3 Toxic Reduction of Daphnid Grazing Effectiveness

3.1 Daphnid Ecotoxicology

Daphnids as Ecotoxicological Test Species

During the past decades, a large number of freshwater invertebrates have been used in ecotoxicity testing. However, world-wide, only the cladoceran crustaceans have emerged as a key group for standardised ecotoxicological tests (Persoone and Janssen 1993). Scientific as well as practical considerations directed the choice of cladocerans (Baudo 1987; Persoone and Janssen 1993; Mark and Solbé 1998):

- Cladocerans occur world-wide in a large variety of freshwater types;
- They fulfil a key role in freshwater food chains;
- They are assumed to be relatively sensitive compared with other organisms;
- They are sensitive to a wide variety of contaminants;
- They are relatively easy to culture in the laboratory;
- Reproduction is normally parthenogenic;
- They have a short life cycle;
- They can be tested in small volume test systems.

The standardised tests that have been developed assess the relative toxicity of existing and newly developed chemical substances. A tiered approach is usually followed in environmental hazard and risk assessment. A first screening is performed consisting of simple short duration tests, which identify clear end-points, such as mortality. If this first screening indicates that toxic effects are expected, more sophisticated tests are set up to determine any sub-lethal endpoints resulting from chronic exposure. Tests are usually performed on species from three major taxa: algae, crustaceans (and/or insects), and fish. For pesticides, this tiered approach, which is required in regulatory procedures, may eventually result in the execution of mesocosm experiments in order to assess the environmental effects in test systems that mimic field conditions, including field relevant exposure and biodiversity.

The cladoceran species most frequently used are *Daphnia magna, D. pulex* and *Ceriodaphnia dubia* (OECD 1993a), but many other cladoceran species have been used in ecotoxicological testing (Baudo 1987). In general, the sensitivity variation between cladoceran species is less that the variation between invertebrate species. In selecting cladocerans as the standard, the OECD regarded overall sensitivity and widespread experience with the test species as being of more importance than

the testing of local species which might be relevant to (local) waters giving cause for concern (OECD 1993a).

Daphnia magna and *D. pulex* are the most commonly used species in acute toxicity tests for the purpose of assessing the relative toxicity of chemical substances in which mortality is used as the toxic end-point. In other words, the number of individuals killed by a range of substance concentrations in water is recorded after an incubation period of 24 or 48 hours. Several ring tests have shown that the test has a reasonably well intra- and inter-laboratory repeatability (Persoone and Janssen 1993).

Both *Daphnia* and *Ceriodaphnia* species are also used for chronic tests in which survival and reproduction (number of young produced) is recorded over a period of 21 and 7 days, respectively. Water is renewed daily or three times a week, and the animals are fed daily. As in acute tests, exposure to the test substance is exclusively via the water since the test set-up does not facilitate uptake via the food.

Daphnids and other cladocerans appear to be very sensitive to various pesticides, most notably insecticides. In Table 3.1, the toxicity of pesticides to cladocerans, algae and fish is listed, showing the sensitivity of cladocerans. The relative sensitivity of cladoceran species compared to other invertebrates and algae has also become evident from several mesocosm studies (see Sect. 3.2) in which the response of different populations can be observed resulting from the same toxic exposure concentration.

Standardised single-species ecotoxicological tests are especially useful when comparing chemicals (e.g., for notification purposes). When assessing the impact of substances in actual field situations, however, different information may be needed, including data with more chemical and biological 'realism'. The extrapolation of standardised test results to field situations for ecological risk assessment may be troublesome for several reasons (Baudo 1987; Baird et al. 1991):

- Laboratory tests indicate the sensitivity of a certain, inbred, laboratory population, which does not necessarily resemble that of genetically diverse field populations;
- Laboratory test conditions may be markedly different from field conditions;
- The test species is not always representative of the most sensitive member of a given community for a given contaminant in the field;
- Food-web interactions between species in an aquatic community are neglected;
- The bioavailability of the substance differs from the field (see below).

Role of Food

The role of (food) particles in the bioavailability of substances is usually ignored in toxicity testing. In standardised tests, single toxicants are tested to which the organisms are primarily exposed via the water. In acute tests, daphnids are not fed at all during exposure. This means that exposure and uptake of the contaminant only takes place via the water. In chronic tests, daphnids are fed, but exposure to the contaminant is still mainly via the water and not via the food, since the food is