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# Microbial ecotoxicology: A new era of research in Malaysia

**Chee Kong Yap*[1] and Wen Siang Tan[2,3]**

[1]Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[2]Department of Microbiology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[3]Laboratory of Vaccines and Biomolecules, Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

***Corresponding Author:** Chee Kong Yap, Department of Biology, Faculty of Science, University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia; Email: yapckong@hotmail.com; yapchee@upm.edu.my

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Microbial ecotoxicology was initially proposed by [1], while the field of ecotoxicology was founded by René Truhaut [2]. The anthropogenic pollution caused by population growth is the main cause of environmental problem nowadays [3]. It answers to a growing demand in social-economy around the world as a result of the harm to the environment and human health posed by intensive anthropogenic activities [4]. Most of the 17 United Nations Sustainable Development Goals (UN-SDGs) have made the underlying link between environmental health and human health and well-being a top focus [5].

When it comes to the abundance and distribution of living species, the ecosystem nutrient cycling has always been a basic ecological element with four primary components (nutrient pool, producers, consumers, and decomposers) under the energy flow (Figure 1). The ecological distribution and abundance of living organisms in the presence of a single chemical pollution or a combination of organic and inorganic pollutants (Figure 1) are well documented in the literature. From the molecular [6,7] to population levels [8-10], investigations on marine mussels are widely documented. However, in the presence of emerging novel viruses including bacteriophages, plant and animal viruses, the mechanisms of nutrient cycles are poorly known (Figure 1). It is believed that the components of decomposers consisting of bacteria, viruses and other microorganisms, may have accelerated the decomposition processes, resulting in a higher rate of mortality among producers and consumers. The goal of the microbial Eco toxicological study is to perform both basic and applied research in order to develop tools that society may use to track the evolution of environmental quality, and rehabilitate damaged locations [11]. Microbial ecotoxicology, in addition to Eco toxicological investigations, can provide novel ecological indicators and insights into

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quantifying the influence of contaminants on 'ecosystem health' [12].

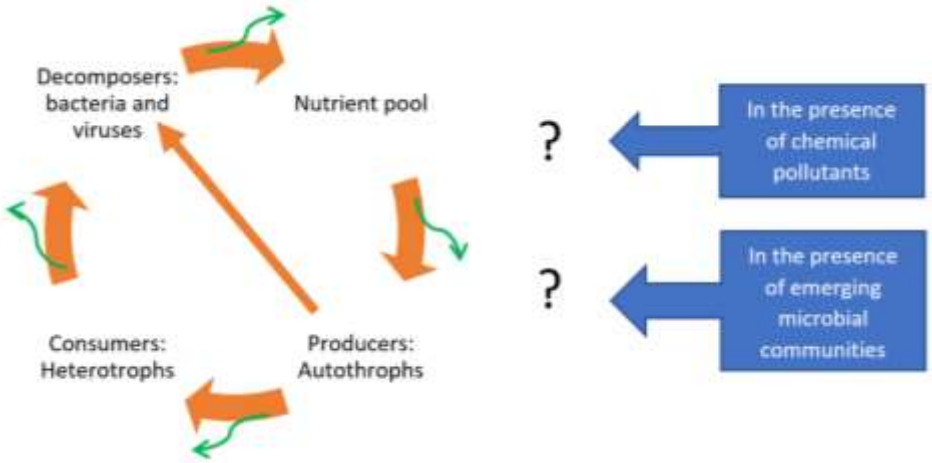


**Figure 1:** An overall ecosystem concept with the flow of energy (single line with green arrows) and nutrient cycling (solid bar with orange arrows), in the presence of chemical pollutants and emerging microbial communities.

Microbial contamination occurs when infectious microorganisms (mostly viruses, bacteria and fungus) or their toxins and by-products are accidentally introduced into the environment, according to [13]. Microorganisms, on the other hand, can cope with chemical and/or biological toxins, allowing for the restoration of damaged habitats. Bioremediation cleans up contaminated environments by involving biotransformation and biodegradation, which involves the conversion of toxins into non-hazardous or less harmful compounds [14]. Effective microorganisms, such as plant growth-promoting rhizobacteria, are a mix of beneficial microorganisms and naturally occurring microorganisms that can be used as an inoculant to increase the microbial diversity of soil and plants in agriculture industries [15,16]. According to [4], the most pressing challenge is to improve our understanding of environmental pollutants and microbial mechanisms that contribute to pathogenic microorganism development, proliferation and dispersal, as well as microbial resistance to pharmaceuticals and microbial toxins in various environmental compartments. Is the increase in emerging microorganisms a factor in the rate of decomposition? Is it possible that the increased amount and rate of decomposition will make essential carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulphur more bioavailable to producers and, eventually, to consumers?

Finally, how is the increased rate of decomposition owing to new microorganisms related to the health of the terrestrial and resourceful mangrove ecosystems? These fundamental problems should serve as a springboard for further microbial ecotoxicological studies. To summarise, all of the above questions are awaiting responses from upcoming studies. Beyond a shadow of a doubt, we believe that microbial ecotoxicology will be a fruitful and exciting study specialty in the future. This will, of course, require more research grants, and eventually produce more microbial ecotoxicologists. This editorial is intended to serve as a starting point for microbial ecotoxicological research in Malaysia.

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