Biomarkers and community indices as complementary tools for environmental safety

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Abstract

Research on biomarkers as early bioindicators of perturbation in populations and individuals has been gaining ground over the last decade. This ecotoxicological approach relies on the fact that changes occur at low levels of organization before the community is affected and thus they can be monitored to assess environmental safety. Changes may concern behavior, physiology, biochemistry, or genomic structure and functioning, and may impair population dynamics in the long-term.

Ecotoxicity studies based on biomarkers allow us to measure the impact of environmental stressors and to easily follow the evolution of the systems towards degradation or restoration. Over and above their use as simple indices of exposure to specific pollutants, biomarkers can give an insight into ecosystem health.

The results of our experience in field studies involving ecotoxicologists and ecologists will be presented in order to illustrate the relevance of such an integrating strategy for environmental quality assessment.

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1. Introduction

As physicochemical analyses shed no light on the biological status of ecosystems, a biological approach is needed to evaluate environmental health. Indeed, the search for pollutants in compartments of the environment is not exhaustive and routine analyses generally give no information either on specification or the chemical form of pollutants. Moreover, the biological effects of contaminant interactions cannot be expressed by physicochemical investigations.

Biodiversity and community studies are traditionally used to assess the biological quality of the environment. They provide indices, which reflect the impact of ecological traits, stress factors and anthropogenic activities. Yet, disturbances can only be diagnosed a posteriori when changes have become significant. By the time degradation is recorded, a number of species have already disappeared, which limits the effectiveness of the ecological approach.

This explains why research on biomarkers as early bioindicators of perturbations in populations has developed over the past decades. The ecotoxicological approach based on biomarkers measured in individuals relies on the fact that changes occur at low levels of biological organization before the community is affected.

Biomarkers are biological parameters measuring behaviors, physiology, biochemistry, cell integrity, genomic structure and expression (Lagadic et al., 1997a). They are indicators of either a normal status, or changes in individuals of the population studied. The use of biomarkers for environmental safety implies a thorough knowledge of their biological function. A range of normal values taking into account the influence of sex, the reproductive phase, seasonal and climatic factor, has to be determined. This is necessary to avoid any misinterpretation, which would lead to the conclusion that abnormalities were caused by environmental perturbations, when in fact they were only normal variations.

Our conceptual approach of environmental health assessment includes ecosystem characterization by means of studies on biodiversity, taxonomic richness and populational indicators. This must be complemented by studies of the physicochemical and geological characteristics of the system, since communities cannot be analyzed without considering ecological conditions, for instance, habitat, hydrodynamic parameters, etc. Biomarker investigations can be integrated into this in situ approach of ecosystem quality as a means of predicting changes at the population level. These changes may result from environmental stress factors, and can be responsible for abnormalities, toxicity in individuals, fol-