# MONITORING CHEMICAL CONTAMINATION LEVELS IN THE MEDITERRANEAN MUSSEL, *MYTILUS GALLOPROVINCIALIS*, OPTIMIZED BY THE USE OF DYNAMIC ENERGETIC BUDGET (DEB) MODEL

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## Abstract

Within the framework of the biointegrator network (RINBIO), 92 man-made cages containing mussels ( *Mytilus galloprovincialis*), distributed over 1800 km of the French Mediterranean coast, and made it possible to assess chemical contamination by heavy metals. Bioaccumulation of contaminant within an organism results from interactions between physiological factors, chemical factors and environmental factors. To account for such interactions in the mussel *Mytilus galloprovincialis*, we combined accumulation and Dynamic Energy Budget models. Field experiments were conducted to measure contaminant (metals and organics) kinetics for contaminant in 3 Mediterranean sites with differences in contamination levels, and to calibrate the models. By combining environmental and biological data, the model provided an efficient bio-monitoring tool which can be applied to various coastal environments and enabled us to assess the real level of contamination in water on the basis of contamination measured in mussels.

*Keywords : Bio-accumulation, Bivalves, Inverse Methods, Monitoring.*

Monitoring and interactions

Many monitoring programs are based on the concept of quantitative bioindicator, which uses the properties mussel to concentrate contaminants in their soft tissue with a relationship with the ambient level [1-2]. Nevertheless, interpreting bio-monitoring data reveals some difficulties related to the contaminant dynamics, possible changes in the environment (temperature, trophic conditions and contamination level) and interactions with the bioindicator physiology (size, reproduction stages, and seasonal growth cycles). The data obtained give only information on the bioaccumulation level without taking into account the contaminants dynamic. There is still a lack of knowledge about the significance of the concentration at time "t". Furthermore, comparing concentrations between different sites appears to be difficult because of the variations in environmental conditions, and subsequently variations in growth rate of the mussels among sites, may involve changes in the concentration level in the animals. Subsequently, modeling bioaccumulation of metals in mussels can be a pertinent tool to optimize the use of quantitative bioindicators.

Dynamic Energy Budget (DEB) model

Uptake and elimination kinetics of metals in the mussel *Mytilus galloprovincialis* can be described by a dynamic energy budget (DEB) model (Figure 1). A multi-compartment-pharmaco-kinetic model has been used to describe metal kinetics [3]. The contribution of physiologically determined variables, such as body size and tissue composition, on its influence on the pharmaco-kinetics of the xenobiotics has been evaluated. The metal uptake / elimination model has been designed to account for change in the physiological conditions of the organism. The uptake is considered to be carried out directly from the environment and/or *via* food and the elimination is *via* reproduction and/or directly to the environment.

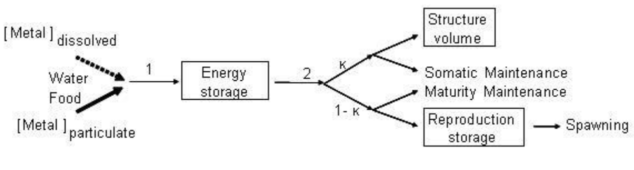


Fig. 1. Schematic representation of the energy flow through an organism in the DEB model (Kooijman, 2000), and contaminants bioaccumulation. 1: assimilation, 2: utilisation.

However, the uptake/elimination model proposed by Kooijman and Van Haren (1990) for organic micro contaminants and has been designed to account for changes in the physiological (feeding/lipid) conditions of the organism [3]. This modelling attempt suggests that bioaccumulation models could provide an appropriate tool to analyse bio-monitoring data. In this perspective, applications to heavy metals have been applied to *Mytilus galloprovincialis* to assess uptake-excretion kinetics, calibrated on *in situ* experiments [4].

Field validation

In order to couple growth and metal accumulation, it's essential to have complementary data: (i) physico-chemical variables of water, (ii) chemical variables of contaminant, and (iii) biological variables of mussels [4]. In this experiment, mussels originating from a same site have been transplanted for six months in two sites known for their contamination (Lazaret bay and Bages lagune). The two mussel sets were sampled fortnightly and allometric parameters and contaminant concentrations in the mussel tissues were measured. In addition, water conditions were recorded: temperature, suspended solids and dissolved and particulate metal concentrations. After these six months, mussels were transplanted to a clean site (Port-Cros Island) in order to examine the decontamination kinetics during three months. All these data have been integrated into the DEB model to adjust parameters and validate it [4].

Monitoring application

The coupled DEB bioaccumulation model was used to assess the level of water contamination on the basis of the contamination measured in mussels by an inverse method. Unknown food and contaminant concentrations were determined by fitting simulated mussel growth and contaminant concentrations to measured values [4]. Application of the model by inverse analysis to monitoring data (RINBIO) showed the usefulness of the DEB model as an operational tool. The model linked concentrations in the living organism with those of the surrounding environment using an explanatory method. It provided an evaluation of the effective chemical contamination on sites which have different trophic conditions in the Gulf of Lions by accounting for differences in physiological response. The successful reconstruction of contaminant concentrations in surrounding water at different sites with concentrations in tissues and the measurement of growth encourage the implementation of the DEB-based model in scenario simulation studies for management purposes. After application to heavy metals, we are actually applying it to organic contaminants like PCBs, DDTs and PAHs.

## References

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