Can water fleas *(Daphnia)* provide insights into lake water methane concentrations?

An investigation of the relationship between $\delta^{13}C$ in cladoceran remains and CH_4 abundance at Gerzensee (BE)

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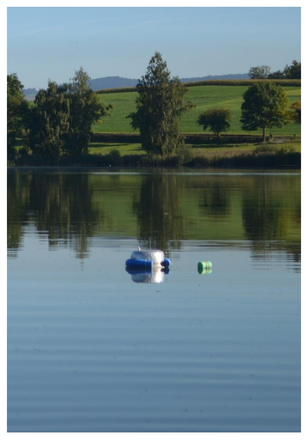
OESCHGER CENTRE CLIMATE CHANGE RESEARCH



Introduction

- Lakes are one of the main natural sources of methane (CH_4), contributing 6 - 16% to the total natural methane emissions [1].
- Biogenic CH_4 is oxidised by methane oxidising bacteria (MOB), and becomes available to the food web [2,3].
- This CH_4 is depleted in the heavier carbon isotope ($\delta^{13}C$ between -50 ‰ and -110 ‰) [4], whereas typical $\delta^{13}C$ values of algae are in the range of -30 to -25 ‰ [5]. Therefore $\delta^{13}C$ analysis may provide information about MOB as a potential food source.
- *Daphnia* ephippia (resting eggs) are also found in the sediment, and may thus allow the reconstruction of past CH_4 concentrations [6].
- This project combines $\delta^{13}C$ measurements of living *Daphnia* and floating *Daphnia* ephippia at Gerzensee with the analysis of fossil remains.

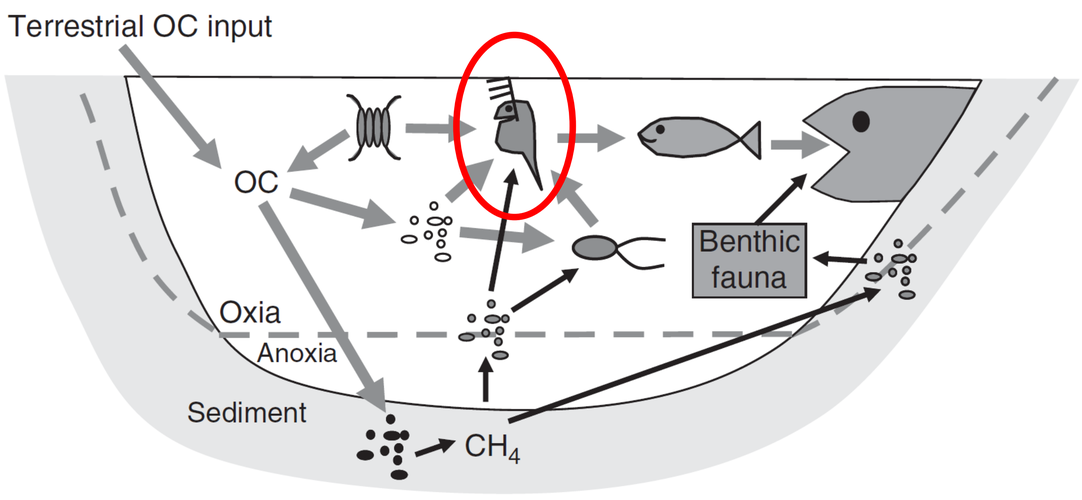


Figure 1: Cycling of organic and methanogenic carbon through lake food webs. Black arrows show one pathway by which biogenic methane may become as a food source for the lake fauna. The importance of this pathway should be reflected in the carbon isotopic composition of the invertebrates. Figure modified from [7].

Ongoing fieldwork

- Biweekly measurements are being carried out during autumn overturning, winter and spring 2013 / 2014.
- *Daphnia* and *Daphnia* ephippia, temperature and oxygen profiles, particulate organic matter (POM), and DIC are collected and measured.
- Diffusive CH_4 fluxes are estimated by extracting gas samples from shielded floating chambers at the lake centre after 2-hours exposure.
- Bulk POM is used to provide an estimate of the $\delta^{13}C$ of algae, the fraction of algae in the POM is roughly estimated by chlorophyll-a measurements.

Sedimentary analysis

- A 62 cm long sediment core was taken in 2012. It is dated to 140 years (± 25 years) at 48.5 cm (dating based on ^{210}Pb / ^{137}Cs).
- *Daphnia* ephippia, *Ceriodaphnia* ephippia and *Plumatella* statoblasts (Figure 3) are picked and analysed for $\delta^{13}C$.
- XRF-scanning will be performed on a new sediment core using the equipment at the Department of Geology, University of Bern.

Initial fieldwork results

- *Daphnia* $\delta^{13}C$ values show a pronounced seasonal cycle which closely follows the POM. Yet, *Daphnia* individuals are always more depleted.
- In contrast, *Daphnia* ephippia lack this seasonal cycle which may indicate batch-wise production of the resting eggs.
- During winter and early spring, $\delta^{13}C$ values below -40 ‰ clearly point to methanogenic carbon as an additional food source of the *Daphnia*.

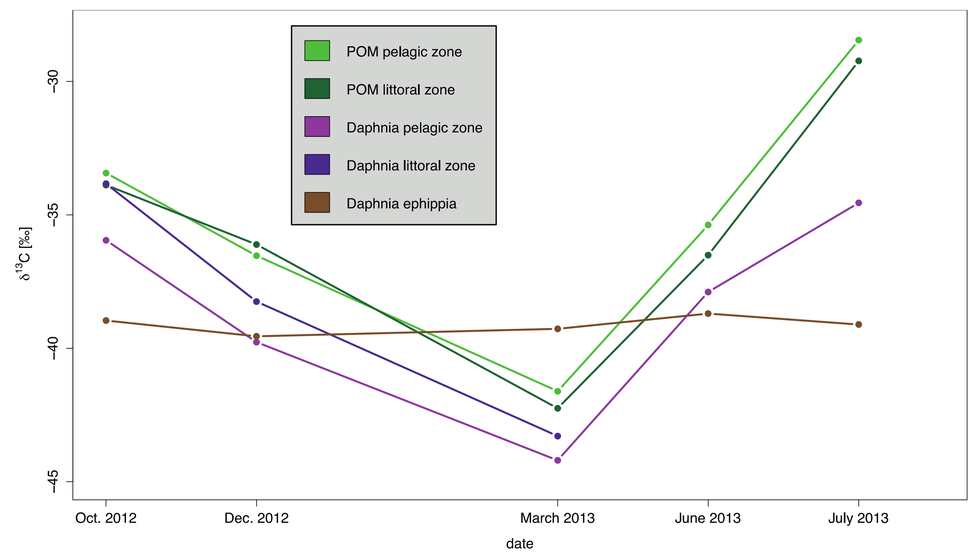


Figure 2: Annual cycle of $\delta^{13}C$ values of POM, *Daphnia* and *Daphnia* ephippia. Data was collected at Gerzensee in a bi-monthly interval between October 2012 and July 2013. Living *Daphnia* individuals were collected from the water column at two locations on the lake, picked into tin cups, and analysed for $\delta^{13}C$ in a mass spectrometer. *Daphnia* ephippia were collected in the flotsam of the lake, treated with KOH for 2h, picked into tin cups, and analysed for $\delta^{13}C$. POM $\delta^{13}C$ was assessed by filtering lake water using a Whatman Glass Microfiber GF/C filter.

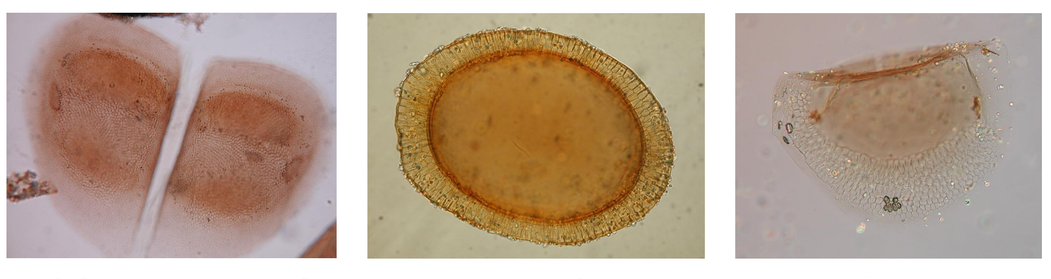


Figure 3: *Daphnia* ephippium, *Plumatella* statoblast and *Ceriodaphnia* ephippium as found in sediments.

Outlook

- High-resolution seasonal data of *Daphnia* and *Daphnia* ephippia will provide information about the intra-annual differences in $\delta^{13}C$ values.
- A potential relationship between *Daphnia* ephippia $\delta^{13}C$ and current CH_4 concentrations and flux may help to interpret *Daphnia* ephippia $\delta^{13}C$ values in the sediment record.
- Data from the sediment record may thus allow to look back at changes in the CH_4 concentration in Gerzensee for the last 150 years.

References

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