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How far has our waste gone?

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Jellyfish are ancient and fascinating marine zooplankton organisms with a design that has survived more than 500 million years. They play an important ecological role as an energy source in oceanic food webs and in the ocean's carbon trophic transfer system. Jellyfish also constitute an alternative group of top predators, which is gradually becoming one of the most dominant predator groups in the ocean (Graham et al., 2014). *Pelagia noctiluca*, commonly known as the mauve stinger, is a species of holoplankton scyphomedusa with a wide Atlantic and Mediterranean distribution.

It is well recognized that jellyfish play an important role in the marine food chain and that they do not constitute a trophic dead end. They feed mainly on a large variety of zooplankton, fish eggs, fish larvae, different fish life-stages, as well as other members of pelagic ecosystems (Chiaverano et al., 2018; Purcell and Arai, 2001). On the other hand, they serve as food for various invertebrates, fish, seabirds and sea turtles (Hays et al., 2018).

P. noctiluca frequently appears along the coasts of the Canary Islands in the subtropical Atlantic. These jellyfish are exposed to climate and physical forcing that control their circulation near and offshore. Similar mechanisms control the circulation of surface water plastic debris. Both, jellyfish and plastics share time in the surface waters, aggregate and periodically strand in coastal areas. In particular, the Canary Islands are exposed to the circulation of material transported by the Canary Current. In this region of the subtropical gyre, the sources of the surface water, and its associated material, transported southward are: the North Atlantic, the Mediterranean and even water from the other side of the Atlantic transported by the Gulf stream. Jellyfish and plastic are probably both forced by this surface circulation to converge in the Canary Islands where their beaches experience strandings of both allochtonous *P. noctiluca* and exogenous marine plastic debris (Herrera et al., 2020).

Recent papers have reported jellyfish ingestion of macro and microplastics (Macali et al., 2018). Macali and Bergami (2020) have even proposed that jellyfish could serve as an innovative bioindicator for plastic pollution. It was also suggested that plastic, associated with jellyfish, may serve as an alternative pathway to expose numerous diverse jellyfish predators to plastic ingestion besides direct ingestion. Here, our photo of *P. noctiluca* ingesting a large disk of plastic supports this proposal (Fig. 1).

Thompson et al., 2004 asked the big question, “Where is all the plastic?” We know that plastics are found in all marine environments, on beaches, on the sea surface, in the water column, on the seabed and in marine sediments (Lusher, 2015). The presence of plastic has already been documented in mammals, birds, turtles, fish and, to a lesser extent, invertebrates, thus, another possible answer would be that some of the plastic that enters the ocean is inside marine organisms. However, at present, there is no clear estimate of the amount of plastic that could be inside complete food webs. A recent review article on the ingestion of microplastics by marine vertebrates indicates that the group most affected by microplastics are the turtles, 88% of the specimens studied were contaminated with an average of 121.7 particles per individual,

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Fig. 1. Photo Alicia Herrera Ulibarri. Jellyfish *Pelagia noctiluca* photographed in Canary Island waters with a big plastic piece inside.

Fig. 2. Photo Alicia Herrera Ulibarri. Photograph of a mask floating in the coastal waters of La Graciosa island, Canary Islands.

the rest of the groups present very similar values: 42% of the fishes, 59% of the marine mammals, and 50% of the sea birds affected (Ugwu et al., 2021).

We still do not know the total number of different species affected -up till now, almost all the marine species studied-, nor the retention time, nor do we even know with certainty the impact that plastic is having on the health of marine organisms. What we do know is that between 4.8 and 12.7 million tons of plastic reach the sea every year (Jambeck et al., 2015), that in the areas of greatest accumulation there is more plastic than plankton (Herrera et al., 2020; Moore et al., 2001) and that the small plastic fragments (microplastics) carry high levels of chemical pollutants associated with them, including DDT, PCBs and UV filter derivatives from our sun creams (Camacho et al., 2019).

Plastic pollution is a problem of global dimension to which we have not yet found a solution. The "Age of Plastic" has its fossil record that will account for the human presence and the exponential increase in its consumption of plastic since 1945 (Brandon et al., 2019). We are the only species that generates waste, and we still do not know how to manage it properly. More than 79% of the plastic waste we generate still remains in the environment (Geyer et al., 2017), and it is likely that a large percentage has been incorporated into food webs and is found inside organisms. The photo of *Pelagia noctiluca*, an organism of singular beauty, is the tangible proof of this (Fig. 1).

Jellyfish, fish, turtles and seabirds are clear biondicators of marine pollution by plastic, more than hundred scientific studies have been published reporting this incidence (Ugwu et al., 2021), but actions regarding the prohibition of single-use plastics are being slow and ineffective; it is not clear that the replacement of plastic polymers by "biodegradable" plastics is the solution, for example in the sea the conditions are not suitable for the rapid biodegradation of the product, so they continue to impact and damage marine life. A biodegradable bag or balloon could remain in the sea for many days, during which time it would cause the same damage as conventional plastic.

In addition, nowadays plastic has had a resurgence due to the global pandemic caused by the coronavirus, logically, because its usefulness in the production of personal protective material and medical ware is unquestionable. However, the inadequate treatment of all these disposable products turns them into a new source of marine pollution (Canning-Clode et al., 2020; Gallo Neto et al., 2021) (Fig. 2).

The solution is not to continue manufacturing single-use products, whatever the material, the solution is to make efficient use of natural resources and make products that last over time. The solution is a change of mentality, the throwaway culture has put us in this critical situation, and this is what we have to change. In less than 70 years since the beginning of large-scale production of plastics, our wasteful habits have been impacting an increasing number of ecosystems. We must make rational use of this material so that it does not harm -more than it already has- marine biodiversity. We cannot continue to ignore this serious problem and we cannot look the other way without asking ourselves "How far has our waste gone?"

CRediT authorship contribution statement

A.H. wrote the manuscript. All authors have been involved in the reflection and have reviewed this opinion article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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