Use and relevance of artificial organic matter substrates to assess the functional effects of metals on natural sediment communities

Sophie CAMPICHE[1], Ayanleh M. AHMED[2,3], Carmen CASADO-MARTINEZ[1], Chloé BONNINEAU[2], Aymeric DABRIN[2], Emilie LYAUTEY[3], Stéphane PESCE[2], Benoit JD FERRARI[1]

[1]Swiss Centre for Applied Ecotoxicology Eawag-EPFL, EPFL-ENAC-IIE-GE, Station 2, CH-1015 Lausanne, Switzerland

[2]Irstea, UR MALY, 5 rue de la Doua, CS70077, 69626 Villeurbanne Cedex, France

[3]CARRTEL, UMR CARRTEL-INRA/USMB, 73376 Le Bourget-du-Lac Cedex, France

Phone: +41-(0)-21-6936258

E-mail: sophie.campiche@centreecotox.ch

Introduction: Benthic ecosystems are important areas both in terms of biodiversity and functioning. They are receiving direct or indirect inputs from the water column or from the watershed and may therefore be accumulating zones for contaminants. Many benthic and epibenthic organisms may be exposed to these substances, with as consequences, disruption of ecological traits and functions at the ecosystem level such as changes in community structure and ecosystem functioning. However, knowledge about the ecotoxicological effects of accumulated contaminants at the benthic community level is scarce. Accordingly, the present study aimed at assessing the functional impact of chronic exposure to environmental concentrations of metals on natural sediment communities. We evaluate the usefulness of assessing/studying feeding activity and organic matter breakdown as endpoints, using two kinds of artificial organic matter substrates.

Methods: Natural uncontaminated surface sediments collected in a French River (Ain) were exposed for 21 days to copper (Cu) and/or arsenic (As) at nominal individual concentrations of 40 mg/kg d.w. in laboratory channels (70 * 10 * 3 cm). The functional effects of metal contamination were assessed on the natural benthic community (microbial and macro-invertebrates communities) present in the collected sediments by studying feeding activity and organic matter breakdown using the bait lamina method (ISO 18311) and artificial tablets modified from both DECOTABs [1] and bait laminas and consisting of cellulose, bran flakes and active coal embedded in an agar matrix. The study was completed with metal concentration analysis and classical ecotoxicity tests (ostracod mortality and growth inhibition test, ISO 14371) performed in sediments over the 21 days of exposure.

Fig. 1: *Experimental laboratory channels*

Results: Before spiking, the sediment used to fill the channels contained about 2.9 mg As kg-1 dw and 1.8 mg Cu kg-1dw. Following the spike (Day 0), concentration of about 31 mg As kg-1 dw and 55 mg Cu Kg-1 dw were obtained. Over the 21 days of experiment, Cu and As concentrations in sediments decreased by 13% to 23%, depending on the kinds of metal and of treatment (individual or in mixture).
The two tested substrates (i.e. bait lamina and artificial tablets) showed similar results with low effect of As on feeding activity and organic matter breakdown whereas Cu demonstrate a strongest functional effect. When the two metals were present in a mixture, a total inhibition of these two parameters was observed, whatever the kind of substrate. The ostracod toxicity test revealed a similar pattern, showing high toxicity of Cu-spiked and mixture-spiked sediments and low toxicity of As-spiked sediments

Discussion: Our results highlight the potential utility of artificial organic matter substrates such as bait laminas or artificial tablets to assess the functional effects of contaminants on sediment communities (microorganisms and invertebrates) and on biochemical processes. Indeed, using a laboratory microcosm study, we showed that environmentally realistic concentrations of Cu (alone or mixed with As) could exert a functional impact on sediment communities, thus reducing their ability to consume organic matter and contribute to decomposition. Such effects can potentially lead to ecological disturbances in contaminated benthic environments. These results open new perspectives to assess the ecological quality of sediments and confirm the need for developing studies to better understand the ecotoxicological impact of contaminants on natural sediment communities.

Acknowledgements: The authors thank Bernadette Volat, Josiane Gahou, Bernard Motte and Christophe Rosy for their technical support.

References: [1] Kampfraath et al. (2012) *Freshwater Sci.* **31**:1156-1162