Workshop Summaries

Workshop 'Ecotoxicology: Scientific Profile and Practical Needs'

10–11 July 2003, University of Bayreuth, Germany
Organisation: Prof. Dr. Hartmut Frank, Chair 'Environmental Chemistry and Ecotoxicology' (encetox@uni-bayreuth.de)

Program

Thursday, 10 July 2003

13:30 Opening
Prof. Dr. Helmut Ruppert, President, *University Bayreuth*
Prof. Dr. Ulrich Schlottmann, Ministerialrat, *Federal Ministry of Environment, Bonn*

13:50 Dr. Klaus-Günter Steinhäuser, *Federal Environmental Agency, Berlin*
Regulatory Needs for Ecotoxicologists

14:10 Prof. Dr. Hartmut Frank, *Environmental Chemistry and Ecotoxicology, University Bayreuth*
Scope and Profile of Academic Ecotoxicology

14:30 Prof. Dr. Heinz-Peter Gelbke, *Head, Central Toxicology Laboratories, BASF, Ludwigshafen*
Ecotoxicology from an Industrial Perspective

15:10 Prof. Dr. Paule Vasseur, *Institute for Ecotoxicology, University Metz, France*
Experiences in France on University Programs

15:30 Prof. Dr. Stephen H. Safe, *Veterinary Physiology, Texas A & M University, College Station, USA*
Experiences in the USA on University Programs

16:10 Prof. Dr. Roland Nagel, *Institute for Hydrobiology, Technical University Dresden*
Ecotoxicology, Effects and their Assessment

16:30 Prof. Dr. Christian Steinberg, *Leibniz Institute for Aquatic Ecology, Berlin*
Expectations in Ecotoxicology

16:50 Prof. Dr. Dietrich Henschler, *Institute for Toxicology, University Würzburg*
The Role of Toxicology in Ecotoxicology

Friday, 11 July 2003

09:00 **Summaries:** Needs (Steinhäuser, Gelbke) • Scientific profile (Vasseur, Safe) • Academic training (Rether, Frank)

11:00 **Recommendations for a Curriculum in Ecotoxicology** (all participants)

Regulatory Needs for Ecotoxicologists

Klaus-G. Steinhäuser, Federal Environmental Agency, Berlin, Germany

The numerous functions of the German Federal Environmental Agency (Umweltbundesamt) open up a large field of activities for the trained ecotoxicologist. In order to assess the risks for humans and the environment from the exposure to industrial chemicals, biocides and drugs, a rather broad knowledge of ecotoxicology is necessary. Physicochemical data as well as information on degradation and accumulation in the environmental compartments water, sediment, soil and atmosphere have to be validated, modeling has to be carried out to calculate the distribution and fate of chemicals in these compartments, and the predicted environmental concentrations have to be verified by comparing them with measured data. In order to evaluate the effects of chemical substances on organisms and ecosystems, ecotoxicologists must have sound knowledge in the field of biology. In addition, at least basic knowledge of the toxicokinetics and metabolism of chemicals as well as of molecular biology, ecology, and statistics is essential.

Considerations on the effects of individual substances on individual organisms have been the main focus in the past; in the future, increased emphasis will be placed on understanding the effects of substances and substance mixtures on complex biological systems. This concerns the simultaneous release of large numbers of substances to environmental compartments, their distribution pathways and transformation mechanisms, critical effect thresholds as well as effects on organisms, populations, and communities of organisms, and likewise functional ecosystem parameters. Furthermore, ecotoxicological expertise is needed for the assessment of polluted waters, sediments, and soils as well as complex mixtures of chemicals of unknown identity in wastewater and waste. The Federal Environmental Agency is also involved in the development and validation of new ecotoxicological tests including experimental studies ranging from laboratory tests with single species up to model ecosystems like lentic and lotic mesocosms. Thus, performing such risk assessments requires wide-ranging training, which encompasses biological, ecological, chemical, biometric aspects as well as knowledge in fields outside the natural sciences, e.g. law and economics.

Scope and Profile of Academic Ecotoxicology

Hartmut Frank, Environmental Chemistry and Ecotoxicology, University of Bayreuth, Germany

Ecotoxicology is a young scientific discipline needed for assessing the impact and disturbances of chemicals introduced or mobilized by human-industrial activities and by natural processes, and also for developing models and theories for the prediction of future developments in this area; in this respect, it is a knowledge-based 'future-science'. The latter is particularly urgent in view of the fact that 1. the human population will grow by more than hundred percent in the next half of the century, and 2. the resulting chemical impact by the increased industrial turnover is likely to become heavier. Therefore, a deeper understanding of the scientific base of the respective, extremely complex interdependencies is necessary, not only in a descriptive sense but, more importantly, in respect to the cause-effect relationships. As ecotoxicology, at the interphase of chemosphere and biosphere, is still in its infancy and has to cover a wide span of disciplines – from physics and chemistry via the geo-sciences, biochemistry, toxicology, physiology, morphology all the way to ecology and biogeography, under inclusion of psychological, economical, and judicial aspects –, it is clear that such expertise can only be acquired by studies which correspond in their total scope to no less than a classical, but transdisciplinary academic teaching program, a doctoral thesis and, desirably, a few years of postdoctoral experience.

Ecotoxicology from an Industrial Perspective

Heinz-Peter Gelbke, BASF AG, Ludwigshafen, Germany

The upcoming chemicals regulation in the EU under REACH will put a heavy burden on the European Chemical Industry with regard to testing requirements for ecology and ecotoxicology. Similar requirements do not exist in other regions, neither in the US nor in the Far East.

Eco(toxico)logy test requirements and associated costs are compared in respect to 1. the existing chemicals regulation for new chemicals, and 2. the upcoming regulation under REACH for new and existing chemicals. In total and to-date, the number of chemicals to be covered by REACH within 11 years is more than one to two orders of magnitude higher than the chemicals evaluated in Europe (depending on the production volume) during the last 20 years.

Therefore, uniquely in Europe, REACH will lead to a large amount of data for many chemicals to be evaluated by risk assessments and possibly regulated by risk management decisions. What will be the impact on the global competitiveness of the European Chemical Industry?

With all these upcoming data, assessments and management decisions, we (as a society and industry and regulatory authorities) urgently need well-trained professionals for eco(toxico)logy. Their expertise should be proven by a rigorous examination, and it is proposed that such an examination is a **must** for regulators since our society and economy depends on their professional judgments. It should be under the responsibility of our universities to provide an appropriate curriculum with theoretical courses and experimental training to guarantee the availability of the necessary professionals in Europe. Training courses should be set-up in close cooperation with authorities and industry to meet the regulatory requirements.

There is one specificity for eco(toxico)logy as compared to toxicology: an appropriate design on test strategies depends on the environmental fate and compartment distributions. Thus, the computer for environmental fate modeling will be the 'workhorse' for the eco(toxico)logist in respect to the environment, as is the rat for the toxicologist in respect to human health.

Experiences in the USA on University Programs in Ecotoxicology

Stephen Safe, Veterinary Physiol., Texas A & M University, College Station, USA

Ecotoxicology training and research are carried out at over eighty Universities in North America, and these are listed on their respective web sites by the Society for Environmental Toxicology and Chemistry (SETAC) and the Society of Toxicology (SOT). With few exceptions, ecotoxicology is not offered as a single field of study but is part of a more extensive curriculum in toxicology, environmental health, or environmental sciences. These programs are highly interactive and are coordinated from a single department/college or as an interdisciplinary faculty. The broad spectrum of this field is reflected by the diverse coordinating departments which include chemistry, biochemistry, pharmacology, biology, pathology, geosciences, civil and chemical engineering, and plant sciences. Ecotoxicology research at Texas A&M University is coordinated through our Interdisciplinary Faculty of Toxicology (IFT) which manages the degree programs and catalyzes faculty and student interactions and development of collaborative grant applications. This type of approach facilitates ecotoxicology research and training by providing a broad base of scientific expertise required for successfully competing for external grant funding. Examples of this expertise include analytical services, cellular imaging, proteomics, genomics, bioinformatics and biostatistics.

Ecotoxicology, Effects and their Assessment

Roland Nagel, Institute for Hydrobiology, Technical University of Dresden, Germany

Based on the definition "Ecotoxicology investigates and assesses adverse changes of structures and functions of ecosystems, which are caused by environmental chemicals. The assessment can be done prospectively or retrospectively", some results and ideas have been presented.

UV-filtering substances, TBT and intersexuality in *Gammarus fossarum* are the examples for the retrospective assessment. Two examples for prospective assessment have been given. The effects of the genotoxicant 4-nitroquinoline-N-oxide (4-NQO) on fish populations have been discussed. As an example for the investigation in multispecies tests, the effects of the herbicide terbutryn on aufwuchs and oligochaetes in artificial indoor streams have been shown. Finally, the concepts for ecotoxicological investigations and assessments have been presented.

Expectations in Ecotoxicology

Christian E.W. Steinberg, Humboldt University and Leibniz Institute for Aquatic Ecology, Berlin, Germany

Ecotoxicology claims to be a natural science rather than a tool for administration or legislation. Without any doubt, the traditional (prospective) ecotoxicology has gained merits in reducing the anthropogenic chemical load into the environment. However, there are still big gaps in understanding ecological structures and functions. Ecotoxicology has to cope with basic ecological laws, such as

- the probabilistic character of ecological events instead of simple *if-than* rules with 100% probability of occurrence,
- repair, acclimatization, and adaptation mechanisms on organismic as well as supra-organismic levels,
- the analytical rather than evaluative character of ecological science (the opposite leads to bias in scientific disguise). Evaluation and assessment are well developed scientific disciplines in applied mathematics and social science.

At present, ecotoxicology does not understand much of the ecological environment. Instead, it is a highly developed monitoring tool that spends a lot of its capacity and resources in answering the wrong questions with un-ecological means.

The Role of Toxicology in Ecotoxicology

Dietrich Henschler, Institute for Toxicology, University of Würzburg, Germany

Toxicology is as old as mankind, ecotoxicology is very young. So far, ecotoxicologists have made use of all established elements as applied in elaborating the toxicological profile of a given chemical. However, toxicology as a learned discipline constitutes a multidisciplinary approach including a variety of academically established basic sciences with their respective methodologies, rather than a classical scientific entity. Moreover, the spectrum of uncovered chemical-biological interactions with a toxicological outcome is rapidly and ever increasing. How much toxicology, then, should an ecotoxicologist be familiar with? To comply with credibility, I favour a differentiation between research and regulation. Research in the highly complex fields of ecosystems needs super-specialists who should focus on and confine their activities to a certain sector of living organisms in environmental compartments (say, e.g., worms, trees, microbia), and for this purpose adapt and use specific methodologies as established in toxicology. Regulatory activity needs generalists who should be able to perform risk analyses, thereby critically evaluating data obtained from all mandatory toxicological tests. To obtain the necessary basic knowledge for scrutinising toxicological data files, the generalist needs thorough training in all test systems routinely used in the course of elaborating the toxicological profile of old and new chemicals. This comprises: acute, sub-acute, sub-chronic, and chronic toxicity testing; toxicokinetics; xenobiotic metabolism (activating and deactivating); reproductive toxicity; carcinogenicity; characteristics and care of laboratory animals including basic principles of pathology and histopathology; biostatistics; and epidemiology; and last not least regulatory legislation. Refreshment courses in given intervals of time for keeping up with scientific progress should be made mandatory.