

Sedimentation rate of seston during the formation of temperature stratification after ice break-up in the partly meromictic Lake Verevi

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Abstract

The small strongly stratified hard-water hypertrophic lake Verevi (max. depth 11.0 m, surface area 12.6 ha, mean depth 3.6 m) was investigated in 2000 and in 2001. The lake is sheltered from winds, and the role of waves in mixing the water column is minimal. Eutrophication favours the strengthening of stratification. Early warm springs cause a fast stagnation of the water column forming partly meromictic conditions. Seston content of water and in sediment traps in 3 layers was measured several times during the formation of stratification. Besides measuring particulate matter, in 2001, the nutrient content of the trapped sediment was analysed. During the first 7 days of the investigation, 30% of the total particle sedimentation took place. The sedimentation rate of particulate matter was $0.4\text{--}6.3\text{ g m}^{-2}\text{ d}^{-1}$ dry weight in different layers of the water column. Daily average sedimentation loss rate was 27% of the total amount of seston of the epilimnion, whilst from the meta- and hypolimnion the settling was much slower (9.6 and 7.3%, respectively). In our experiments with twin sediment traps, to one of which formaldehyde was added, the $\text{PO}_4^{3-}\text{-P}$ concentration was 19% smaller in the trap without formaldehyde, probably due to planktonic uptake. The relationship between primary and export production is loop-like. The shape was irregular, indicating a high grazing rate of zooplankton.

Introduction

Sedimentation of particulate matter is one of the key processes in the circulation of matter in small stratified lakes. The effects of eutrophication in limnic environments are manifested as increased production and sedimentation (Heiskanen et al., 1999).

Under some circumstances the cycling of energy and particulate matter of lakes might not be so intensive, although the nutrient content is high. The strong competition between organisms for resources during the strengthening of stratification at the beginning of the vegetation period is crucial for

the whole vegetation period. Large amounts of nutrients remaining in the aphotic layer cannot be used by autotrophic biota. A contradictory situation of starvation of plankton organisms, while nutrients are abundant, occurs. Early warm springs shift the beginning of thermal and chemical stratification, and resource limitation nearly by a month. If there is no spring overturn, several events unusual for the lake phenomena will occur, e.g., the changing of ordinary communities during the summer stagnation. Acceleration of limnological processes is characteristic of the spring season.

The aim of our investigation was to follow the dynamics of suspended solids, plankton, nutrients,

primary production and sedimentation rate in spring in different water layers in order to measure the rate of the processes. The key questions were: which is the general sedimentation rate of suspended solids? which is the daily sedimentation loss of suspended matter from different layers of water? which is the dependence of export production from primary production? and how intensive could be the phosphorus uptake by plankton in the water column?. This study forms only a small part of the complex investigation of Lake Verevi that deals with ecosystem functioning during formation of stratification and changing of environmental conditions in the water column. Holistic study includes main trophic levels and biotic groups: bacterioplankton, protozoa, phytoplankton, metazooplankton, periphyton, macrophytes, meio- and macrozoobenthos, fishes (see: Tammert et al., 2005; Zingel, 2005; Nõges & Solovjova, 2005; Nõges & Kangro, 2005; Kõiv & Kangro, 2005; Kangro et al., 2005; Kübar et al., 2005; Laugaste & Reunanen, 2005; Mäemets & Freiberg, 2005; Timm & Möls, 2005; Järvalt et al., 2005).

Materials and methods

Description of lake (Ott et al., 2005), its environmental properties and peculiar partial meromixis in 2000 and 2001 is described in different articles of present issue (Nõges & Kangro, 2005;

Reinart et al., 2005; Kõiv & Kangro, 2005; Nõges & Solovjova, 2005; Nõges, 2005).

Vertical flux measurements

In 2000 and 2001, in Lake Verevi, the seston content of water and its vertical flux in sediment traps was measured several times during the formation of stratification (Table 1). Besides measuring suspended matter, in 2001, the nutrient content of the trapped sediment was also analysed.

In the year 2000, five replicate plastic dark grey opaque cylinders (length 50 cm, inner diameter 5 cm, volume 0.98 l) were suspended at a depth of 5 m (at this spot the lake depth was 8 m). The cylinders were of the best height/diameter ratio of 10:1 (Rosa et al. 1994). On the basis of the great value of relative depth (2.7%; Wetzel, 1983), we assume that resuspension in L. Verevi was very small, and chose simple devices although much more sophisticated sampling techniques and methods exist (Bloesch, 1996). According to Huttula & Krogerus (1986), the material is not resuspended in these traps even in very dynamic conditions. Twin cylinders at depths of 1, 5 and 7 m were used in the water column also in 2001. Every time, a perforated 50 ml vial with concentrated formaldehyde was put at the bottom of one trap cylinder to preserve the settled material, while to the other no fixative was added.

Table 1. Sampling dates of water and trapped seston in 2000 and 2001

2000			2001		
Seston in water	Sedimentation	Exposition time	Seston in water	Sedimentation	Exposition time
24.04.00			29.03.01		
03.05.00			16.04.01		
16.05.00	16.05.00	13 days	19.04.01		
22.05.00			23.04.01		
29.05.00	29.05.00	13 days	26.04.01	26.04.01	3 days
05.06.00			30.04.01	30.04.01	4 days
13.06.00	13.06.00	15 days	03.05.01	03.05.01	3 days
			07.05.01	07.05.01	4 days
			10.05.01	10.05.01	3 days
			24.05.01	24.05.01	14 days
			05.06.01	05.06.01	12 days