Heavy Metal Toxicity on *Idotea baltica* (Crustacea, Isopoda)

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Résumé
On décrit la toxicité acute (LT_{50}) de 6 métaux lourds (Cd, Cu, Cr, Hg, Fe, Zn) sur des femelles, des males et des juvéniles de l'isopode *I. baltica*. Des concentrations subletles de Cd ou Cu produisent des retards de survie et de croissance, et notamment des altérations du sex-ratio. Nos résultats confirment la susceptibilité des populations à des contaminations chroniques.

Environmental stresses caused by heavy metal contamination resulted in population disturbance, consequently reflecting the whole ecosystem biotic relationship (1). It has been showed (2, 3, 4) that acute toxicity tests (LT_{50}) are unable to state the true ecological damages if no correlated to long term effects, being the persistence of a species more easily affect by continuous sublethal contamination than by a single massive one.
Idotea baltica, a crustacean isopod widely distributed along marine coasts, constitutes a very important link between detritus and grazing food chains (5).
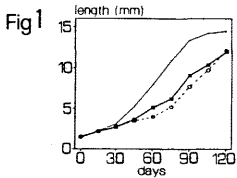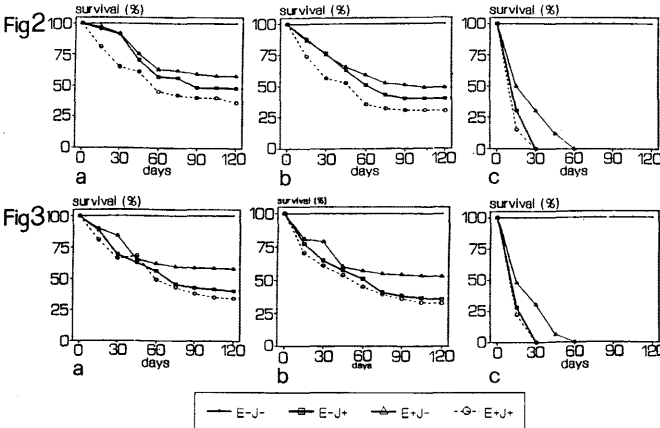

Fig.1 Body growth (as mm lenght) of juveniles bred SW (— control) in 0.5 mg·l⁻¹ of Cd (-•-) or Cu (-⊖-) These data refer only to females.
Fig.2 Survival of *I.b.* juveniles with 0.005 (a), 0.01 (b) and 0.5 mg·l⁻¹ of Cd.
Fig.3 Survival of *I.b.* juveniles with 0.005 (a), 0.01 (b) and 0.5 mg·l⁻¹ of Cu.

Under standard laboratory conditions acute toxicities of Cd^{+2}, Cu^{+2}, Cr^{+4}, Hg^{+2}, Fe^{+2}, Zn^{+2} were evaluated by means of LT_{50} separately on males, females and juveniles exposed to several concentrations of metal ions, rancing from 0.01 to 10 mg·l⁻¹. An increasing scale of toxicity, $Cd^{+2} < Fe^{+2} < Zn^{+2} < Cu^{+2} < Cr^{+4} < Hg^{+2}$, has been evaluated. Juveniles result more sensitive than adults (p<.01) and, for low concentrations of Cd^{+2} or Cu^{+2} only, males appeared more sensitive than females (p<.01).
Since Cd^{+2} and Cu^{+2} are more frequently recorded in coastal waters, their long-term effects has been studied on growth rate, sex-ratio and survival of juveniles. Low contaminations (0.5 mg·l⁻¹, 0.01 mg·l⁻¹, 0.005 mg·l⁻¹) during: i) embryonic development (E⁺J⁻), ii) juvenile development (E⁻J⁺), iii) both embryonic and juvenile development (E⁺J⁺), were performed.
The highest concentration (0.5 mg·l⁻¹) induces significative modifications in all tested biological parameters. When sex differentation takes places, sex-ratio measured on day 60, appears strongly modified, females largely exceeding males (75% and 84% respectively for Cd and Cu). This indicates a higher male sensitivity respect to the females during the first two month of development. Consequently the growth rate was determined at this concentration only for females specimens, whose lenght is strongly reduced (p<.01) by both Cd and Cu treatment (Fig.1).
No modifications of growth and sex-ratio is given by exposure to 0.005 mg·l⁻¹ or 0.01 mg·l⁻¹ Cd or Cu, while the survival is significantly affected (Fig.2,3), resulting the embryonic and juvenile treatment (E⁺J⁺) the most toxic and the embryonic treatment (E⁺J⁻) less. The Cu is more toxic than Cd in the juvenile treatment (E⁻J⁺).
No morphological differences between exposed and control animals never appeared.
In conclusion the acute toxicity test indicates the Hg the most toxic and the Cd the less one. The chronic toxicity test indicate that 0.5 mg·l⁻¹ affects strongly growth rate, sex-ratio and survival up to the total disappearance of *Idotea baltica* population. On the other hand the lower concentrations (0.01 - 0.005 mg·l⁻¹) mainly reduce the survival up to about 40%-60% of the control values with a general repercussion on the community.

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The Filtration Rate in the Mediterranean Mussel *Mytilus galloprovincialis* as a parameter to assess the toxicity of Zinc and Copper acting together

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The effects of two heavy metals, copper and zinc, acting together on the filtration rate of the Mediterranean blue mussel *Mytilus galloprovincialis* was studied, providing data on the synergism or antagonism between these two trace metals. This study also tried to evaluate a fairly simple and rapid procedure for screening and monitoring pollutants and effluent.
The animals were obtained in early December 1988 from a mussel farm located near the Salamis Island (Saronikos Gulf, Greece) and were kept at a depth of about 1 m. for a period of 4 weeks with mortality less than 0.8%. All experiments were conducted in a constant temperature room with 18±2 ° C. The nominal concentrations, in the 21 experimental aquaria, that were used to study the effects on the filtration rate, made up from a stock solution, were the following: Conc.1: 0.025 ppm Cu + 0.25 ppm Zn; Conc. 2: 0.05 ppm Cu + 0.5 ppm Zn; Conc. 3: 0.1 ppm Cu + 1 ppm Zn; Conc. 4: 0.2 ppm Cu + 2 ppm Zn; Conc. 5: 0.3 ppm Cu + 3 ppm Zn; Control. Measurements of the above solutions showed very small variation from the actual values.
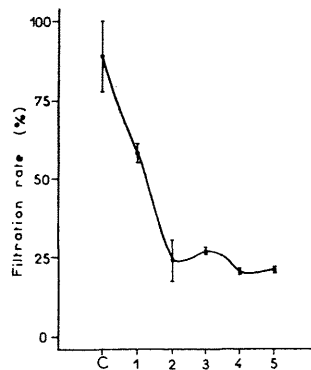

Fig 1. Effect of Cu and Zn on the filtration rate as percentage of the controls after 20 min. Vertical lines represent 95 % confidence limits.
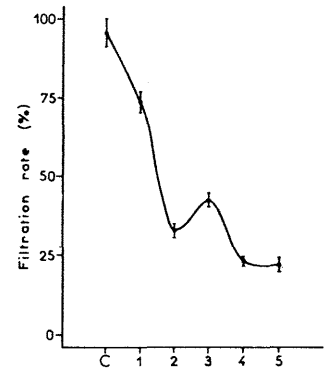
Fig 2. Effect of Cu and Zn on the filtration rate as a percentage of the controls after 40 min. Vertical lines represent 95 % confidence limits.

Following the procedure described by Abel & Papathanassiou (1984), samples of about 20 ml of water were removed after 20 and 40 min and measured, using a Perkin-Elmer/Hitachi Spectrophotometer. The formula described by Coughan (1969) was then used to determine the filtration rate. Three replicates were made for each combination of the concentrations including the controls. For the first period (0-20 min) there was a significant difference between groups (F=10.008, p = 0.0006) namely between the controls and the lowest concentrations and all other concentrations (Fig 1). Significant differences were also observed for the second period (20-40 min) (F=7.187, p = 0.0025) (Fig 2). The sensitivity from these experiments resembles to a large extent the filtration rate of the control samples of *Mytilus edulis* described by Abel (1976) and relatively lower than that described by Abel & Papathanassiou (1984); they took their samples from the local fish market (commercial supply) while in this experiment the animals were collected from a relatively undisturbed site offshore from the Salamis Island. Another factor which could also affect the filtration rate is the season in which the experiments are carried out. Abel & Papathanassiou (1984) experimented during the summer months, at the peak of the spawning season, while the present experiments were conducted during the winter months, preceding spawning, when lower metabolic activity is involved. Similar experiments in bivalves showed that when heavy metals are applied individually, the filtration rate is generally lowered (Cappuzo & Sasner, 1977; Watling & Watling, 1982; Howell et al, 1984; Mathew & Menon, 1984).
The concentration 1 is not significantly different from the controls, which suggests that the filtration rate is not affected under this environmental regime. The higher filtration rate reported for animals exposed at concentration 3, is unknown and must be related to the different physiological state of the animals, suggesting that the elevated activity observed at the low concentrations may alone be due to the increased metabolic rate to compensate the metal stress (Mathew & Menon, 1984). The decrease of the filtration rate that was observed for low concentrations suggest that at this level there is a reduction in the filtration rate due to the presence of heavy metals. The combination of concentrations of the two metals in the present study suggest that copper and zinc have certainly synergist effects but no additive ones. Finally there are advantages and disadvantages in using *M. galloprovincialis* as a test organism in the Mediterranean region. Among these are such extraneous factors as the organism's size and age, its habitat and seasonal variations. Some lack of precision in the results may be resolved if a lot of specimens are used. There are also the added effects caused by the possible metal-metal interactions and the time period during which the experiment should be conducted.

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