

Spatial variability and germination potential of cyanobacterial akinetes in sediments of deep dimictic lakes

Introduction

- Resting stages (akinetes) of nostocalean cyanobacteria overwinter in lake sediments and germinate under reasonable conditions.
- Pelagic population mainly recruits from akinetes (Rücker et al. 2009).
- Sediments in shallow water areas are more important for recruitment than deep ones (Karlsson-Elfgren 2004).

Aim

- Determination of horizontal distribution of akinetes in surface sediments.
- To test if light and temperature conditions are feasible for germination in different water depths.

Hypotheses

- Higher amount of viable akinetes in profundal sediments because of unfavorable germination conditions.
- Only part of total akinete pool contributes to recruitment of planktonic Nostocales population.



Summary

Spatial variability

- Number of viable akinetes increased with increasing water depth (regression analysis, Fig. 2).

i) Hypothesis was confirmed

- Species composition of sediment akinetes differed in the basins of Lake Scharmützelsee although Nostoclean species were evenly distributed in the pelagic (NMDS analysis, Fig. 3).

ii) Hypothesis was confirmed

Potential inoculum size

- Higher potential inoculum size in Lake Scharmützelsee ($2.8 \cdot 10^{14}$ akinetes in 51 % of sediment surface, Fig. 5) than in Lake Stechlinsee ($2.6 \cdot 10^{13}$ akinetes in 30 % of sediment surface, data not shown).

Study sites

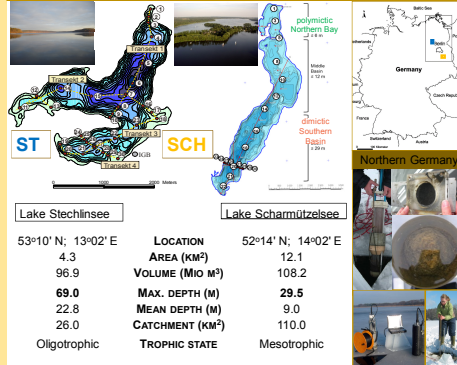


Fig. 1 Bathymetric maps of lakes with transect points for sediment sampling and morphometric details of lakes.

Materials and Methods

Sediment sampling

- Winter 2009/2010 in transects across a depth gradient
- 0 - 1 cm surface sediment (pooled sample of 3 cores)

Microscopical analysis

- Abundance of akinete morphotypes
- Biovolume of pelagic Nostocales (2005 - 2010)

Assumed germination conditions

- Light intensity $\geq 6 \mu\text{E m}^{-2} \text{s}^{-1}$ (Agrawal and Singh 2000)
- Temperature $\geq 8^\circ \text{C}$ (Rücker et al. 2012)

Light and Temperature

- 2009 - 2011 SCH, vertical profiles recorded fortnightly in 0.5 m intervals

Results

Nostocales species were grouped according to akinete morphotypes

Table 1: Occurring Nostocales species in Lake Stechlinsee and Lake Scharmützelsee, akinetes found in sediment samples (+/-).

Nostocales species	ST SCH		Akinete morphotype
	Akinetes	Akinete morphotype	
<i>Anabaena affinis</i>	+	+	<i>Anabaena oval</i> viable - akinete - empty
<i>Anabaena circinalis</i>	+	+	
<i>Anabaena crassa</i>	+	+	
<i>Anabaena flos-aeque</i>	+	+	
<i>Anabaena macrospora</i>	+	+	
<i>Anabaena planctonica</i>	+	+	
<i>Anabaena viguieri</i>	+	+	
<i>Anabaena mendotae</i>	-	+	<i>Anabaena cylindric</i>
<i>Anabaena solitaria</i>	+	+	
<i>Anabaena lemmermannii</i>	+	+	<i>Ana. lemmermannii</i> Heterocyte Akinete
<i>Aphanizomenon flos-aeque</i>	-	+	
<i>Aphanizomenon gracile</i>	-	+	<i>Aphanizomenon</i>
<i>Aphanizomenon issatschenkoi</i>	-	+	
<i>Cylindrospermopsis raciborskii</i>	-	+	

photos: M. Knie

Pelagic biovolume and akinete abundance in different lake basins

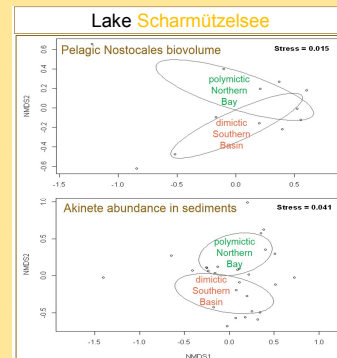


Fig. 3 NMDS analysis of pelagic Nostocales biovolume (annual total 2005 - 2010) and sediment akinetes pooled according to akinete morphotypes of Lake Scharmützelsee.

Increase of viable akinetes with increasing water depth

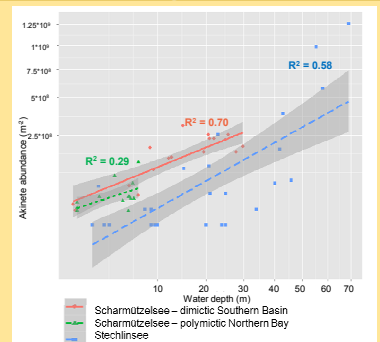


Fig. 2 Linear regression models and confidence bands of viable akinete abundances in relation to increasing water depth of Lake Scharmützelsee and Lake Stechlinsee. Values were square root transformed.

Light and Temperature conditions

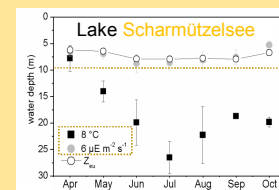


Fig. 4 Water depth where light and temperature reach the assumed threshold values for akinete germination.

- SCH Germination is feasible in ≤ 9 m water depth and in ST ≤ 12 m (data not shown)

Estimation of potential inoculum

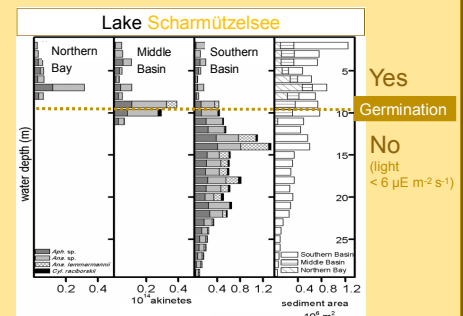


Fig. 5 Akinetes per sediment area and sediment area at different water depths of basins of Lake Scharmützelsee.

- 51 % of sediment area suitable for germination
- 20.5 % of total akinete pool

Literature

- Agrawal, S. C. & Singh, V. (2000) Vegetative survival, akinete formation and germination in three blue-green algae and one green alga in relation to light intensity, temperature, heat shock and UV exposure. *Folia Microbiologica* 45, 439-446.
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