ZOOPLANKTON AS A POLLUTION MONITOR IN A COASTAL MARINE ENVIRONMENT (TOULON BAY, FRANCE)

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Abstract

Polychlorinated Biphenyls (PCBs), Organochlorine Pesticides and Polycyclic Aromatic Hydrocarbons (PAHs), were measured in samples of zooplankton collected in spring-summer 2002 in two separate areas of Toulon Bay, Petite Rade and Grande Rade. Abundance and diversity of zooplankton community were also evaluated. Zooplankton samples from the more polluted Petite Rade, had significantly higher PCB concentrations than those of Grande Rade. Moreover, compared to Grande Rade, Petite Rade had lower diversity and evenness indices, and higher dominance index due to a single species (*Oithona nana*). PCB pollution can be regarded as a probable factor causing stress to the Petite Rade's zooplankton organisms.

Key words: zooplankton, bioaccumulation, PAH, PCB, organochlorine pesticides, biodiversity

In zooplankton samples collected between May and July 2002 in the Toulon Bay the concentrations of Polychlorinated Biphenyls, Organochlorine Pesticides (HCB, DDT, DDD, DDE and HCH) and Polycyclic Aromatic Hydrocarbons were determined.

The semivolatile, chemically-stable and lipofilic nature of organochlorine compounds combined to their resistance to biodegradation and photolysis and the low water solubility and hydrophobic properties of PAHs, cause these compounds to be accumulated in the marine organism's lipid rich tissues. All these compounds are included in the list of persistent organic pollutants and are of great concern because of their toxicity and suspected or manifest carcinogenic activity.

Zooplankton and particulate matter represent the organic contaminants' main route for entering the living matter cycle and the food webs in the marine environments. Organic compounds adsorb onto particulate matter and are taken up by smaller organisms because of their high lipid content and relatively higher biomass in the smaller sizes (1). Therefore, zooplankton can be used as a monitor of **recent pollution** because of its short life-cycle.

Moreover, abundance and diversity of zooplankton communities can be affected by **long term disturbances** due to anthropogenic inputs. Arfi *et al.* (2) reported that some species tend to cluster in facies characteristic of polluted environments and affected by a low diversity index. They emphasized that the copepods *Acartia clausii*, *Oithona nana* and the appendicularian genus of *Oikopleuridae* were the most abundant organisms in perturbed ecosystems, because of their euriecious and tolerant nature.

In this study, chemical and ecological analyses of the zooplancton community were coupled in order to evaluate interactions between pollutants' body burden and community structure modifications.

An artificial breakwater divides the Toulon Bay into two different basins, Petite Rade and Grande Rade, contaminated by different pollutants' loads.

Zooplankton samples were collected every 1-2 weeks at four stations, in both Petite Rade (S1, S2), heavily polluted, and Grande Rade (S3, S4), less affected by human inputs.

The highest abundance of zooplankton was found in Petite Rade, where human activity is more intense because of the commercial and military port. The copepod *Oithona nana* was the most abundant species of the overall community in S1 (53-78%) and S2 (11-71%) for the entire period. Petite Rade had low diversity and evenness indices and high dominance index due to the single species *Oithona nana*.

Grande Rade, on the other hand, had low zooplankton abundance and higher diversity and evenness indices. Dominance index was on average lower than in Petite Rade and *Oithona nana* was not the dominant species, until the beginning of July, when it represented 72% of the community. This situation was probably due to strong N/W winds that made waters of the two basins mix together.

Differences in zooplankton communty structure between Petite Rade and Grande Rade were also described by Jamet *et al.* (3) and Richard and Jamet (4).

Chemical analyses were performed on lyophilised plankton samples using solvent extraction (n-hexane, dichloromethane) clean up and separation with column chromatography (alumina and silica gel) and HRGC-LRMS determinations (5).

Results showed no temporal trends for the concentrations of pollutants.

A significant difference was found between PCBs concentrations in Grande Rade and Petite Rade where PCBs were significantly higher. On the other hand, Pesticides and PAHs in zooplankton of Petite Rade and Grande Rade were not significantly different.

In Petite Rade, PCBs concentrations could be ten times higher in zooplankton than in sediments (6), whereas concentrations in Grande Rade's zooplancton and sediments were similar.

The concentrations of the parent compounds o,p'- and p,p'-DDT in zooplankton were in most samples below the detection limits, while the metabolite, *p,p'*-DDD, was at relatively high levels. A DDT/DDE ratio lower than 1 and the *p,p'*-DDD high concentration are probably the result of a past DDT contamination. Total pesticides concentrations were much more abundant in zooplankton than in sediments (6).

PAHs were quite abundant in zooplancton, and concentrations were similar to those in sediments. Despite the zooplankton ability to metabolise and excrete PAHs (7), concentrations of these compouds remained quite high in all cases suggesting a continuous input of these contaminants into the bay.

Considering that Pesticides and PAHs did not show different concentrations in Petite Rade and Grande Rade, they were thought to be hardly responsible for the differences in zooplankton community structure between the two basins.

Therefore, only the correlation between PCBs concentrations in zooplankton and some ecological indices was investigated. A negative correlation between richness, evenness and diversity indices was found. A positive correlation resulted between dominance index and PCBs concentrations.

These preliminary results indicate that PCB pollution can be reasonably considered as a probable factor causing stress to the Petite Rade's zooplankton organisms, which suffered a reduced diversity in response to perturbed environmental conditions (8).

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