Functional endpoints in ecotoxicology: A case study in freshwater indoor microcosms

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Background

Little is known about the influence of toxics on the function of freshwater sediments. To better understand these effects, a microcosm experiment was carried out with Cadmium (Cd) as a model pollutant (50 and 400 mg Cd kg⁻¹ dry sediment). In a 7 month study the effect of Cd was examined on biomass (B), secondary production (P) and its relationship (P/B) of the zoobenthos. The results can provide new insights into benthic community disturbances and the functional consequences thereof.

Materials and methods

The secondary production of the benthic community was studied in indoor microcosms over seven months with monthly sampling at eight occasions (T0 - T7; T0: initial value, T1 - T7: experimental time). The temperature was maintained at 20 °C under a 12:12 h light:dark regime. The overlying water was skimmed to sediment surface level after which a 1-L aqueous Cd solution (as CdCl₂·H₂O, dissolved in deionized water) was added to final nominal low (LC) and high (HC) concentrations of 50 and 400 mg kg⁻¹ dry sediment, respectively. For the control, 1 L of deionized water was added. Five replicates were set up for the control and each of the two Cd concentrations (= 15 microcosms). The Cd-spiked sediments were gently mixed using a large plastic comb. Skimmed water was refilled up to 10 cm one day later. Abundance, biomass and secondary production was determined as outlined below:

- **Abundance was determined by direct counts using DAPI** (Porter and Feig, 1980; Schallenberg et al., 1989)
- **Biomass was calculated after Bratbak and Dudas (1984)**
- **Secondary production was measured using the H³ marked thymidine method of Findlay (1993)**

Results

![Image](image-url)

**Fig. 1. Succession of estimated P/B ratios of metazoans, protozoans, bacteria and the entire community under three conditions (control, LC = 50 mg Cd kg⁻¹ dry sediment, HC = 400 mg Cd kg⁻¹ dry sediment; mean ± SE, n=5).**

**Fig. 2. Secondary production of the zoobenthic community under three treatment conditions (control, LC = 50 mg Cd kg⁻¹ dry sediment, HC = 400 mg Cd kg⁻¹ dry sediment; mean ± SE, n=5).**

**Table 1. Biomass, secondary production and the corresponding P/B ratio of metazoans, protozoans, bacteria and the entire community in microcosms over seven months (T1 - T7) under three treatment conditions (control, LC, HC; mean ± SD, n=5). Asterisks indicate level of significance (mANOVA with post-hoc 2-sided Dunnett or Games-Howell).**

**Table 2. Secondary production of benthons in response to three different treatments over 7 months (CN, LC, HC; mean ± SD, n=5). Asterisks indicate level of significance (mANOVA with post-hoc Games-Howell).**

Discussion

- **Strong effects on biomass, secondary production and their relationship P/B**
- **Strong differences among taxa. Relatively fast reproducers within metazoans and protozoans (r-strategists) are able to thrive under LC condition.**
- **Increased P/B ratio under Cd stress of bacteria and protozoans (fast reproducers)**
- **Functional endpoints (secondary production, P/B) provide new insights into community disturbance and appear to be sensitive endpoints with acceptably low variance of data.**
- **Increasing the evaluation options of microcosms**
- **Extending the available information for ecotoxicological risk assessments**