Many chemicals – high risk:
Challenges for effect analysis in aquatic ecosystems

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moderator / organiser
et al. (as listed below)

Purpose: Identify the needs for effect-based methodologies in (aquatic) ecotoxicology
Perspective outcome: Position paper with suggestions on how to implement and further develop methods for aquatic hazard and risk assessment

As a consequence of considerable efforts to reduce and avoid contamination of rivers and lakes, classical parameters to assess water quality have improved significantly in the last decade. However, the advent of new, often specifically acting "emerging" compounds, as e.g. pharmaceuticals, and the continuously rising number of chemical compounds occurring in the environment and co-acting in biota has become a major challenge in aquatic ecosystem health assessment. Whereas established risk assessment procedures mainly focus on unspecific effects of single substances at comparatively high concentration (as found, e.g., during chemical spills and accidents) the advent of new groups of chemical contaminants, which no longer display acutely toxic effects, but have on purpose been designed to address specific modes of action, require a shift towards an effect-based risk assessment, which integrate mixture toxicity and address specific molecular and physiological processes in biota.

This shift from the assessment of acute toxicity of single compounds to the assessment of chemical mixtures of specifically acting substances at low concentrations fundamentally questions existing strategies of ecotoxicity assessment and emphasizes the necessity of effect-based risk assessment strategies. During the 2 h workshop, five ecotoxicologists will give brief statements (6 – 8 min) on their views on how ecotoxicological testing may integrate effect-based risk assessment strategies. These should go as provocative theses to be discussed in an open exchange with the audience of the workshop.

Rita Triebskorn (Univ. Tübingen):
In view of increasing needs for risk assessment strategies which also allow to evaluate risk posed by often specifically acting substances and multiple stressors (including confounding factors) on a larger time scale, i.e. as early warning signals, biomarkers are recommended as sensitive diagnostic tools, by which both the general health status of exposed biota as well as interferences of stressors with specific biochemical or physiological pathways can be characterized. The set of recommended biomarkers needs to be adjusted according to the respective question of interest. In general, biomarkers can be applied in retrospective as well as in prospective risk assessment with a focus on both vertebrates and invertebrates.

Dirk Jungmann (TU Dresden):
For the monitoring of water quality in central Europe, the use of in vivo biotests is a story off success within the last centuries resulting in improving water quality. However, environmental protection is an ongoing task, and under growing economic conditions and accelerating development biotests have to be developed further as well. Lower tier studies are well developed, but, in order to assess the diversity of micropollutants, higher tier studies must be established including at least to a minimum reproduction- and, thus, population-relevant endpoints. An important tool, in vivo biotests with native species have to be implemented in a more general strategy for biomonitoring.

Thomas Braunbeck (Univ. Heidelberg):
With the advent of REACH, the development of alternative methods has been made an imperative component of testing strategies in both toxicology and ecotoxicology. As vertebrates and established monitoring organisms, fish traditionally play an important role in aquatic ecosystem health and toxicity assessment. However, given the mandate to replace, refine and reduce vertebrate testing in particular, there is an urgent need to develop alternative methods for toxicity assessment. With various cell culture models and the increasing acceptance of fish embryo toxicity testing, methods are underway that – at least in combinations – allow to significantly replace vertebrate testing in aquatic hazard and risk assessment.

Manfred Frey (Steinbeis-Innovationszentrum Zellkulturtechnik, Mannheim):
The removal of pharmaceuticals from wastewater remains frequently inefficient. Consequently, a biologically active mixture of pharmaceuticals as well as their mostly unknown metabolites and transformation products is regularly discharged into surface waters. Due to the conservation of central signal transduction pathways in different organisms, highly specific pharmaceuticals can affect species even at low concentrations. For simultaneously monitoring all active compounds as well as metabolites with the same mode of action (MOA), MOA-directed in vitro assays should be developed. Specific and sensitive live cell imaging assays based on genetically encoded fluorescent biosensors provide a tool for environmental monitoring programs, e.g. in the context with the characterization of the efficiency of new wastewater treatment purification technologies.

Rolf Altenburger (Helmholtz Center for Environmental Research, Leipzig):
Various omics-based molecular approaches allow the identification of multiple changes in both in vivo and in vitro test systems. Although still under development, these technologies should also have the potential to identify novel modes of action as well as combinations of MOAs. Within the concept of Adverse Outcome Pathways (AOPs), such approaches frequently serve to align sequences of biological events, which are then related to adverse effects. Given the multiple occurrence of aquatic contaminants chemical invariant AOPs offer scope for the aggregation of multiple exposure into fewer effect-based measures which may complement current chemical monitoring.