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High-resolution automated approaches to study in situ mesozooplankton abundance and migration.

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In situ imaging has the potential to create a paradigm shift in zooplankton ecology by expanding the spatial and temporal resolution of classical zooplankton detection approaches by orders of magnitude. Automation and thus drastically increased temporal and spatial resolution will allow integration of these data in present large data systems. In addition imaging approaches are non-intrusive and give new information on interactions between organisms in their undisturbed natural environment that classical experimentation cannot. Although automated imaging of mesozooplankton has been attempted for decades, it is still challenging to reach high taxonomical precision at high throughput rates, i.e. without time-consuming human assistance.

We present results from *in situ* video imaging in a Czech Lake (Barbora) and a large LakeLab mesocosm facility (http://www.lake-lab.de) in the German Lake Stechlin. Images were acquired with a Mini Deep-Focus Plankton Imager (MDPI by Bellmare LLC, SanDiego, CA, USA) equipped with a far red light source to minimize light disturbance of the zooplankton. We use an automated image-processing pipeline to transform the collected images into numerical data and a dataset of objects. These were used to train a neural network for classifying objects into three mesozooplankton groups: large rotifers, cladocera and copepods with an overall precision of ca. 80%. Together, the numerical data and neural network classification allows us to assess migration and abundance distributions of mesozooplankton with a 0.25 m resolution and able to classify groups of mesozooplankton from 300 μm body length and larger. Our work suggest that processing *in situ* video images, using image processing software and neural-networks, goes toward its enormous potential to expand the spatial and temporal resolution of classical zooplankton assessments in mesocosms, and in other pelagic environments.