

## LimCo International - innovative methods to assess water pollution

**“Water is everything, nothing is without water” – so says a “water word” on the LimCo International GmbH website. This “water word” clearly highlights the essential importance of water. Faced with the continually rising levels of water pollution and the effects of toxins on the environment, many of which are not yet known, the Konstanz-based company is committed to protecting this valuable resource through research, education and consulting. LimCo International has developed the Multispecies Freshwater Biomonitor, a unique continuous early warning system that enables the fully automated detection of water contamination. The company’s GamTox toxicity test can be used to assess the ecological situation of flowing waters.**

Nowadays, (online) biomonitoring systems are used to monitor the state of plants and animals and draw conclusions on the quality of the environment. With her company LimCo International, Dr. Almut Gerhardt has developed a test system that enables water quality to be assessed on the basis of real-time measurements: the Multispecies Freshwater Biomonitor.

The fully automated, biological early warning system allows the quantitative measurement and analysis of specific stress reactions of a broad range of different indicator organisms (for example insects and fish) when water is polluted with toxic substances. "Changes in water quality, for example through toxin pulses (contamination waves), lead to changes in the animals' behaviour, which is recognised by the software, which in turn sounds an alarm. When this occurs, water samples are removed from the test site and analysed chemically," said Dr. Gerhardt explaining the principle of the Multispecies Freshwater Biomonitor. The system's small size and the ability to run on battery or generator power make it ideally suited for applications in the field, and also for testing waters that are difficult to access.

### Monitoring of a broad range of different organisms



LimCo-Geschäftsführerin Dr. Almut Gerhardt  
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The animals under investigation are monitored for several weeks in specific sensor chambers where they can move around freely. The Multispecies Freshwater Biomonitor (MFB) consists of several modules with measurement units of between eight and 96 channels. This large number of channels

allows the monitoring of many organisms of one species or several key species simultaneously. It also makes it possible to investigate the effects of toxic substances across several trophical levels. "We have already tested around 30 different species, including millimetre-size plankton and big fish," said Dr. Gerhardt highlighting the broad application spectrum of the system. "This increases the reliability and relevance of an alarm, because different species tolerate toxins differently. In addition, a larger number of measurements involving a broad range of animals increases the statistical power of the measurement result."

## Special methods open up a broad application spectrum

The recording principle of the Multispecies Freshwater Biomonitor is based on quadrupole impedance conversion: one pair of electrodes at opposite walls of the test chamber generates a high-frequency alternating current. The animals' movements change the conductivity and the electrical field between a second pair of electrodes and generate specific electrical signals for different kinds of behaviour. Different behaviours (locomotion: swimming, crawling, etc.; breathing: ventilation of gills) are measured. Almut Gerhardt points out the uniqueness of the Multispecies Freshwater Biomonitor: "The Multispecies Freshwater Biomonitor differs considerably from other biomonitoring systems. The MFB is based on a non-optical method." This enables the MFB to be used in different media (freshwater, sea water, sediment, turbid water, etc.), thereby doing away with the filtering of the samples which might lead to false results and hence to the underestimation of toxic substances.

The MFB has already been used to investigate marine organisms, something that is of great relevance in relation to oil spills. "For me, 2010 is the year of oil catastrophes. And this also shows us that we need to take oil spills a lot more seriously. It is necessary to monitor the effects of even the smallest leaks in terms of the impact on marine organisms," said the scientist who obtained her PhD from the University of Lund (Sweden) in 1995. Dr. Gerhardt's long-term goal is to adapt the MFB for practical use in connection with the petrol industry. She also regards the fact that the Multispecies Freshwater Biomonitor "is a product of a scientific environment" as a major advantage: more than 35 scientific articles have already verified the functionality of the comparatively inexpensive device. In addition, the system is available for use by scientists, public authorities and government organisations.

## GamTox – common freshwater shrimp as indicator organisms

Dr. Gerhardt's second major research project focuses on the development of rapid in-situ ecological tests and methods for the assessment of water quality. In addition to the ecotoxicological characterisation of flowing waters in general, the biologist is specifically focused on developing testing guidelines for GamTox: "GamTox stands for Gammarus toxicity testing". Many Gammarus freshwater shrimp species are found in streams and rivers in the Northern Hemisphere," explained the biologist. Gammarus species play a key role in these waters. The importance of Gammarus in the analysis of flowing waters is due to its active participation in the substance flow and its key position in the food chain. The presence or absence of Gammarus enables the researchers to draw conclusions on water pollution. Many species, including several "neozoa", i.e. invasive species in Europe, are often more resistant to contamination than endemic Gammarus species. The investigation of the ecotoxicity of invasive species allows the researchers to potentially use these species as indicators of pollution tolerance. Some of the work associated with the development of the GamTox test is carried out with the environmental engineering bureau AquaPlus in Zug (Switzerland) with the aim of establishing its practical application.



The Multispecies Freshwater Biomonitor in the flowing water simulation facility of the German Federal Environment Agency.  
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## Toxicity testing used all over Europe

“Numerous ecotoxicological studies have been carried out with *Gammarus*,” said Dr. Gerhardt explaining that the goal is to establish *Gammarus* as the standard test organism for assessing the health of flowing waters. The multimetric aquatic ecotoxicity test, which is suitable for use in the laboratory and the field, aims to bring together diverse methods as well as all available information. The testing guideline stipulates which test methods need to be applied and how they need to be applied as well as listing mechanisms detected on the basis of measurement parameters and their effects on the environment. Dr. Gerhardt provided an example of an impact chain that can be elucidated with GamTox: “The determination of the enzyme acetylcholinesterase enables the biochemical identification of neurotoxic substances; changes in swimming behaviour can be captured with the Multispecies Freshwater Biomonitor and modifications in population density and the entire species spectrum can be documented with biomonitoring methods in the field.” The comprehensive GamTox test will also be implemented under the European Water Framework Directive (WFD); it will be integrated into the routine monitoring of freshwater ecosystem health in order to help improve the quality of freshwater until 2015.

## Environmental education is of key importance

In addition to carrying out research, Almut Gerhardt also acts as consultant to government authorities, universities and industry. She sits on a number of international boards and collaborates

with the EU to assess research applications for European framework programmes. The establishment of LimCo International is based on Dr. Gerhardt's doctoral work, which led to the development of the Multispecies Freshwater Biomonitor. The huge interest generated by the test system led to Dr. Gerhardt's participation in international research projects, in China, Bolivia and Portugal, amongst others, which eventually resulted in her being able to establish her company.

The biologist attaches great importance to disseminating her knowledge and making the public aware of environmental pollution. "I very much enjoy the work related to environmental education, and I also see it as extremely important," said Dr. Gerhardt who gives courses and visits kindergartens, schools and universities to teach schoolchildren and students about water ecosystems. In addition, Dr. Gerhardt is also active in the International Decade for Action "Water for Life" and in Agenda 21. "It is very important to acquaint schoolchildren and students with the topic by introducing them to life organisms," said Dr. Gerhardt going on to add "this helps children and students to appreciate nature and learn about its original state. I have realised that I am able to provoke the children's fascination and enthusiasm for the topic." The biologist uses a book she has published as well as numerous scientific articles and photographs to show people how beautiful nature is.

Closely connected with these endeavours is her attitude towards collaboration: "I believe that only interdisciplinary approaches will lead to true innovation, to innovation that is suitable for practical application and accepted by the wider public." Dr. Gerhardt's company is also active in a broad range of national EU projects. Currently, LimCo International is planning to relocate to Konstanz and is looking for partners for the further development of environmental measurement technologies.

**Further information:**

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