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EDITORIAL SPECIAL ISSUE « MICROBIAL ECOTOXICOLOGY »

Microbial ecotoxicology: an emerging discipline facing contemporary environmental threats

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This special issue of ESPR is focused on microbial ecotoxicology. What is 'microbial ecotoxicology'?

It is a branch of science that studies both (i) the ecological impacts of chemical (synthetic or natural origin) or biological (toxic species) pollution at the microbial scale and on the various functions that they ensure in the ecosystems and (ii) the role of microbial communities in the ecodynamic of the pollutants (source, transfer, degradation, transformation). It is a multidisciplinary scientific endeavor at the crossroad between microbial ecology, microbial toxicology, physics and chemistry (Fig. 1). It responds to an increasing demand worldwide of the politics and society because of the threat on environmental and human health caused by intense anthropogenic activities. In the context of the Anthropocene, microbial ecotoxicology seeks not only to conduct fundamental researches to understand the impact of pollutants on microbial processes and vice versa but also to carry out applied researches to provide tools readily usable by the society to monitor the evolution of the quality of the environment and to restore polluted sites.

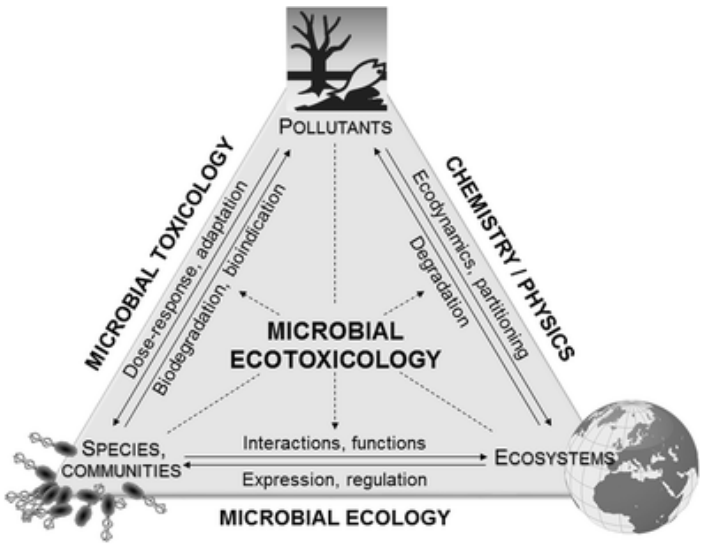


Fig. 1. Microbial ecotoxicology is a multidisciplinary science at the crossroad between microbial ecology, microbial toxicology, physics and chemistry

Why is it important to consider the microbial biosphere in ecotoxicology?

The history of microbial ecotoxicology pops up recently (Ghiglione et al. 2014) decades after the emergence of ecotoxicology (Truhaut 1977). Such investigation arose because of tremendous technological breakthroughs in the last decades by applying molecular tools such as next-generation sequencing giving new insight in estimating the abundance, structure and diversity of microbial community in complex environments (Tautz et al. 2010, Ghiglione et al. 2012). Because microbial ecologists demonstrated that microbial life is very diverse and plays a primary role in supporting various ecosystem functions in virtually all of our planet's environments (Barton and Northup 2011), microbial ecotoxicologists go beyond the restricted use of model organisms generally used in toxicology, preferentially performing investigations at community level. This statement is nicely illustrated by the word cloud generated from title words and keywords in this special issue (Fig. 2). Microbial ecotoxicology paves the way to assess the impacts of contaminants on taxonomic and functional microbial biodiversity which is supporting ecosystem functions and ensuring their stability and recovery. This is in accordance with the need to reinforce the ecological relevance of ecotoxicological studies (Schmitt-Jansen et al. 2008) in order to provide new ecological indicators and give new insight in measuring the impact of pollutants on 'ecosystem health' (Costanza et al. 1992).microbial processes and vice versa but also to carry out applied researches to provide tools readily usable by the society to monitor the evolution of the quality of the environment and to restore polluted sites.



Fig. 2. Word cloud generated by Wordle (http://www.wordle.net/) using the most frequent 60 words in the titles and keywords of the 'microbial ecotoxicology' special issue articles. Words used in both title and keywords were only considered once in the Wordle analysis

Possibly, one of the originality of microbial ecotoxicology lies in the role of microorganisms in the ecodynamic of the pollutants, which is not strictly taken into account in ecotoxicology. Microbial contamination can occur by accidental introduction of infectious microorganisms (bacteria, yeast, mould, fungi, virus, prions, protozoa) or their toxins and by-products in the environment (Proft 2009). Inversely, microorganisms present the capability to cope with chemical and/or biological contaminants to restore polluted sites. Bioremediation uses mainly microorganisms to clean up contaminated environments, involving biotransformation and biodegradation by transforming contaminants to non-hazardous or less hazardous chemicals (Alexander 1999). Natural communities of microorganisms in various habitats have an amazing physiological versatility, being able to metabolize and often mineralize huge number of molecules.

What are the researches given in this special 'microbial ecotoxicology' issue?

One can argue that given the green thinking that arose at the end of the last millenary notably following the publication of the Millennium Ecosystem Assessment, the human society tried to adopt environmentally friendly resolutions, reducing the risk of acute and high-volume pollution, at least in Europe and North America. However, despite these constant efforts marked by the succession of international conventions under the United Nations flag, the society is having difficulties to reach international agreements to reduce anthropogenic threats to nature. Consequently, ecosystems are still threatened by low concentrations of a steadily increasing number of pollutants that cause subtle and chronic effects.

This special issue gives a number of examples reporting the broad variety of pollutants that microbial ecotoxicologists are studying: nanoparticles (gold, silver, zinc, titanium, multi-walled carbon nanotubes), metals (copper, ferrous iron, arsenic, lead), antibiotic and antimicrobial ionic liquids, solvent (methanol), high alkaline (pH >13 !), aromatic hydrocarbons (toluene, PAHs), PCBs, pesticides (atrazine, chlordecone, 2,4-D, mesotrione, nicosulfuron, sulcotrione, sulfamethoxazole). The international scientific community that contributed to the special issue proposed works performed on samples originated from a large variety of ecosystems: freshwater, sewage water, drainage water from landfills or from watershed, fluid systems in an automobile industry, lake, groundwater, river, estuarine, seawater, wetland and planted or unplanted soils. As illustrated by the word cloud (Fig. 2), microorganisms of interest were mainly bacteria, fewer on fungi and microalgae, archaea being rarely considered. A majority of articles focused on the impact of pollutants on microbial diversity and functional capabilities, but numerous papers were dedicated to the study of biodegradation processes and the improvement of bioremediation strategies. Relatively few studies presented here were done under culture conditions with only one model species, while most of them were studying the communities as whole or specific functional communities under micro- or mesocosm conditions or in the field. The large broad of technological tools used in each of the articles is also representative of the multidisciplinarity and the high degree of technicality that are needed today for acceptance in international peer review journal.

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