SARGASSUM, A COMPLEX PHENOMENON

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Pelagic Sargassum occurs in tropical and subtropical areas of the North Atlantic and provides essential habitat for more than 120 species, playing an important ecological role in coastal areas. However, the massive influx of sargassum causes damage through accumulation and decomposition, affecting coastal ecosystems, tourism and human health.

Initial description of the phenomenon

Sargassum is a group of marine macroalgae, of the genus Sargassum, which are brown, black and green in color, with different textures (curled, rolled, lamellated, matted) and can occupy large areas in a wide variety of habitats.
Some species of Sargassum have gas-filled vesicles that allow them to stay afloat in the ocean and thrive. The most representative species of Sargassum that make up the floating mangroves are: Sargassum Natans (Linnaeus) and S. Fluitans (Børgesen).

Sargassum in the ocean functions as habitat, refuge and feeding or spawning site for several marine species that use these macroalgae as a means of food, protection and transport. It has been observed that the biomass of floating mats can reach up to 20 million tonnes live weight over 8,850 km in the Atlantic. This phenomenon of massive Sargassum accumulation has been named the Great Atlantic Sargassum Belt (Wang et al., 2019).

Massive upwelling of Sargassum, an ecological problem

Sargassum patches pass through different Caribbean countries, from the coasts of Brazil to Mexico, and can become an important ecosystem that allows the spatial distribution of many species to expand, leading to ecological changes and the introduction of invasive species. Ocean currents and winds are two factors that influence the arrival of these macroalgae on the coasts. In 2010, a new area, known as the new sea of Sargassum, was discovered where conditions triggered the bloom (Wang et al., 2019) in the South Atlantic region, off the coasts of Brazil and Africa.

Since 2014, there have been massive arrivals of Sargassum on the coasts of the Mexican Caribbean. This has been deteriorating the environment, damaging beaches and affecting the tourism sector, which is one of the country's most important sources of income.

In 2015, an accumulation of Sargassum was estimated at 2360 m3 per beach kilometer per month. In an effort to control this massive influx, some measures have been implemented to collect it at sea before it reaches the coasts, or by means of the collection of accumulated Sargassum on the beach.

The impact of this phenomenon has been both economic and social in the wider Caribbean region; in particular, it represents an abrupt problem for tourism. Faced with the social, economic and environmental threat posed by the massive arrivals of Sargassum, affected countries have responded with short-term actions and intuitive approaches, such as manual collection or the use of machinery on the beach. However, the latter measure is not ideal, as it compacts sand, modifies beach profiles and can destroy turtle nests. Another recurrent strategy is the use of sea barriers to contain and collect Sargassum before it reaches the beaches; however, the barriers tend to break or become dislodged and drift towards the beach, which puts the reefs at risk. In addition, the collection of Sargassum without an adequate protocol affects the aquifer, due to the infiltration of leachate (NOM-083-SEMARNAT 2003) as the macroalgae decompose in the disposal area.

Therefore, the scientific community is facing a very complex scenario which requires a lot of effort in order to understand the phenomenon and to propose strategies for Sargassum management. In 2017, 11.523 000 tourists arrived in the Mexican Caribbean, attracted by the scenic beauty not only of the beaches, but also of the Mesoamerican reef system (the second largest barrier reef in the world). However, they encountered a scenario of natural and economic "disaster". This represents an enormous challenge, but it is also an opportunity to generate and promote a new tourism model in which sustainability is the central axis of development.

Affectations in the Mexican Caribbean coastal area

The water of the Caribbean Sea is low in nutrients and organic matter, which maintains the ecosystemic functioning and balance of coral reefs. However, the enormous amount of Sargassum that reaches the coast - around 200,000 tonnes per year (SEMA, 2018) - accumulates and decomposes on the beach, causing alterations in the quality of the environment. Recent events of atypical influx and increased Sargassum biomass have been linked to high nutrient concentrations in the water. Likewise, the decomposition of Sargassum on the beach allows the proliferation of bacteria that, as a consequence, can alter the water chemistry, resulting in the death of fish, crustaceans, turtles and small sharks due to the generation of anoxic conditions (Rodríguez Martínez et al., 2020). It is not yet fully understood how the presence of these macroalgae modifies the chemical conditions of sub-surface water and coastal areas. It is therefore imperative to determine the impact of the massive upwelling of Sargassum on water quality and biodiversity.

The decomposition of Sargassum in shallow water generates hydrogen sulphide, which causes the temperature to rise by 3 to 4 °C; this destroys the habitat of fish, crustaceans and molluscs, as well as inducing the loss of reefs (Louime et al., 2017). The effect of Sargassum decomposition led to the hypothesis that this phenomenon could be the origin of the arrival of the pathogen that caused white coral syndrome in the Caribbean. However, although this is a very interesting explanation, it has not yet been fully tested.

Tackling the Sargassum problem

A comprehensive understanding of the problem of the massive arrival of Sargassum and its sequences in the coastal zone is essential, as is an understanding of the community structure of Sargassum-associated species and the contribution of invasive species associated with the phenomenon.

Given the conditions of karstification In the Yucatan peninsula, the generation of leachate as a result of the decomposition of Sargassum and its release into the open air at sites where it is deposited without adequate containment is the source of many toxic substances and pollutants that infiltrate into groundwater, affecting its quality and potentially having important repercussions for public and ecosystem health.

The Sargassum phenomenon in the region requires comprehensive solutions in the short, medium and long term. However, due to the urgency of solving the problem, quick "solutions" have been proposed that have more to do with cushioning the scenic effects. These measures correspond to the collection of Sargassum on the beach and its final disposal in inland areas - mostly clandestine dumps. A comprehensive vision and interest from various levels is needed to secure investment funds for basic and applied research, with which we can understand the effects of Sargassum upwelling and generate concrete and innovative solutions to use these macro-lakes in a sustainable way. This will allow us to move from a complex phenomenon to a real opportunity for development.

We are facing an uncertain environmental future, but the best solution will always be prevention. The scientific community needs to concentrate on finding solutions as sargassum continues to accumulate. For the time being, the academic consensus has focused on proposing offshore rather than coastal collection; however, the installed capacity for this is still in its infancy. On the other hand, the most advanced technological proposals for the use of Sargassum are aimed, among others, at obtaining plastic wood, generating biofuel and - most notably - obtaining raw materials for the chemical and food industries; this last approach has the greatest potential.

Leachate
Liquid formed by the reaction, entrainment or filtration of the materials constituting the waste, contained in dissolved or suspended form.

White Syndrome
Generic name for a lethal disease affecting more than 20 species of scleractinian corals that is causing mass mortalities on Caribbean reefs (Sociedad Mexicana de Arrecifes Coralinos).

Anoxics
When an environment lacks oxygen. In the aquatic environment, contamination by organic substances promotes intense bacterial growth that consumes the oxygen dissolved in the water

Karstification
Indirect dissolution of calcium carbonate from limestone rocks, due to the action of slightly acidic water. This erosion creates a landscape with formation of dolines (cenotes), product of the dissolution, fractures and conditions of other hydrogeological systems.

Anoxics
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