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Editorial

Aquatic Pollutants: Risks, Consequences, Possible Solutions and Novel Testing Approaches

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It is undeniable that there is a wide variety of pollutants in the various water bodies around the planet, including organic and inorganic compounds, pathogenic microorganisms, and microplastics. The existence of these aquatic pollutants has a direct impact on the survival and well-being of all species that are present in these habitats and poses, directly or indirectly, a risk to human health. Although the origin of these pollutants has already been identified in most situations, the study of their effects, in the short and long term, as well as the best solutions to prevent or avoid the adverse consequences of pollution, remains a challenge for researchers.

Human activity, both at the agricultural and livestock production level and at the industrial level, has a profound impact on water pollution [1]. In addition, the use of detergents, pharmaceuticals and other health products and substances in our daily lives also contributes to the increased concentration of various pollutants that affect aquatic life. Currently, many effluents discharged into the aquatic environment are still not subject to appropriate prior treatment that ensures the removal of all these potentially toxic substances. Although much progress has already been made in the treatment of various types of effluent, many compounds are still identified that resist the process and continue to be discharged into the water [1,2].

The identification and quantification of all potential toxic substances requires that analytical techniques continue to evolve, because many of these pollutants can have a significant negative impact on aquatic species and humans, even when present in very low concentrations (possibly below the detection level of currently available analytical procedures), such as heavy metals [3–5]. Heavy metals are also a good example of substances that can bioaccumulate along the food chain [4,6,7], making them a particularly great risk to humans, who consume not only drinking water, but also various aquatic species in which the levels of accumulated pollutants may be particularly high [8].

An endocrine disrupting compound (EDC) is an "exogenous substance or mixture that alters the function(s) of the endocrine system and causing adverse health effects in an intact organism or its progeny, or (sub) populations" [9]. This group of substances have become an important target for research, considering not only their various negative impacts that have been identified on various species, including humans, wildlife and laboratory animals, but also their worldwide distribution in water, and therefore their degradation/removal from the environment constitutes an urgent need [9–11]. This family of compounds includes the naturally occurring estrogens, excreted in large amounts by humans and animals, and, consequently, present in domestic sewage and animal waste, as well as several synthetic molecules [11], some of which are used as drugs, in therapeutic approaches.

In fact, pharmaceuticals constitute a group of emerging pollutants that demonstrate biological activity and that persist in the environment, with some regions presenting worrying concentration values of some of these products in water [12]. A recent review showed that many studies have been carried out on this subject, focusing more on fishes and mollusks, but less is known about the impact on crustaceans and algae species. Regarding the groups of pharmaceuticals studied, there are relevant differences in terms of the available data, with some drugs (e.g., anticancer drugs) still being poorly studied. Additionally, it was reported that water characteristics may have specific impacts on the effects and bioaccumulation of these compounds, which implies that the study design to evaluate these effects may be relevant [13].

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Many other groups of equally relevant compounds in terms of their impact on the aquatic environment could be mentioned. Of these, we can highlight the presence of microplastics in water, since it has only been recognized and subject to intense investigation in the last decade, constituting a global threat, as their presence has been detected even in remote regions of the planet, with no human activity that could explain their presence. Microplastics are difficult to degrade or eliminate from the water, and it is already known that they can absorb other pollutants. When entering the food chain, they become an important risk factor for all species through water and food exposure, which cannot be ignored [14]. As this is still an emerging issue, there is a lack of reference methods to properly collect and analyze samples to assess the degree of pollution and risk that microplastics represent [15].

The removal, biodegradation or inactivation of all pollutants present in the aquatic environment is an urgent global need, and all environmentally friendly treatment processes that can be described and demonstrated to be effective, with low costs and elevated capacity to remove pollutants, will make an important contribution to solving the environmental crisis we are experiencing. Examples of procedures that have shown promise for this purpose include chemical, biological, physical, and hybrid techniques, although some constraints still need to be overcome before these methods can be implemented in water treatment plants [1,2,11,14,16–18].

Monitoring and assessment processes of aquatic pollution levels and their effects are indispensable to determine the possible worsening of the situation, in terms of environmental impacts. The use of non-invasive models, such as the use of fish scales [19] or more innovative models including "omic" techniques or machine learning processes [20–22], represents an important contribution to the success of this task. However, we still lack information about the most suitable organisms and/or analytical procedures to assess the toxicity of many pollutants, as well as more detailed information about the types of pollutants and their concentrations in many locations. Another aspect that has been scarcely studied is related to the possible synergistic effect that can result from the presence of mixtures of compounds in the same regions [12]. Increasing available data by studying less evaluated regions, species, and pollutants [15,23] represents a very important contribution to combating the negative impacts of pollution, as well as to defining methods to avoid and/or control these impacts. It would be desirable if the periodic monitoring of the evolution of pollution levels could reveal a positive effect of any prevention and/or treatment measures that are being implemented, globally, including the application of appropriate legislation and more efficient technology.

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