Assessing zooplankton foraging depths using a Bayesian fatty acid-specific stable isotope mixing model

Matthias Pilecky1,2, Samuel K. Kämmer1, Katharina Winter1, Radka Ptacnikova1, Leonard I. Wassenaar1, Patrick Fink1,3 and Martin J. Kainz2,4

1) WasserCluster Lunz – Biological Station, Inter-University Center for Aquatic Ecosystem Research, Dr. Carl-Friedrich-Planck-Straße 1, 3200 Linz, Austria
2) University of Southern Bohemia, Na Sádkách 1, 370 05 České Budějovice, Czech Republic
3) Helmholtz Centre for Environmental Research – UFZ, Department Aquatic Ecosystem Analysis and Management, Promenade 5, 3293 Lunz/See, Austria
4) Institute of Marine Biology, University of Southern Bohemia, Na Sádkách 1, 39114 Magdeburg, Germany

Background

• Lake zooplankton typically perform diel vertical migration movements and feed on particles, mostly phytoplankton (<40 μm) for herbivorous zooplankton, across the lake water column.

• Edible phytoplankton vary in their dietary energy composition that consumers rely on for their somatic development, reproduction, and eventually survival.

• Lake zooplankton access dietary energy, such as lipids and their fatty acids, at various lake depths and require the essential fatty acids linoleic acid (LIN; 18:2n-6) and α-linolenic acid (18:3n-3, ALA), and long-chain polyunsaturated fatty acids (PUFA), such as eicosapentaenoic (EPA; 20:5n-3).

Problem

• The presence of zooplankton at specific lake depths does not necessarily correlate with their feeding location, hence spatial and temporal zooplankton feeding dynamics throughout the lake water column requires high temporal sampling resolution.

• The use of bulk stable isotopes does not discriminate between diet sources from different lake layers and are not linked with information about the nutritional quality of site- and lake depth-specific available diets.

Objective

• To examine spatial and temporal zooplankton feeding dynamics across various lake depths, and

• To assess source-specific metrics of diet quality across the lake water column using a compound-specific stable hydrogen (δ2H) and carbon (δ13C) isotopes of fatty acids.

Hypothesis

• Compound-specific stable isotope analysis (CSIA) of fatty acids can discern the foraging depth and diet quality of zooplankton species

Compound-specific stable isotope analysis (CSIA)

Results

• Dual-carbon and hydrogen isotope analysis revealed different feeding grounds for the acquisition of ALA and LIN of the four zooplankton genera (Fig. 2).

• Daphnia showed the highest probability of feeding on epilimnetic seston (Fig. 3).

• Calanoids were the only zooplankton group with significant diet contributions attributed to hypolimnetic seston (Fig. 3).

• Bayesian Mixed Model suggests different feeding habits for different zooplankton body sizes (Fig. 3).

→ The dual-isotope (δ13C and δ2H) CSIA of FA approach can identify the zooplankton feeding grounds and also provides diet quality data for zooplankton

Implications for trophic ecology

Fatty acid-specific stable isotopes provide

• information about feeding grounds of zooplankton at various lake depths;

• more details on spatial and temporal trophodynamics of planktonic food webs than bulk stable isotopes;

• a measure of dietary energy acquisition for zooplankton and other consumers, including fishes.

This work was funded by the State of Lower Austria (Lake Lunz long-term ecological research grant)