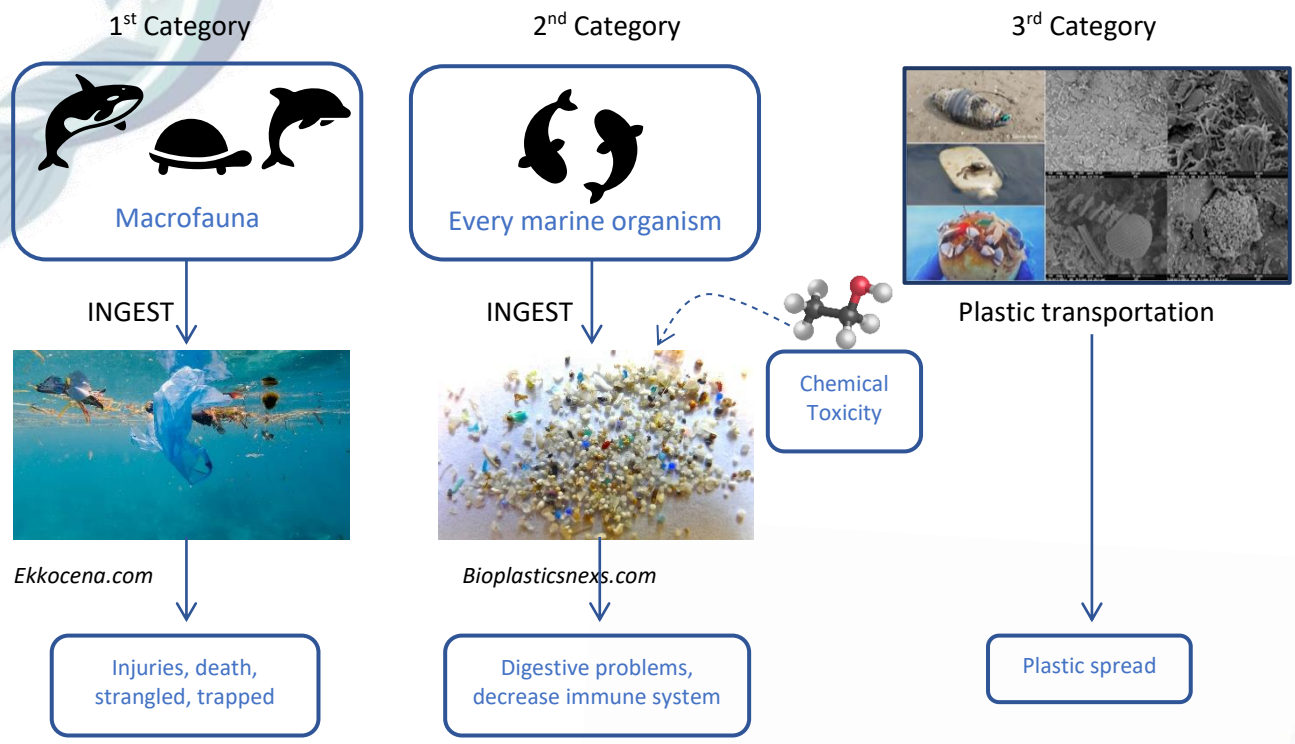
The bigger quantities of microplastics had been found in Africa, Asia, India, Southeast Asia, South Africa, North America, and Europe.

The impact on living organisms

Microplastics has affected a wide spectrum of marine organism creating trouble in the food chain. With time, the plastic never goes away, it will only breakdown with ultraviolet and become almost invisible. The microplastics (5mm) become extremely easy to ingest by a large range of organisms in the marine life. With the evolution of the organisms, they are confronted to health affectations such as: pathological stress, false satiation, reproductive complications, blocked enzyme production and even reduced growth rate.

Mostly, marine organisms mistake the microplastics with food or microorganisms. [3] Not only the marine animals are impacted but also the coral reef which represent the most biodiverse ecosystems on our planet and maintains our natural resources' harvesting. That's should make sense to protect this area before anything else. As time goes by, coral reefs bleach and disappear. The most known coral reef situated in Australia has been part of a study putting in evidence an emerging concern. The presence of plastics has been found in over 50 sampling sites with an average of 4256 items/km². Even coral can ingest microplastics or nano plastics leading to health problem but also it influences the energetics, growth, and photosynthetic performance.[4]

Today, we can estimate the number plastics waste in the oceans reaching 4 to 12 million of tons and 90 % are microplastics. 3 big categories are impacted from this invisible pollution.



The first is linked to plastic affecting the macrofauna. The respiratory tracts and the digestive system are obstructed but also the animals are trapped and strangulated leading to injuries or even death.

The second category is linked to microplastics, very easily ingested from the smallest to the biggest organism, from zooplankton to the biggest marine mammals. Once these particles are ingested, physic interaction occurs in the digestif system and also chemical toxicity due to the salting-out from toxic molecule from plastics to animals. These toxic molecules are either plastic additive or contaminant present in the environment such as oils, PCB, and pesticides. They are adsorbed by plastics in the ocean because plastics are sponges. In both cases, physic interaction or chemical toxicity, the main consequences are seen in the digestive system: animals are not able to eat properly and assimilate food. This will affect the energetic system and even growth, reproduction, and immune system.

Finally, the third category is the carriage from an organism living in one area of the world and lands at an other area because of the transportation with plastics in the ocean. [5]

The case of the oyster's experiment

Different experiment has been the subject of the marine animal's behaviour.

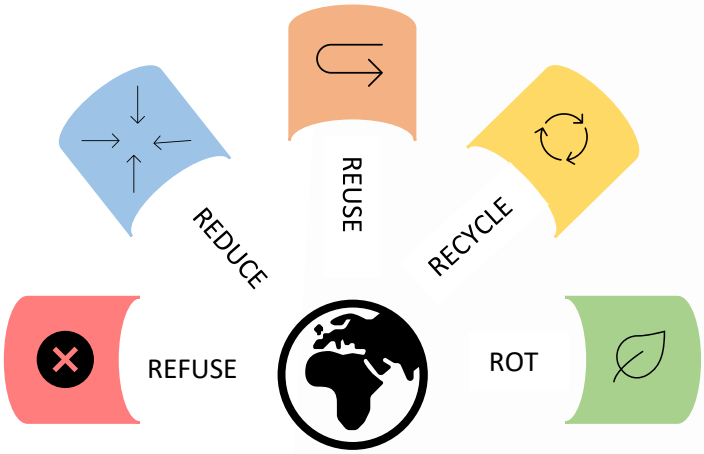
"For two months, in experimental tanks, we exposed oysters to polystyrene microparticles. We used micro-plastics of the same size as the plankton that oysters usually feed on," underlines Rossana Sussarellu, biologist at Ifremer, member of LEMAR during the study. "After two months of exposure to this pollution, the oysters produced fewer eggs, and these were smaller in size. Similarly, their spermatozoa were much less mobile compared to those of oysters placed in tanks without microplastics," explains Marc Suquet, biologist at the Invertebrate Physiology Laboratory, Ifremer Bretagne Center in Brest, member of LEMAR.

"Fertility decreased dire with consequences for the next generation," notes Arnaud Huvet, biologist at the Invertebrate Physiology Laboratory, Ifremer Brittany Center in Brest, member of LEMAR. "The fertilization rate compared to unexposed oysters was 41% lower. The larvae produced were about 20% stunted. » [6]

Various fragments of plastic are inexorably found on our plates, and we ingest them on a daily basis. They release endocrine disruptors into our body. The observation is clear and encourages the implementation of solutions quickly. [7]

Solutions that lie on the land

First of all, the producers and consumers should adopt the guidelines of the 5 Rs which suggest an environmentally friendly manner to handle our waste: Refuse, Reduce, Reuse, Recycle, Rot.[8]



Industrials have to lower their reject and favour to recycled plastics which can be recycled to form a circular use. The principal goal is to sensibilize every employee, so that no plastics residues end up in our oceans.

How cosmetics brands are dealing with plastics

Many polyethylene or polypropylene micro-beads end up in the oceans because of cosmetics, cleanser, and toothpastes. Several recent studies analysed the impact of these microbeads on aquatic ecosystems. The latest: Ifremer shows how polyethylene micro-beads disrupt the reproduction of Pacific oysters. There is, however, a simple solution to reduce this pollution: ban micro-beads in cosmetics. The United States has just passed the milestone. At the end of 2015, they adopted a law which will ban the use of these products at the beginning of 2017.

The European Union could soon follow suit. Several manufacturers did not wait for the entry into force of this ban to act. At the end of 2012, Unilever announced that they were going to stop using plastic micro-beads in their cosmetic products by 2015. Since then, other companies have followed suit: Colgate-Palmolive, L'Oréal, Clarins, The Body Shop, Lush, etc.

Upgrade the wastewater treatment

To reduce the discharges in the oceans and rivers as much as possible, it is therefore necessary to tackle this pollution at the source. The first step is to improve wastewater treatment so that treatment plants retain as much of these microplastics as possible.
In France, things are evolving. The energy transition law for green growth provides for the banning of single-use plastic bags on July 1, 2016, and the banning of plastic bags on January 1, 2020. To improve the recycling of plastics, sorting instructions will be extended to all plastic packaging, by 2022 at the latest. The law also provides for a reduction in the dumping of plastic, in favour of energy recovery.

The majority of the plastic fragments already present at sea and all the waste that has sunk to the seabed will remain in the oceans. To prevent this pollution from continuing to intensify, it is essential that consumers change their behaviour. Collection projects at sea are complex, hence the importance of mobilizing on land to change behaviour. Various awareness campaigns or clean-up operations are organized by Surf Rider Foundation, Mer Terre, Vacances Propres, Let's do it… and many local associations. Cleaning up the beaches is an important step to reduce the amount of plastics in the oceans. With the motions of the waves, plastics on the beaches will be carried away.

Changing the behavior of citizens firstly involves not throwing a single piece of waste into the environment. It supposes understanding that any action can have an impact on water pollution: a cigarette butt thrown into the gutter, cosmetics containing micro-beads or the washing of synthetic clothes... [9]

Change the plastic component

For several years, research has focused on the development of sustainable biobased polymers, obtained from renewable resources, while being both persistent and therefore difficult to degrade. Thus, replacing carbon of fossil origin with biosourced, so-called renewable or "short-cycle" carbon, can be considered as a relevant strategy for limiting greenhouse gas emissions, the repercussions of which on climate change are today. real today. Nevertheless, obtaining sustainable biosourced materials is far from being neutral from an environmental point of view, justifying the many reservations expressed regarding the availability of agricultural resources, the competition in the use of resources as well as the risks of deforestation and depletion of water resources that they could cause. In addition, the substitution of plastics from petrochemicals by their biobased counterparts does not solve the problems of pollution and accumulation of plastics in the terrestrial and aquatic environment.

Given the magnitude of the cumulative phenomena generated, it now seems essential to succeed in reconciling these two aspects, by also focusing on the end of life of these materials and favoring more virtuous end-of-life scenarios. Numerous studies have been initiated in the world of academic and industrial research to bring out and develop new polymers whose time of resistance to biodegradation would be equivalent to the time of use.

Plastic waste from these so-called "biodegradable" materials would thus have the advantage of being able to biodegrade in situ (water, soil, compost), which appears to be a particularly relevant strategy in the case of plastic waste that comes out of the collection channels. Afterwards to become litter, the source of contamination of all ecosystems, and the marine environment in particular.

Finally, in order to be able to compete with and replace conventional plastics, these new materials, biodegradable and biosourced, will have to meet certain requirements in terms of functional and use properties (ductility, thermal stability, balanced mechanical properties, permeability reduced, slow crystallization, ability to be shaped by extrusion and/or injection, etc.). [10]

Different operations off the oceans

Cleaning projects

Despite all the goodwill in the world, micro-fragments will continue to pollute the oceans for decades to come. Going against the tide of often fatalistic statements, relying solely on awareness to reduce discharges, several projects aim to directly attack the pollution floating on the surface of the oceans. The most publicized project is Ocean Cleanup is led by the young Dutch Boyan Slat. His idea is to deploy a series of floating barriers, a sort of giant funnel, concentrating and bringing the debris back to a platform capable of processing it. Its solution will attack macro-waste floating on the surface of the oceans but will intercept only a few floating micro-plastics.

This non-profit organisation is developing technologies to one day be able to get rid of plastics in the ocean. This can only happen once the amount of plastics thrown on the ocean is inferior to the numbers of plastics being cleaned-up. This operation will mostly impact the plastics but not the microplastics due to their minimal size.

A project could complete Boyan Slat's solution for removing micro-fragments of plastic located on the surface. This is SeaVax, a boat powered by solar and wind energy, developed by the company Bluebird Marine Systems LTD. A prototype is under development. According to these designers, a SeaVax vessel should generate enough energy to process 89.9 million liters of seawater. In a soup rich in micro-plastics, it could suck up and store 150 tons of plastic debris per trip. SeaVax aims to have treatment sites on land, with industrial partners.

Biological answers

In mid-March, a discovery made by Japanese researchers, published in Science, made the headlines in the newspapers: a bacterium would be able to eat plastic and break its molecular bonds! The media have seized on the subject and shared the enthusiasm of researchers who see in it the possible end of

marine pollution. While the bacteria discovered only attacks polyethylene terephthalate (PET), the researchers aim to discover other bacteria that degrade other plastics. Despite many potential industrial applications, this solution would not help fight plastic pollution in the oceans. “Is it reasonable to think that spraying millions of tons of genetically modified bacteria on the surface of the ocean will wipe out the 7th continent with no effect on the marine environment? asks the 7th continent expedition. [9]

Plastic gasification

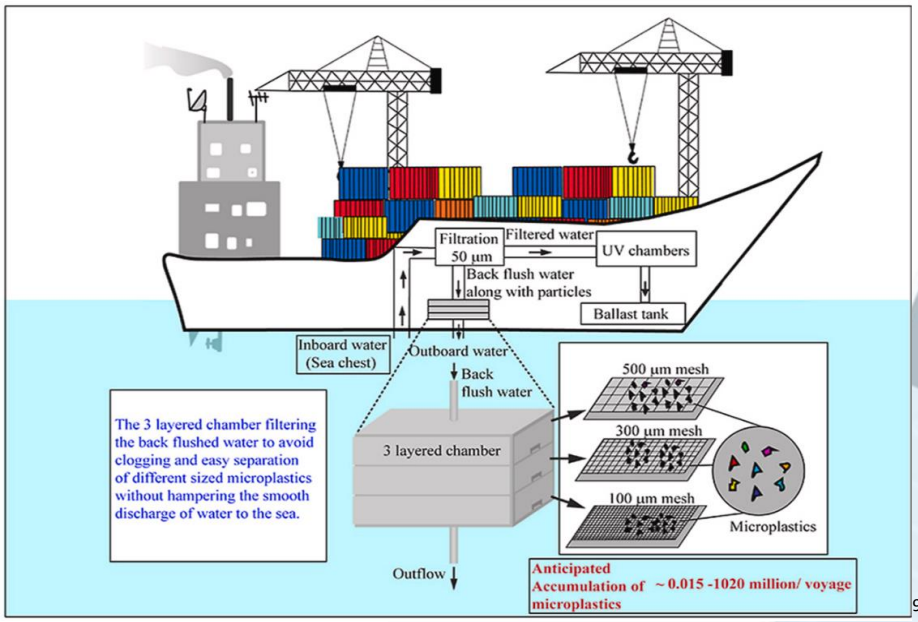
The only lasting solution is indeed to act on dry land, near the source, to prevent the plastic from entering the water. In this perspective, the Race for Water Foundation would like to develop small plastic gasification units for the production of electricity. “A five-tonne unit can transform 1680 tonnes of plastic waste per year into 3500 megawatt hours of energy. That's enough to cover the electricity needs of 2,000 islanders,” reports Swissinfo. The Foundation hopes to use this technology to launch a pilot project on Easter Island at the end of 2016, before extending it to other islands and to coastal towns, the main sources of ocean pollution. [8]

Ballast water transport is considered to be one of the major vectors of microplastic diffusion in the world's oceans. This technique suggested a simple and inexpensive solution to reduce microplastic contamination and its mobility through ballast water.

It has been proposed to attach a screen chamber (using a 3-layer stainless steel mesh) to the existing ballast water treatment system of the cargo ship to filter the backwashed seawater from the BWTS. The 3-layer sieve (500, 300, 100 µm) prevents clogging and not only easily separates microplastic particles of different sizes, but also contributes to the smooth drainage of water into the sea. This technique is expected to remove large numbers of microplastic particles (range 0.0015 to 1020 million) in a single trip.

The proposed chamber will help collect 0.0003-204 tonnes of particles per day, depending on the geographic location of the ballast in the world's oceans. These estimates were made taking into account the daily sales of ballast water worldwide of 0,033 billion tonnes. Attached to the existing BWTS of a cargo ship, this proposed screening chamber, along with other region-specific marine purification initiatives, will help reduce microplastic pollution in the world's oceans. [11]

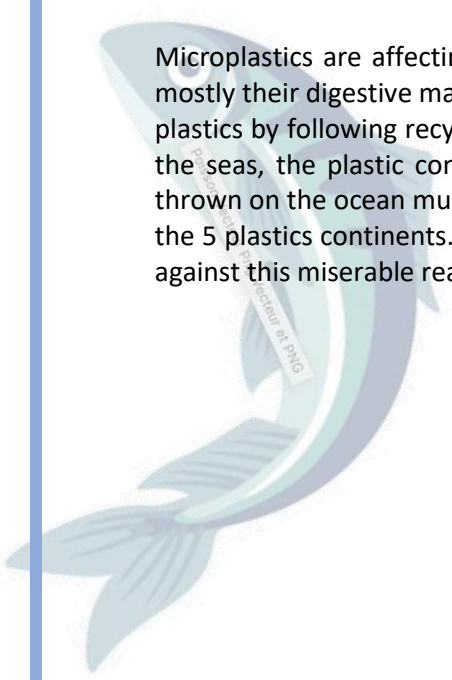
The illustration bellow explains the functioning.

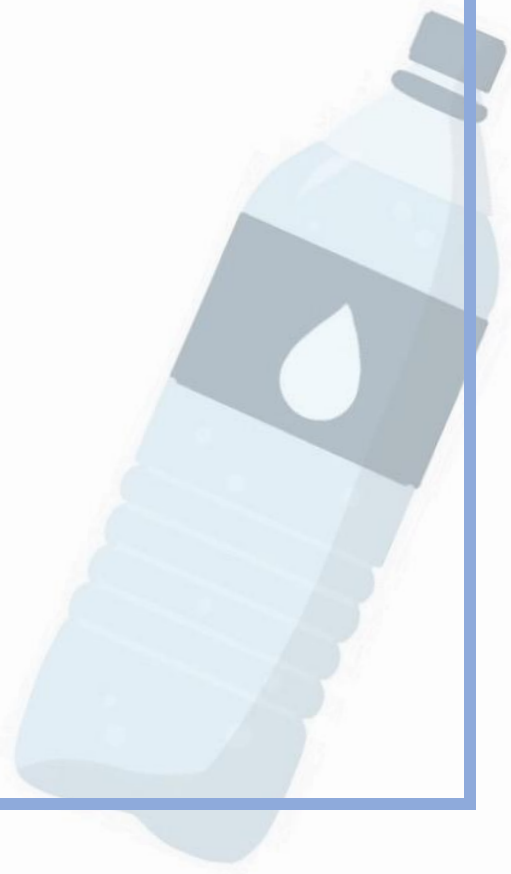


[9]

Conclusion

Microplastics are affecting the life of the marine animals by disturbing their habits, behaviour and mostly their digestive manners. To stop this nonsense, we have to limit the numbers of production of plastics by following recycling and be more vigilant with the reject of water in the natural habitat. Of the seas, the plastic continent must retrieve to land in recycle industries. The amount of plastics thrown on the ocean must be inferior to the numbers of plastics being cleaned-up to make disappear the 5 plastics continents. Hopefully, the future will bring new ideas and innovative solutions to stand against this miserable reality.





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