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Difficulties in Comparison Among Different Microplastic Studies: The Inconsistency of Results and Lack of Guide Values

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In the literature and in international media, there has recently been considerable interest in microplastics in recent years. Microplastics are the result of the constant disposal of plastic waste in aquatic ecosystems, which are commonly fragmented by weathering into smaller particles whose sizes vary between 1 μm and 5 mm. They can also originate in the plastics industry, such as fibers from industrial textile washing, the plastic pellets that are the raw material of manufactured plastic objects, and the microspheres used in the cosmetic sector.

Because of their abundance in environmental compartments and biota, it is essential to determine the ecological and human health impacts and risks of microplastics. In addition, such research could put pressure on stakeholders to take action to combat the irregular disposal of solid waste into the environment; such study is also fundamental for monitoring programs. However, how can we assess microplastic pollution if there are no guidelines for conducting studies on their abundance?

Intuitively, we accept that the presence of microplastics in the environment is undeniable, and that it is necessary to set limits on the levels of microplastic pollution. Researchers have established several analytical methodologies for use in the laboratory, ranging from the simplest and most rudimentary to the most sophisticated (which are not always available for reproduction). These different techniques allow for different forms of data representation, leading to inconsistency of the results and making it difficult to compare them between different studies. Moreover, different sampling sites, geographical regions, ecosystems, and biomes also lead to a variety of field sampling methodologies, and the lack of a consensus in defining the size of microplastics makes it even more difficult to compare studies.

When reporting the density of microplastics in environmental samples, some authors use the term "high" for microplastic pollution. However, high in relation to which parameter? Compared to what? Different studies use different units and methodologies (i.e., it would not be correct to compare the total amount of microplastics with the number of plastic particles per gram of sediment). At least eight different units are used to report microplastic pollution in water and sediment samples (Lu et al., 2021), which leads to the presentation of the results in totally different ways, which can be misinterpreted.

What is needed is standardization with an environmental quality index according to the quantity of microplastics found in a certain area. Alkalay et al. (2007) propose the use of plastic debris as a beach cleanliness indicator, that is, the Clean-Coast Index (CCI), because plastic represents approximately 90% of the total marine debris. However, this index only considers debris larger than 2 cm, which does not include microplastics. Fernandino et al. (2015) adapted the CCI for plastic pellets, as the Pellets Pollution Index (PPI), but without taking into account the new proportions for plastic debris when considering debris smaller than 2 cm. Thus a new index should be standardized considering the sampling unit (area, volume, or mass) that corresponds to the sampling matrix (water, sediment, or biota) and the polymeric density ranges of the main plastics found in the samples. In addition, an index is required for each type of microplastic, either fragments or fibers/lines, because both are morphologically different and consequently have different behaviors in the environment. Moreover, fibers are not only made by polymers (many fibers can be of natural origin, such as cotton and vegetable fibers), and only a few laboratories are capable of identifying them.

A consideration of the limits of microplastic pollution should involve studies of long-term ecotoxicological tests with toxicity endpoints (Van Cauwenberghe et al., 2015). These studies should be conducted using model species of aquatic and terrestrial environments, and should address parameters of physical damage and toxicity of additives and contaminants sorbed in plastic particles. In this way, by determining the

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biological and ecological impacts of different microplastic densities in each environmental compartment, it would be possible to establish the "tolerant" density values of microplastics in the environment. Tolerant microplastic densities combined with a new index specific for microplastics can clarify gaps regarding microplastic pollution levels.

To facilitate sampling and comparison, we suggest that results should be standardized in particles per cubic meter (particles m^{-3}) for beach sediments, because microplastics can be found in different depth layers in sandy beaches (Turra et al., 2014); in muddy sediments, microplastics can be estimated in volume (particles L^{-1}), which facilitates the conversion to particles m^{-3} and allows comparison with the densities of microplastics present in the water column. In the water surface, because some microplastics have low density and float on water, it is reasonable that standardization be particles per square meter (particles km^{-2}). Finally, for biomass, particles per gram of wet weight could be used, following the most recent studies. We suggest particles as a unit instead of microplastic mass or surface, to enable anyone to produce data on this topic, including citizen science programs, which usually have few financial and technological obstacles.

Given the heterogeneity of microplastic analysis methods, we encourage future research to consider the development of protocols to establish guidelines, with the aim of standardizing the representation of the results and microplastic pollution parameters. Thus study results can be used as tools in environmental assessment and monitoring programs. In addition, interlaboratory analyses will be necessary to validate the reproducibility of the proposed methods with sentinel organisms and environmental samples from different ecosystems (using similar units), to obtain an overview of the global situation of microplastic pollution.

Data Availability Statement—Data, associated metadata, and calculation tools are available from the corresponding author (gtgimiliana@gmail.com).

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