A MICROCOSM STUDY TO INVESTIGATE THE EFFECTS OF NONYLPHENOL ON THE ZOOPLANKTON COMMUNITY

Gabriele F. Severin, Gerhard Welzl[1], Gerd Pfister, Ingrid Jüttner, Karl-Werner Schramm and Antonius Kettrup

Institute of Ecological Chemistry, GSF Research Center of Environment and Health, Ingolstaedter Landstr. 1, D-85764 Neuherberg, Germany
[1]Institute of Biomathematics and Biometry, GSF Research Center of Environment and Health, Ingolstaedter Landstr. 1, D-85764 Neuherberg, Germany

Introduction

There is a great focus on substances occurring in the environment and interfering with the hormone system of a wide range of organisms. Many of these so called endocrine disruptors have estrogenic character which means that they have similar effects as the female sex hormone 17β-estradiol. Among the compounds with the potential to affect hormone pathways are besides many others the biodegradation products of alkylphenol polyethoxylates such as nonylphenol (NP)[1]. The estrogenic property of NP was already shown for vertebrates, especially for fish[2]. The results for invertebrates are controversially discussed, due to the fast decrease and fluctuations of the nonylphenol concentrations in the experiments which make it difficult to obtain comparable data[3]. Effects of NP on the zooplankton society were shown in only one field study with littoral enclosures where NP was added directly to the medium[4]. We conducted a microcosm study to assess the hazardous potential of NP on the natural biocenosis under realistic exposure conditions.

Methods and Materials

Cylindrical containers (∅ 80 cm, height 60 cm) made from stainless steel were filled with a 10 cm layer of natural lake sediment, 230 L water and plankton organisms from an oligo-mesotrophic littoral area from Lake Ammersee (Bavaria, Germany). The microcosms were installed in an artificial outdoor pond to maintain constant temperature. An automatically operated transparent roof covered the model ecosystems in case of rainfall events to avoid water overflow. Technical NP was applied in seven different concentrations ranging from 10 μg/L to 120 μg/L (max. conc.) using a controlled release system made from semi-permeable LDPE tubes[5]. The exposure time was seven weeks, nine microcosms served as controls. From May to September the physical and chemical parameters were measured and plankton samples were taken in weekly intervals. Multivariate statistical analysis (CANOCO) was used to show effects of the chemical on the zooplankton groups as well as toxic effects on the phytoplankton[6, 7].

Results and Discussion

The nonylphenol concentrations increased during the first 2.5 weeks, remained constant until the reservoirs were removed, and dropped below the limit of determination in the first two weeks of the six-week-post-application phase. (Fig. 1) The values for oxygen saturation, pH, conductivity as well as NO_3-N, PO_4-P and NH_4-N of the microcosms exposed were on the whole within the range of the controls.

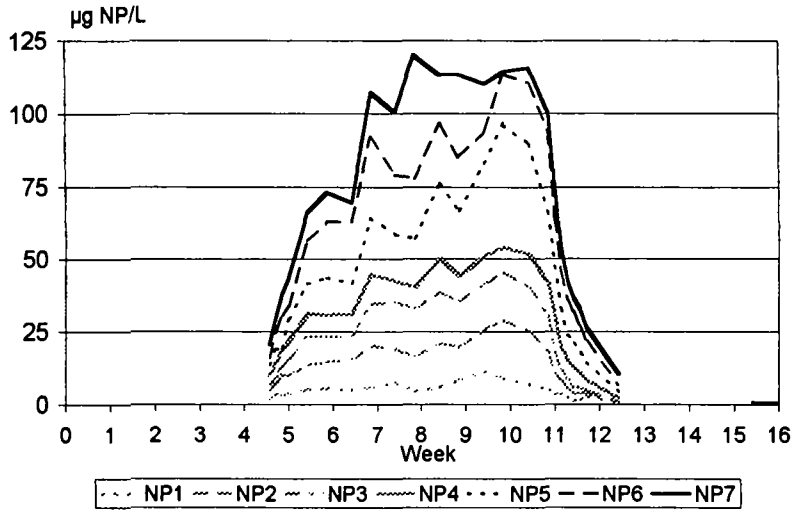

Fig . 1: Concentration of NP in water of 230 L microcosms[5]

The total abundance of the rotifers increased before the nonylphenol dosing and even during and after the application their population dynamic did not show any dependence on the concentration of NP. In contrast to that, the variation within the organism densities of the cladocerans and copepods seemed to be more moderate in the polluted microcosms than in the controls. Likewise the total abundances of the cladocerans in NP6 and NP7 and the copepods in the four highest NP-concentrations were lower during the exposition. (Fig. 2a, b, c)

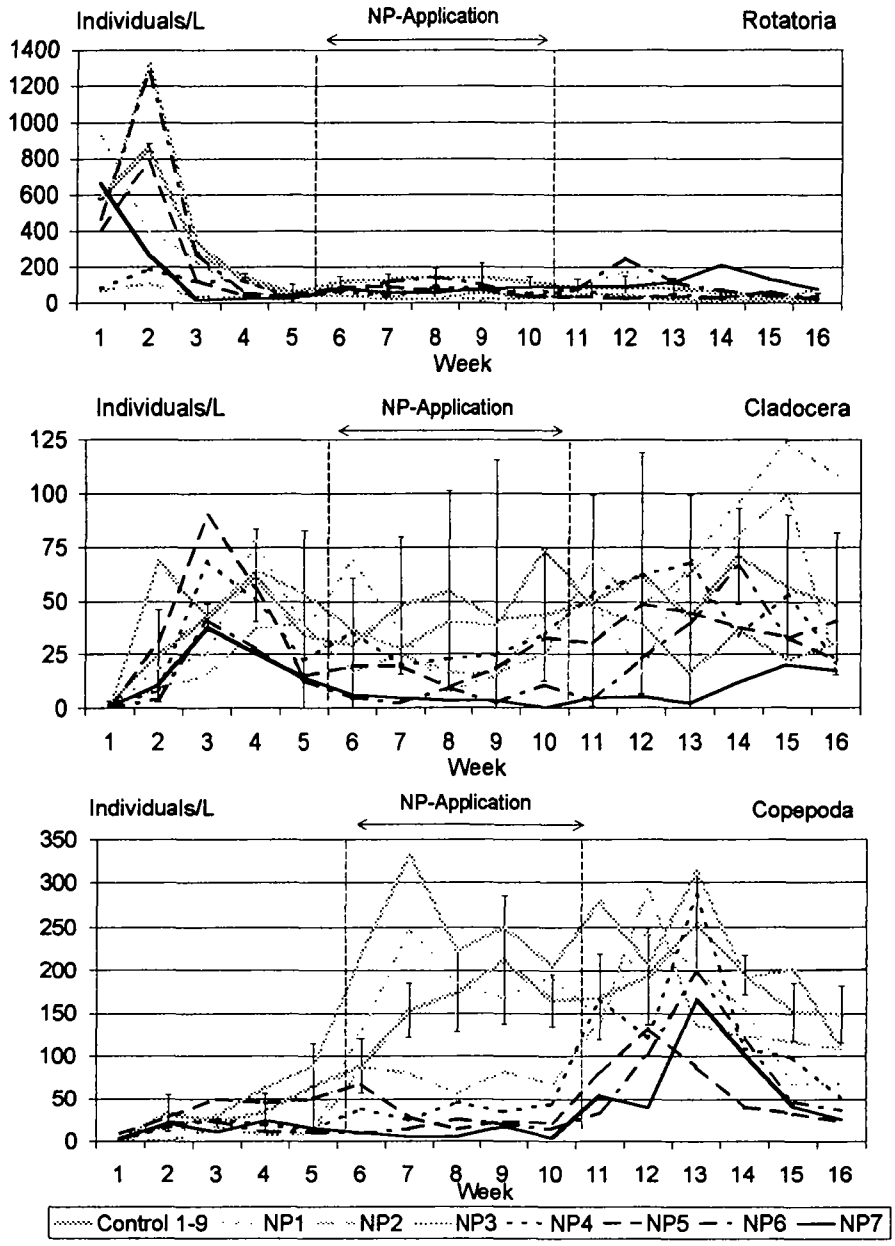

Fig. 2a-c: Population dynamics of the rotifers, cladocerans and copepods in NP-treated microcosms and in controls (with standard deviation)

Conclusions:
Multivariate statistical methods (Principal Response Curves) confirmed the observed effects. The variance of the microcosms treated with NP from the controls is caused by the cladocerans and the copepods. Statements about dose-response-relationships for these groups can be given for NP-concentrations above ~ 65 µg/L. Whether the observed effects are caused by the endocrine disrupting properties of nonylphenol or result from its toxicity has to be verified by an experiment with a positive control, e.g. ethinylestradiol. Additionally, possible interactions (bottom-up, top-down) between producers and consumers have to be considered.

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