TOXICOLOGICAL ASSESSMENT OF RIVER WATER QUALITY IN BIOASSAYS WITH FISH*

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Abstract. A series of bioassays with fish was developed in order to evaluate toxicological aspects of polluted rivers in The Netherlands. A long-term exposition of trout to riverwater under standardized conditions enables the detection of pathological effects such as growth retardation, liver and kidney enlargement and changes in clinical blood parameters. Bioaccumulation of heavy metals and organochlorine compounds can also be measured. Embryo-larval tests with trout were less suitable, because of yearly variations in egg quality. In the near future, sister chromatid exchange (SCE) assays in vivo with Nothobranchius may become available for the detection of mutagenic effects. It was possible to measure trends in toxicological quality of Rhinewater with these tests. However extrapolation of results to ecosystems and tracing of the causes of changes occurring in water quality are still problematic.

1. Introduction

In the past decennia, many aquatic ecosystems, and Dutch rivers in particular, have been burdened with various kinds of pollutants. Most of the time such pollution is monitored by chemical measurements. However, chemical monitoring does not allow detection and quantification of adverse effects on aquatic organisms. Only a small part of organic compounds can be isolated from water and identified with present gas chromatographic and mass spectrometric techniques (Van der Gaag et al., 1982; Noordsij et al., 1982). Most compounds identified in river water in The Netherlands occur at concentrations below the 'no toxic effect' levels stated in literature. Also limited data are available on joint toxic action of different substances. Therefore, it seemed worthwhile to investigate whether bioassays with aquatic organisms are needed to obtain more information on effects of pollution on the aquatic environment.

In order to detect and quantify possible adverse effects on fish of polluted river waters in The Netherlands, a number of bioassays has been investigated or developed in our laboratory. The primary aim of this research was to be able to observe toxic effects in raw water sources for drinking water preparation. In this paper the background and a number of results of this research are discussed, with special attention for the possibilities to use these bioassays for the evaluation of aquatic ecosystems.

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2. Experimental Set-Up

In all experiments fish exposed to river water were compared to control fish reared under similar conditions in unchlorinated groundwater of optimal quality. In order to detect effects of water quality on different parameters, test conditions have to be standardized, with respect to continuous water supply, aquarium dimensions, feeding, temperature and oxygen saturation. Most of the bioassays described in this study were carried out at the KIWA-Toxicological laboratory in Nieuwegein, where Rhinewater was continuously available (Poels et al., 1980).

Sublethal influences of environmental factors can be measured at different levels in organisms. Growth, reproduction and teratogenicity can be monitored in whole animals. Measurements of relative organ weight, enzyme activity, clinical parameters in blood and bioaccumulation as well as histological examination can be carried out in different organs. They give information on specific organ activities, stress and fate of non biodegradable compounds. DNA damage or chromosomal aberrations can be measured at cellular level and are an indication for the presence of mutagens. The determination of all these parameters could be possible in one long term experiment. For practical reasons however, the different measurements have been divided into three standardized assays, allowing shorter test durations:

(1) a long term exposition (24 weeks) of yearling trout (*Salmo gairdneri*, Rich.), including measurements of growth, relative liver and kidney weight, blood parameters, identification of accumulated organohalogens and heavy metals. This assay was derived from the long term test described by Poels et al. (1980).

(2) an embryo-larval bioassay with trout (6 to 10 weeks) for measurements of mortality, embryonic development, growth and teratogenesis (Van der Gaag unpubl.).

(3) a DNA-damage test with mudminnows (*Umbra pygmaea*) or *Nothobranchius rachowi* by measurement of sister chromatid exchange (SCE) frequency (Alink et al., 1980; Van der Hoeven et al., 1982).

3. Longterm Toxicity Tests

3.1. LONGTERM TOXICITY TESTS ON WATER OF THE RIVERS RHINE AND MEUSE

Compared to control, rainbow trout exposed to water from the Rhine showed retarded growth, increased relative weight of both liver and kidney, and lowered haematocrit (Table I). These effects were observed during experiments in 1975/’76 (Poels, 1978; Poels et al., 1980) as well as in 1981/’82, but their impact was stronger in the first series of tests. Accumulation of organohalogens in adipose tissue was also higher in 1975/’76 than in 1981/’82, while a larger number of different compounds was identified in 1975 (DDT, TDE, PCB’s, penta- and hexachlorobenzene and dieldrin) than in 1982 (penta- and hexachlorobenzene, pentachlorothioanisol and γ-HCH) (Table I). Other effects which occurred after longer exposure in 1975 (increased blood glucose levels after 6–8 months, atrophy of hepatocytes, histological changes in the spleen after 15 months) were not observed during the 24 weeks experiment in 1981/’82. Evaluation of effects