Editorial

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New Challenges by Toxic Threats to the Environment

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Environmental pollution leads increasingly to disturbances of organisms and also adversely affects human health. Pollutants affect living beings in different ways. They can cause phenological changes, metabolic effects, or affect the genome and its transcriptomic reading such as through mutations and epigenetic effects. Such effects will also provide biological fitness alterations. Mortal effects lead to a depleted number of sensitive species and are commonly followed by losses in biodiversity. Habitat and food chain alterations will affect productivity patterns that lead to ecosystem function losses. Challenges in environmental toxicology approaches can be empirical and conceptional. Conceptual, there are toxic actions not only from chemicals but from other areas of natural sciences such as physical and biological stressors. Environmental pollution studies thus also need to consider any other threat that affects organisms in their particular habitats. Organisms both in the aquatic and terrestrial surroundings can be caused by physical, chemical, or biological components. Environmental pollution is also very much biased by anthropogenic (man-made) activities. Instead, there is a kind of natural pollution since the early times of organismic evolution on this planet. This holds for volcanic activity on land or under fresh and ocean waters. There is also input from sediments and their contaminants to freshwaters and coastal waters. Climate changes may be of prime importance among the challenges from new stressors since they illustrate best the necessity of profound insights into the relationships between natural resources and climate. Climate changes also provide non-chemical threats to organisms (by invasive species and loss of habitat), and chemical toxicities at the same time. There are general responses of organisms to environmental toxicants at different integration levels (e.g., at the levels of the community, population, individual, organ, tissue, cell, physiology, proteome, and genome). Organisms are also characterized by variability in their systematic and developmental sensitivity. In addition show males and females different reaction norms. There is a complication by toxicants showing a tendency for ontogenetic bioaccumulation and biomagnification within trophic networks.

There are challenges provided by innovative approaches in several areas of environmental pollution. Parallel to this there are challenges for innovative approaches to detect sources, pathways, effects and mechanisms of actions of toxins and other stressors. Such are offering new opportunities for management, education, and innovative policies in environmental health management. There are new approaches needed in order to face new challenges in monitoring the presence and effects of old and novel stressors and in the analytical study of mechanisms-of-action. Some novel approaches are readily available that have to be taken to practice and evaluated in their efficiency. For applications in the field provide geographic information systems (GIS) popularity recently since they offer spatial data assessment and access through the web. To assess environmental hazards, such as of persistent organic pollutants (POPs) and endocrine disrupting chemicals EDCs to organisms, it is important to examine the occurrence, fate, and distribution of contaminants in atmosphere, soil and water column from physical samples. Instrumental analysis, however, is usually time consuming and expensive due to the exhaustive clean-up and the use of sophisticated and expensive instruments. Due to the complex nature of environmental mixtures, it is further difficult to predict potential effects of environmental contaminants based on instrumental analysis alone. Such shortcomings are challenging the development of new and alternative methods which apply bioindication in the study of such compounds.

OMICs approaches characterize and quantify molecules with bioinformatics tools and relate them to structure, function, and processes in organisms. In environmental toxicology it is important to evaluate genotoxicities which alter genetic material which in turn generate mutations with effects on all other organismic integration levels. Proteogenomics has much benefitted from the innovation of next generation sequencing. DNA changes otherwise cause death or sterility and sublethal gene mutations will alter the gene assembly of a population. Sublethal mutations that alter the gene pool also cause microevolutionary changes. Evolutionary adaptations select for toxin-tolerant individuals with consequences on genetic diversity within populations. Modelling approaches to environmental pollution offers predictions that are useful as management tools. Key emerging fields are recent trends that increase data assimilation, operationalization, and the development of improved tools for risk assessment.

Environmental pollution challenges related policies since it creates an economic problem by reducing the natural capital value provided by environmental resources. Attitudes like looking towards immediate profit and ignoring ecosystem services need to be overcome and long term benefits of environmental remediation provide challenging environmental policies.

The challenges of an integrative approach have rarely been met for the risk assessment of environmental health in contaminated ecosystems. These would include genotoxicological, biochemical, physiological endpoints, or biological monitoring, and chemical or physical habitat assessments. Biotic and abiotic endpoints should be integrated by different approaches in a systems-guided way: biological, chemical, physical; laboratory vs. field; trophic guilts (primary producers, consumers, destruents); biological integration levels (subcellular, chemical, behavioral, ecological). This holds for integration levels such as from molecules to ecosystems - in monitoring or experimental approaches. There is a need to consider the effects but also the mechanisms of toxic action. This holds for both natural and anthropogenic pollution. Particular attention should be given to the interactions of environmental toxicants at interfaces. Interdisciplinary studies should particularly consider interactions of land with ocean/freshwater and those with the atmosphere. Environmental health and risk assessments should be integrated in management programs that are monitoring and remediating challenged environments. Here is a need for multidisciplinary and integrative approaches in complex ecosystems for the detection and management of unwanted disturbances. Temporal as well as spatial gradients, such as seasonal shifts, latitudinal, elevational, and geographical are contributing to this. Several levels of environmental toxicity studies are providing rather general challenges: physical, chemical and biological risk assessments, management, social and policy integration at national and international levels.