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MODELING TRACE METAL ACCUMULATION IN THE MEDITERRANEAN MUSSEL, *MYTILUS GALLOPROVINCIALIS*

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Abstract: Monitoring coastal contamination by trace metals pollution using mollusks bivalves as quantitative bioindicators is widely performed in many international biomonitoring programs. In this purpose, modeling metal dynamic in marine mussels is a reliable tool. It allows understanding the bioaccumulation process which results from the interactions between biological, chemical and environmental factors. To calibrate such a model, kinetic experiments on uptake and elimination were conducted on three Mediterranean sites chosen on the basis of their different nutritive and chemical characteristics.

Keywords *: Bioindicator, Mytilus galloprovincialis, bioaccumulation, heavy metals, growth.*

Introduction

Many monitoring programs (the US Mussel Watch, the French RNO and RINBIO) are based on the concept of quantitative bioindicator, which uses the properties of marine bivalves (usually mussel) to concentrate and, in certain conditions, accumulate contaminants in their soft tissue with a relationship with the ambient level; this technique allows the measurements of chemical contaminants technically more simple than in water (1, 2, 3 & 4).

National and international monitoring networks are designed to discern spatial and temporal patterns in contaminant concentrations in the environment. Some difficulties appear in the accomplishment of this objective: 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" ; does this concentration result from a change in environmental conditions, or from a change in the contamination level in the surrounding environment. 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 could be a pertinent tool to optimize the use of quantitative bioindicators.

The aim of this study is to couple growth and bioaccumulation models for the marine mussel, *Mytilus galloprovincialis*. Indeed, each fluctuating condition will interact and affect the concentration of metal in mussels. Hence, the reconstruction of ambient metal concentrations, based on metal body burden, will be only feasible when the effect of food density and/or temperature on the physiological condition of the mussel is known.

Interactions between environmental changes, growth and bioaccumulation

Interpretation of environmental monitoring data is improved by knowledge of the relationship between metal concentration in the environment and in tissues of the mussel. Most of the studies on the bioaccumulation process assumes implicitly steady state conditions for the other physiological processes in the organism. These models do not consider the organism changes in its physiological conditions (i.e. size, energy reserves and reproductive cycle) and do not take into account the impact of these changes on the metal concentration in mussels.

In fact, many biotic and abiotic parameters are known to affect the metals body burden of *Mytilus sp.:* temperature, available food, reproductive cycle, size and weight (5 & 6). This is the reason why the coupling of the growth and accumulation models is of utmost importance in understanding the metal bioaccumulation process within the mussel.

Metal kinetics in the mussel: accumulation model

Uptake and elimination kinetics of metals in the mussel *Mytilus galloprovincialis* can be described by a dynamic energy budget (DEB) model. A multi-compartment-pharmaco-kinetic model has been used to describe metal kinetics (7 & 8). The contribution of physiologically determined variables, such as body size and tissue composition, on its influence on the pharmaco-kinetics of the metals 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.

Adjustment of parameters and field validation

In order to couple growth and metal accumulation, it's essential to have complementary data: (i) physico-chemical variables on the contaminant and the water, (ii) biological variables of the water, and (iii) biological variables of the mussel.

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, pH, salinity, 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 will be integrated into the DEB model to adjust parameters and validate it.

After calibrating the bioaccumulation model and after coupling the two models using dissolved and particulate metal concentrations in the environments, the model has been inverted in order to prove its functionality in assessing the real metal concentrations in water. By combining environmental and biological data, the model could constitute an optimized biomonitoring tool which can be applied to various coastal environments.

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