ECOTOX2

EFFECTS OF POLLUTANTS ON BENTHIC POPULATIONS AND COMMUNITIES OF NORTH SEA ORGANISMS

Duration of the project: 01/02/2002 – 30/04/2006
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CONTEXT

Several classes of potentially toxic contaminants occur at high levels in the North Sea. These worrying contaminants include coplanar polychlorobiphenyls (cPCBs), polybrominated diphenyls ethers (PBDEs), dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and some metals (Cd, Pb, Hg, Zn). Tools for assessing the effects of these substances have been developed, the so-called biomarkers (biological responses indicating the exposure to or the effects of a contaminant in an organism). Most current biomarkers (as well as those in development) consist in responses at biochemical to individual levels of biological organisation. Actually, there are very few data to interpret the significance of the biomarker responses at the population or community level, which should be considered for the preservation of species and biodiversity.

PROJECT DESCRIPTION

Objectives
To determine whether the effects of contaminants of high concern in the North Sea (cPCBs, dioxins, furans, PAHS, PBDE, and metals -Cd, Pb, Hg, Zn- with possible synergic effects due to increased levels of organic matter) monitored at the gene to individual levels result in significant impairments of populations or communities of benthic organisms and if the early signals provided by biomarkers can effectively predict these ecological effects.

Methodology
Considered organisms are marine benthic biota of great ecological and/or strategic importance, namely the starfish Asterias rubens, the mussel Mytilus edulis, and sediment-associated microbial communities (SAMC). The two first species are recognised bioindicators of contamination and provide validated biomarkers or biomarkers in development. They are studied at the population level. SAMC are key components of soft sediments but are poorly known from an ecotoxicological point of view. They are studied at the community level.

The strategy is to determine the effects of contaminants on population or community parameters of the selected organisms in mesocosms and/or in the field together with biomarker responses, environmental and contamination conditions being either imposed (mesocosm experiments) or determined simultaneously (field studies).

Analysed contaminants are cPCBs, dioxins, furans, PAH, PBDEs, and metals (Cd, Pb, Hg, Zn). Environmental conditions taken into account are salinity, temperature, organic load of the sediment, and food availability for starfishes and mussels. Considered biomarkers are, in starfishes and mussels, metallothionein induction, cytochrome P450-1A activity, immune activity, embryotoxic assays, differential gene expression analysis. In addition, a bacterial cell stress gene-profiling assay is used to detect and characterise the nature of the pollution in marine sediments and suspended matter. This is a newly developed assay whereby the status of gene expression is measured through specific reporter constructs.

In field experiments, the strategy is to determine in a limited number of well-contrasted sites (1) general environmental conditions (temperature, salinity, available food), (2) contaminant levels (in sediments, suspended organic matter, and the selected biota), (3) population/or community parameters of the selected organisms, and (4) responses of the selected biomarkers. Then, through multivariate data analysis, differences in ecological parameters will be linked with environmental conditions and/or contaminant levels. Finally, correlations between biomarker responses and impairment of populations or communities will be established. Selected sites include contaminated and background sites in the Southern Bight of the North Sea (from Pas-de-Calais to Grevelingenmeer with stations along the Belgian coast and in the Scheldt estuary) and a hot spot (and associated gradient of contamination) in a Norwegian fjord. The parameters of starfish and mussel populations that are characterised are population dynamics (cohort analysis of size class distributions, to determine growth, survival, and death rates), organ indices (to characterise resource allocation), gametogenetic cycle, and reproductive capacity. Parameters of SAMC are biodiversity and abundance of dominant species (determined by molecular biology techniques).

Mesocosms experiments will allow to separate effects of specific factors (environment and contaminants) on the population and community parameters in controlled conditions. For that purpose, selected environmental parameters and levels of contaminants are manipulated with other parameters maintained at background condition. Studied variables are growth of recruits (i.e. newly settled juveniles), growth and metamorphosis of larvae, and biodiversity and abundance of dominant species of SAMC.

Interaction between the different partners
Four biologist teams (UMH-Biomar, ULB-Biomar -with its subcontractant ULB-ESA-, and RUCA) are in charge of field and mesocosm experiments, and biomarker measures. Two chemist groups (UMH-ChOrg and ULg) will analyse, respectively, PAHs and cPCBs, PBDEs, dioxin and furans. Metals will be analysed by RUCA and ULB-Biomar.

Expected results and/or products
The main results expected are (1) an assessment of the impact of contaminants of high concern on populations of major invertebrates and communities of sediment-associated bacteria in the North Sea and (2) an evaluation of the ability of selected biomarkers to predict these effects. This will provide a case study in the field of ecotoxicology sensu stricto (i.e. at the level of population and community), a fundamental but rarely seeked objective in the marine environment.
The output of the project will provide both environmental agencies and industries with an assessment of the health status of coastal benthic communities of the Southern Bight of the North Sea and a determination of the factors of concern (these data can constitute the basis to decide if remedial actions are necessary or not - e.g. in recreational or shellfishing areas).
Results will also be used to raise the concern of the public and NGO for the protection of marine benthic ecosystems in general and of invertebrates in particular.

PARTNERS

Activities

ULB
The research activities of the Marine Biology Laboratory (Biomar) deal with the biology, ecology, ecotoxicology, and aquaculture of marine invertebrates, with a particular interest for echinoderms. The Laboratory of Ecology of Aquatic Systems (ESA) is specialised in the functioning of aquatic ecosystems and their responses to natural and man-induced changes.

UMH
The Marine Biology Laboratory (Biomar) focuses on the biology of marine benthic invertebrates, notably echinoderms. Main topics are adhesive properties, symbiosis, and larval development including metamorphosis. The Organic Chemistry Laboratory (ChOrg) is specialised in mass spectrometry applied to new reactive molecules, atmospheric and marine pollutants, and amino acid sequences in peptides.

RUCA
The research of the Ecophysiology, Biochemistry and Toxicology group is focused on biological availability and accumulation of contaminants in aquatic organisms and ecosystems, and on the effects of environmental conditions and pollution exposure on physiological condition and toxicological effects.

ULg
The Mass Spectrometry Laboratory research is focused on the development of analytical methods for micropollutants and on the study of molecular recognition between bio-molecules (proteins and DNA and complexes with xenobiotics).

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