

Molecular sensor-based monitoring of toxic algae

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Introduction

Planktonic algae are the most abundant photosynthetic organisms on earth and the basis of the marine food web. **Harmful algal blooms (HAB)** are blooms of planktonic algal species that have negative impacts on humans and aquatic environments. One subset of HAB is able to produce **phycotoxins** that can pass through the food chain and poison co-occurring organisms. Several climate and environmental drivers influence timing and frequency of these algal blooms. There is some evidence that the occurrence of HAB might become more intense, widespread, frequent and unexpected in future decades due to climate variability (1). For prediction and adequate management of harmful and toxic algae, precise and rapid **monitoring** of these species is required.

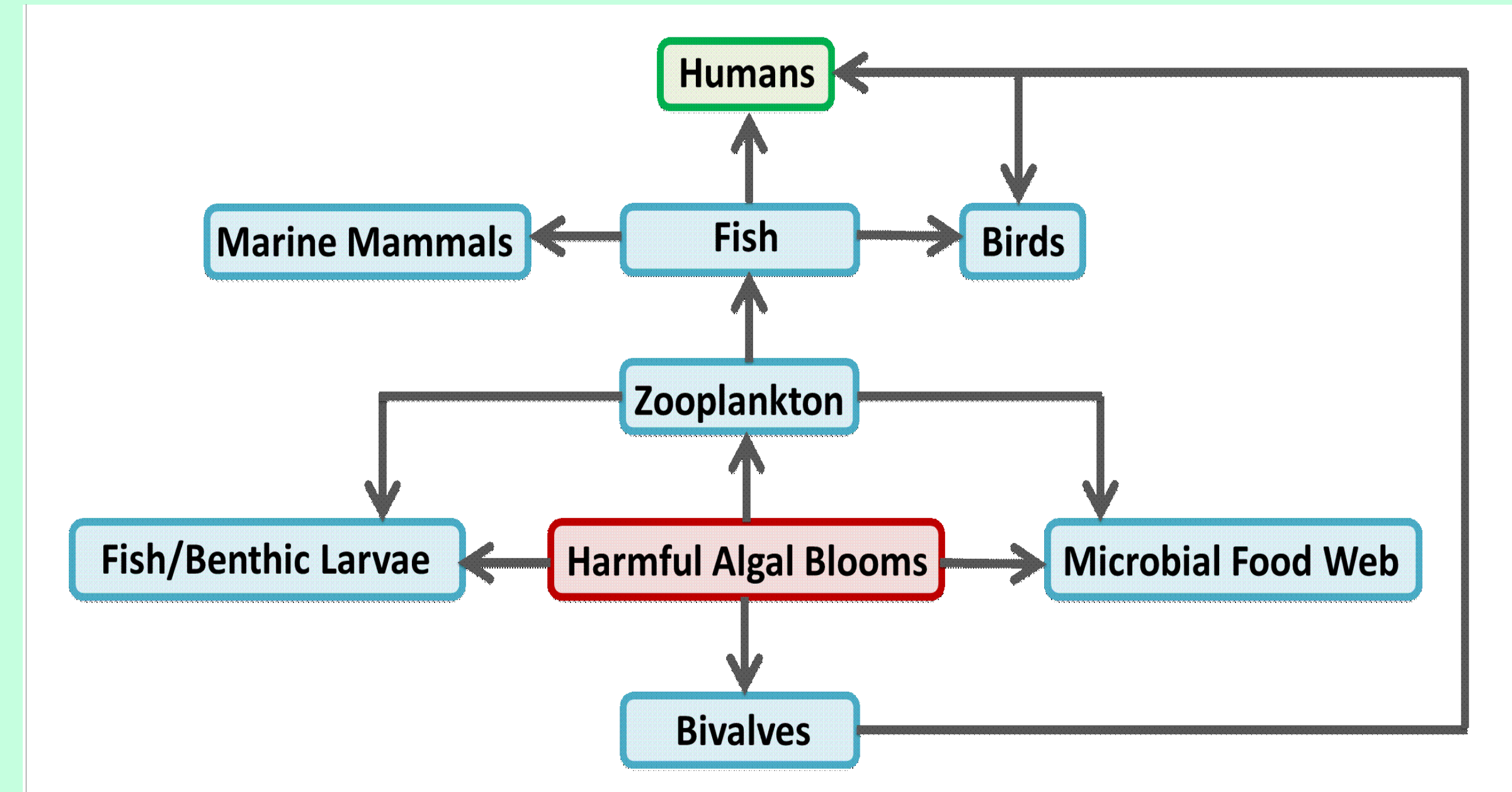


Fig.1: Simplified illustration of food-web toxin routing. Main trophic linkages between harmful algal blooms, primary grazers and upper-trophic-level consumers (modified from 2).

Aim: Develop a sensor system for automated surveillance of marine microalgae

Subtasks:

- Calibrate species-specific probes for molecular detection of selected harmful algal species in the North sea.
- Evaluate the ultrasound module for cell lysis and the optimal sensorchip-design for molecular detection.

Material and Methods



Fig.2: Sampling regions in the North Atlantic. Water samples will be collected during different ship cruises within selected regions (★).

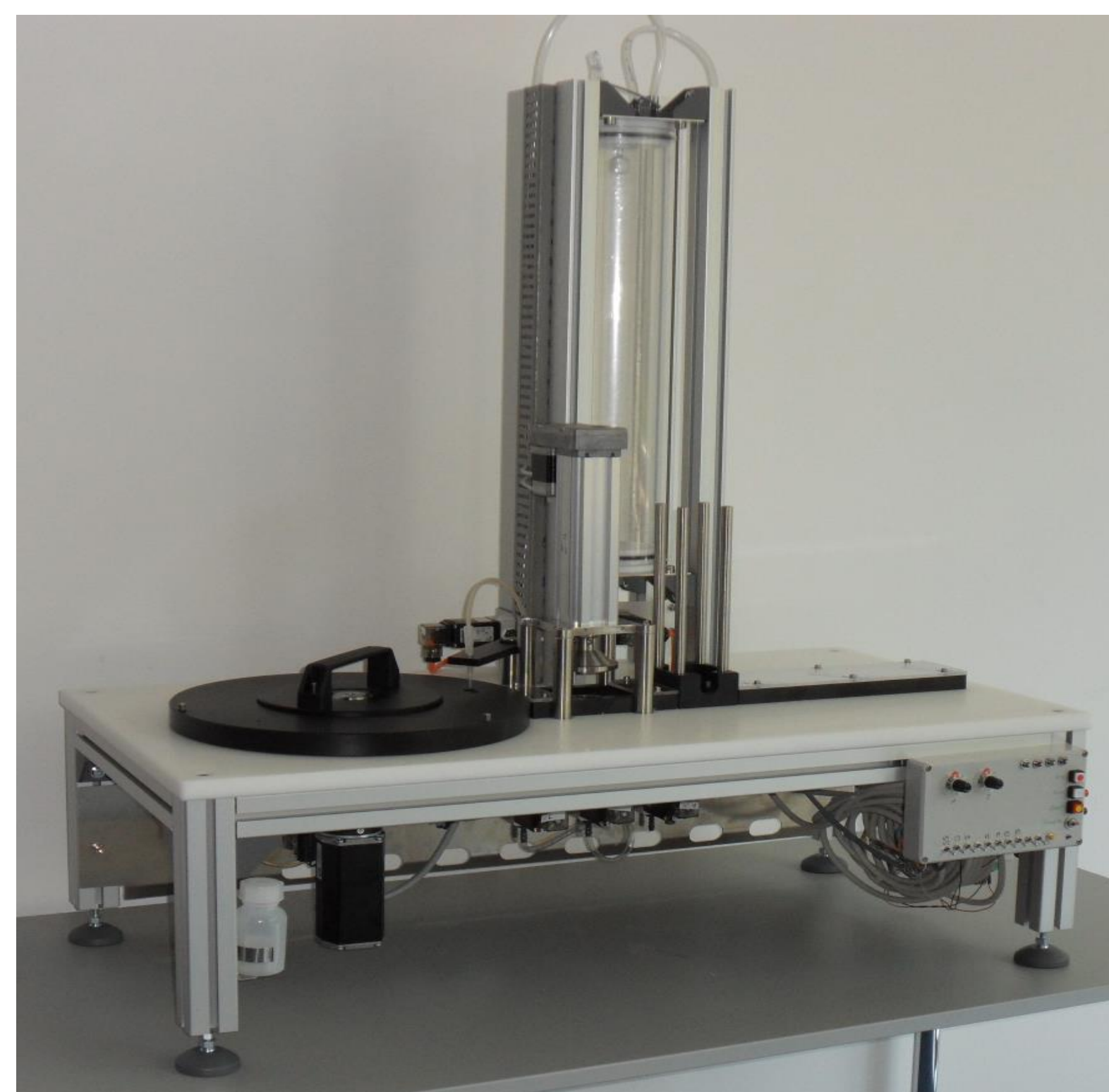


Fig.3: Automatic Filtration Module Auto-FiM. Auto-FiM combines different units for autonomous sampling, filtration and an ultrasound-unit for cell lysis.

Sampling

↓
Filtration

↓
Cell Lysis

↓
18S rRNA

→ Molecular Detection

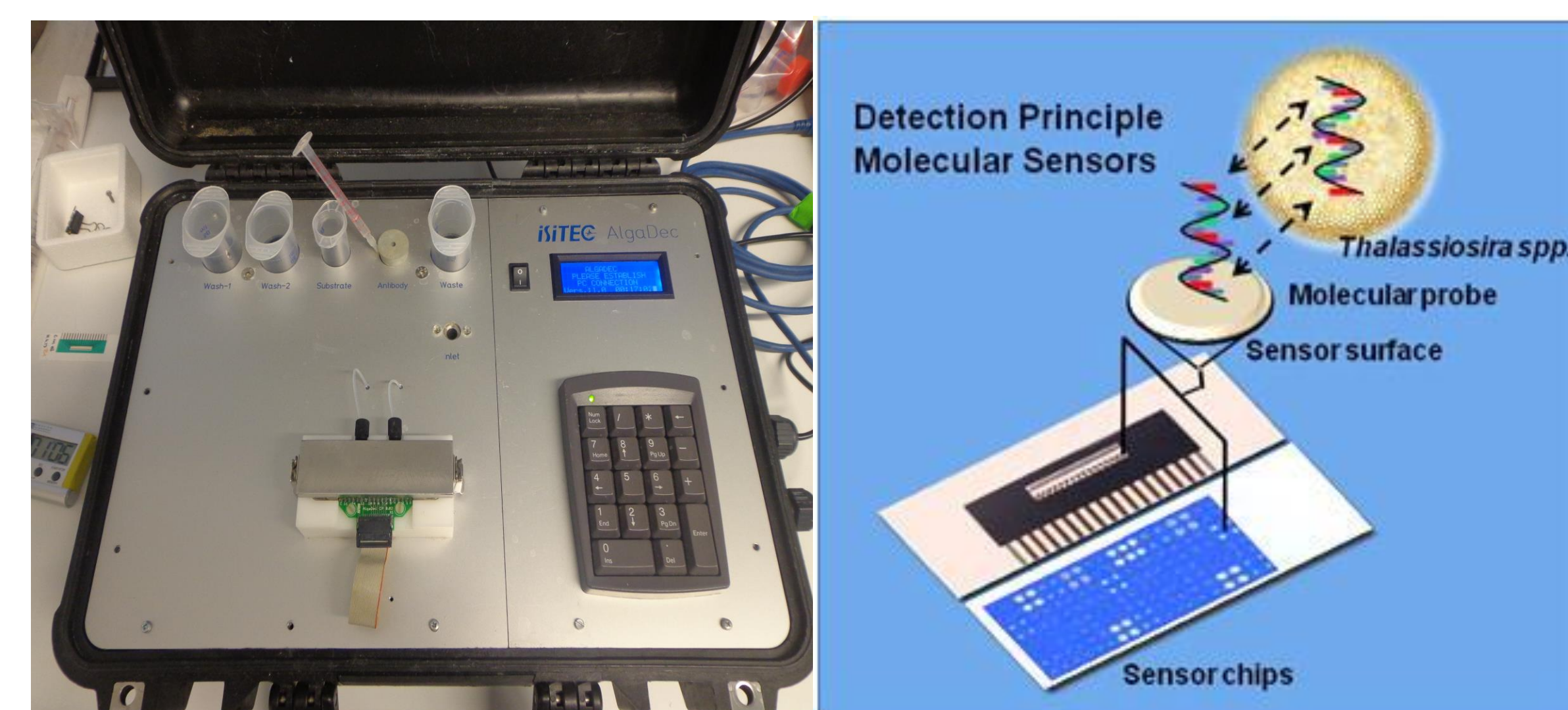


Fig.4: Nucleic acid biosensor device ALGADEC and the reaction principle of the molecular detection. The target ALGAE is identified by binding of two species-specific molecular probes to the ribosomal RNA. One of the probes is immobilised on the surface of the sensorchip, the other is coupled to digoxigenin, which binds to an antibody enzyme complex. The enzymes catalyse a redoxreaction that can be measured as an electrochemical signal (3).

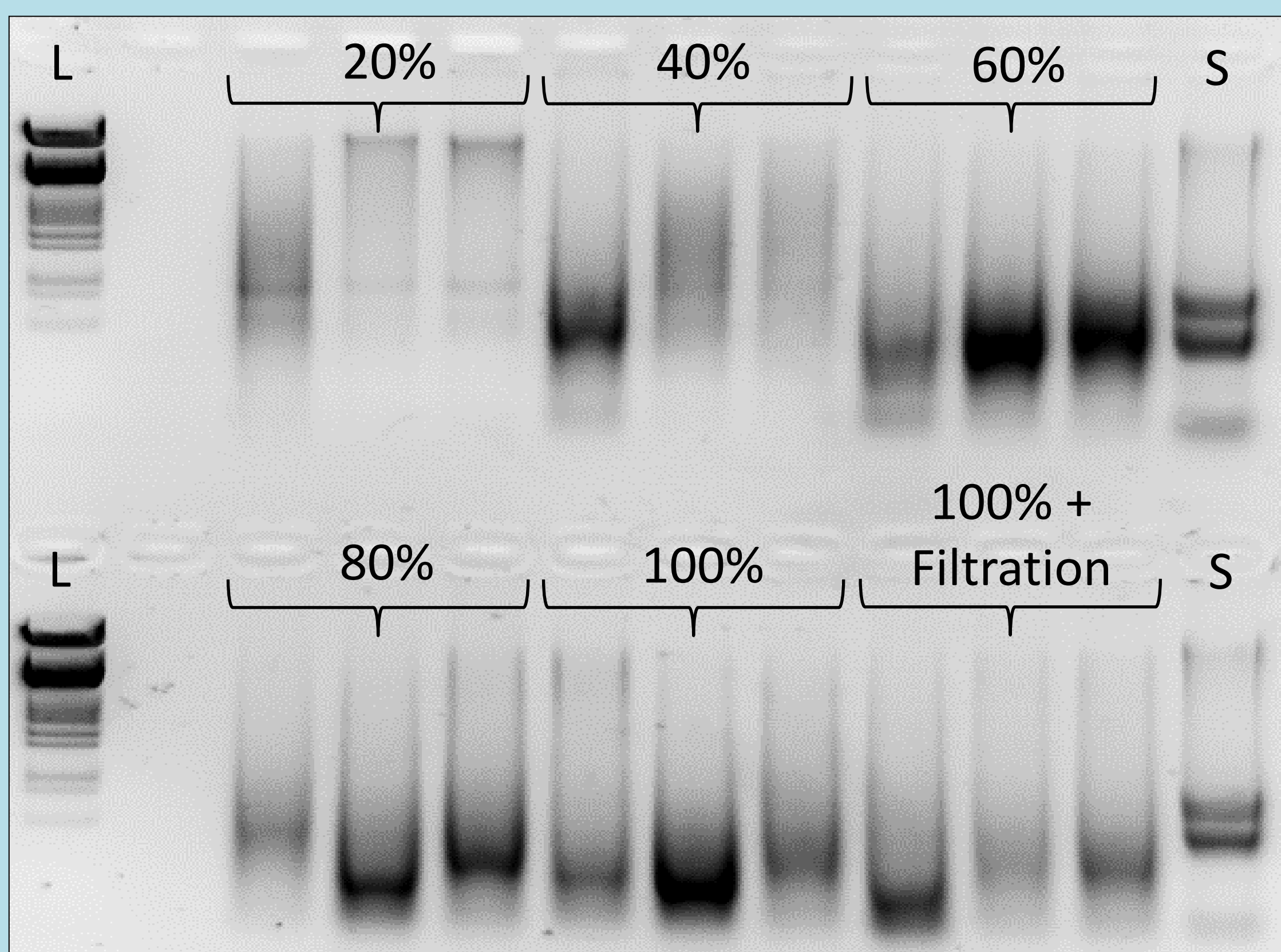


Fig.5: Isolated RNA of *Pseudonitzschia seriata* after 30 sec treatment with ultrasound of different intensities [%]. Cycle 0.5 sec. L: Ladder, S: Standardisation. Image: K. Oetjen (AWI).

→ Successful cell lysis via ultrasound

→ Decreasing quality of RNA and signal intensity with increasing ultrasound intensity

First Results

Ultrasound Unit

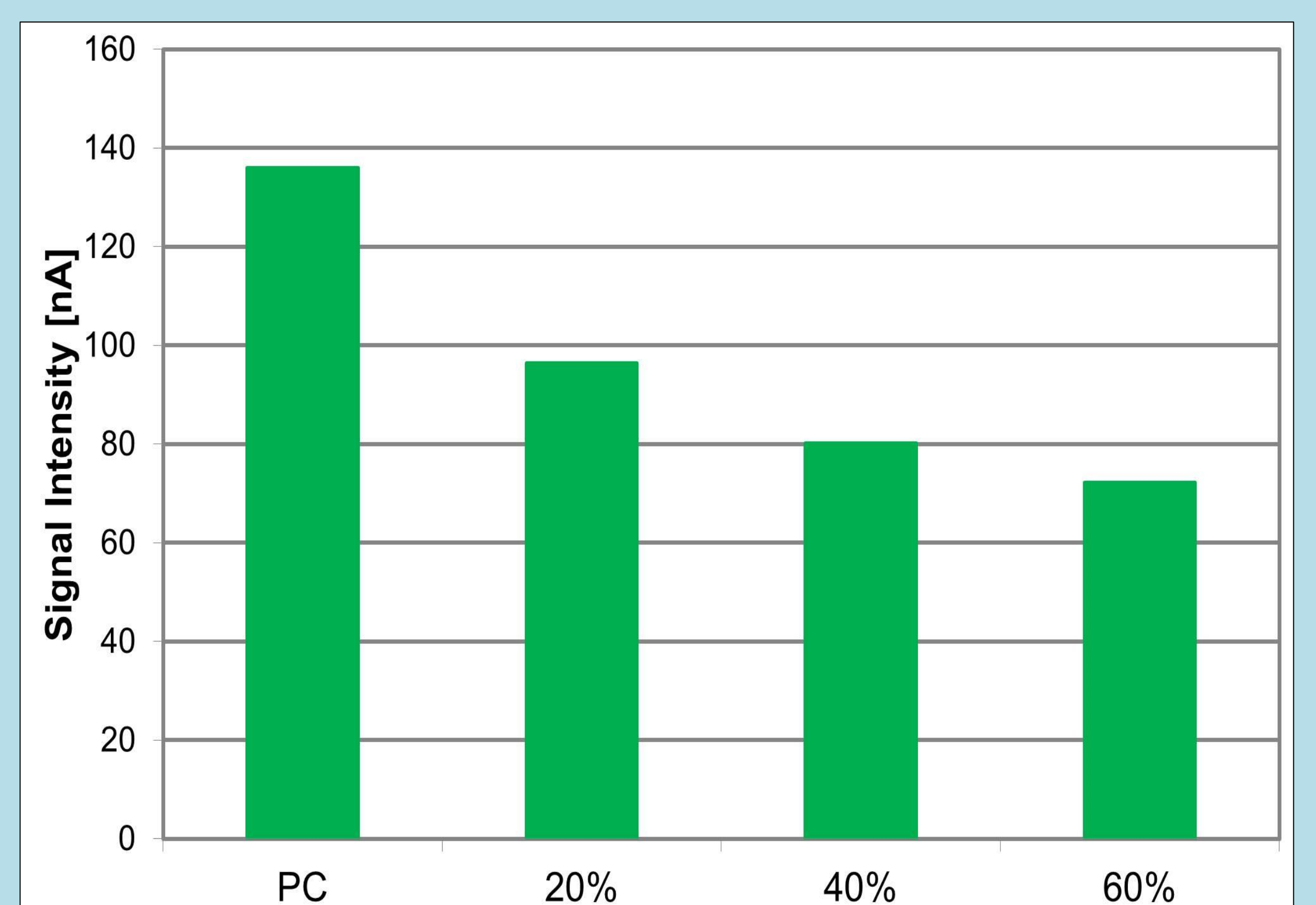


Fig.6: Mean signal intensities [nanoampere, nA] of RNA samples from *Pseudonitzschia seriata* after cell lysis with different intensities [%]. Signals measured with the ALGADEC-device. Negative controls used for value correction. PC = Positive control.

Outlook

- Combine filtration module Auto-FiM and detection unit ALGADEC to an autonomous working sensor system.
- Determine the biogeographic distribution and dispersal of selected harmful/toxic algal species in the North Atlantic.
- Can biosensors serve as early warning systems for human health policies and marine food resources?

