Protocol for Ecotoxicological Risk Assessment at the Population Level

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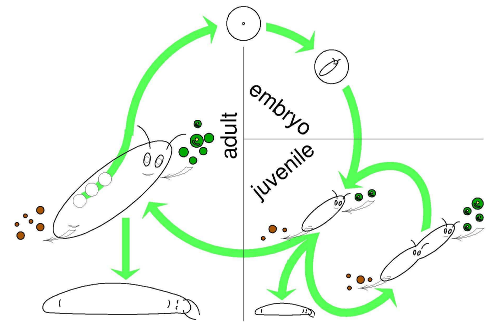
1. FROM SINGLE SPECIES TO POPULATIONS

Chemical risk assessment relies on highly standardised toxicity tests. Extrapolation of the test results to field situations is difficult because tests use unrepresentative species, and because the tested endpoint is not necessarily relevant to the population level.

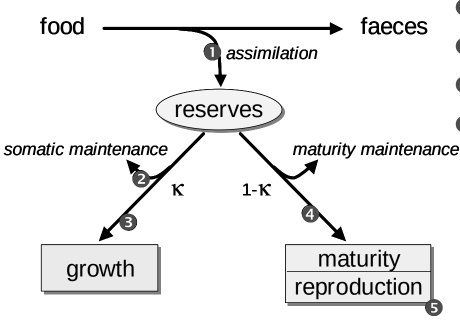
In 2002, we started a project to develop a software protocol, bridging the gap between single-species tests and population effects. We are currently performing life-cycle toxicity experiments with several nematode species, representing various types of life-cycle strategies. The nematodes may serve as a “blueprint” for the risk assessment of other animals.

For the analysis of the life-cycle data, we adapted the existing model DEBtox. Some preliminary results are presented here.

Generalised life cycle



The modes of action in DEBtox



❶ assimilation
❷ maintenance costs
❸ growth costs
❹ reproduction costs
❺ hazard to embryo

2. TOXICITY AND ENERGY BUDGETS

The theory of dynamic energy budgets (DEB) describes organisms based on a full-balance approach for energy. Exposure to toxicants can be understood as a disruption of the energetics.

This approach led to the development of DEBtox, a suite of models to analyse aquatic toxicity tests. Two major adaptations were necessary before the model could be applied to life-cycle tests:

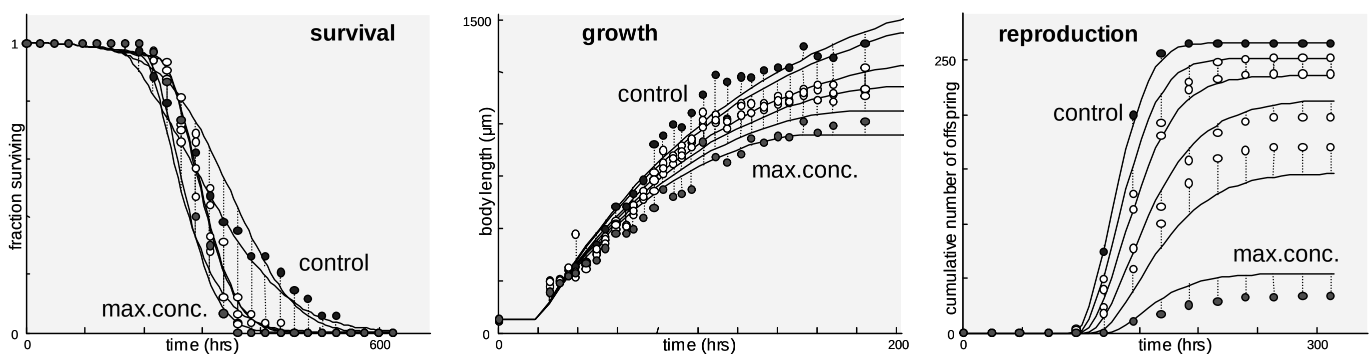
Simultaneous fitting

The different toxic endpoints share common parameters, and therefore, the datasets have to be fitted simultaneously (on the basis of likelihood).

Senescence

Standard toxicity tests terminate before the animals show signs of ageing. In life-cycle tests, we need to model age-related survival, as well as the decrease of reproductive output. The ageing module (Van Leeuwen *et al.*, 2002) is based on the oxidative stress hypothesis.

Simultaneous fit on life-cycle toxicity data for the nematode C. elegans *exposed to cadmium.*



3. EXAMPLE FOR CADMIUM IN *C. ELEGANS*

To demonstrate the model, preliminary results are shown in Figure 3, for cadmium-exposed nematodes (*Caenorhabditis elegans*). The model is able to simultaneously describe all endpoints in time.

The effect of cadmium can be described by assuming that the mode of action is though the assimilation of energy from food (mode 1 in the DEBtox scheme). However, the survival data indicate that ageing increase the sensitivity for cadmium.

4. OUTLOOK

- Experiments will be performed with different species of nematodes, and several other chemicals.
- Model results will be used to predict population growth rates, with the associated uncertainty.
- The nematode data will act as “blueprint” in the protocol for other animals, and a user-friendly software environment will be developed.
- More information on DEB, DEBtox and references can be found on our website.