Depth distribution of bacteriochlorophyll fluorescence in the chemocline of Elovoe lake (White Sea region)

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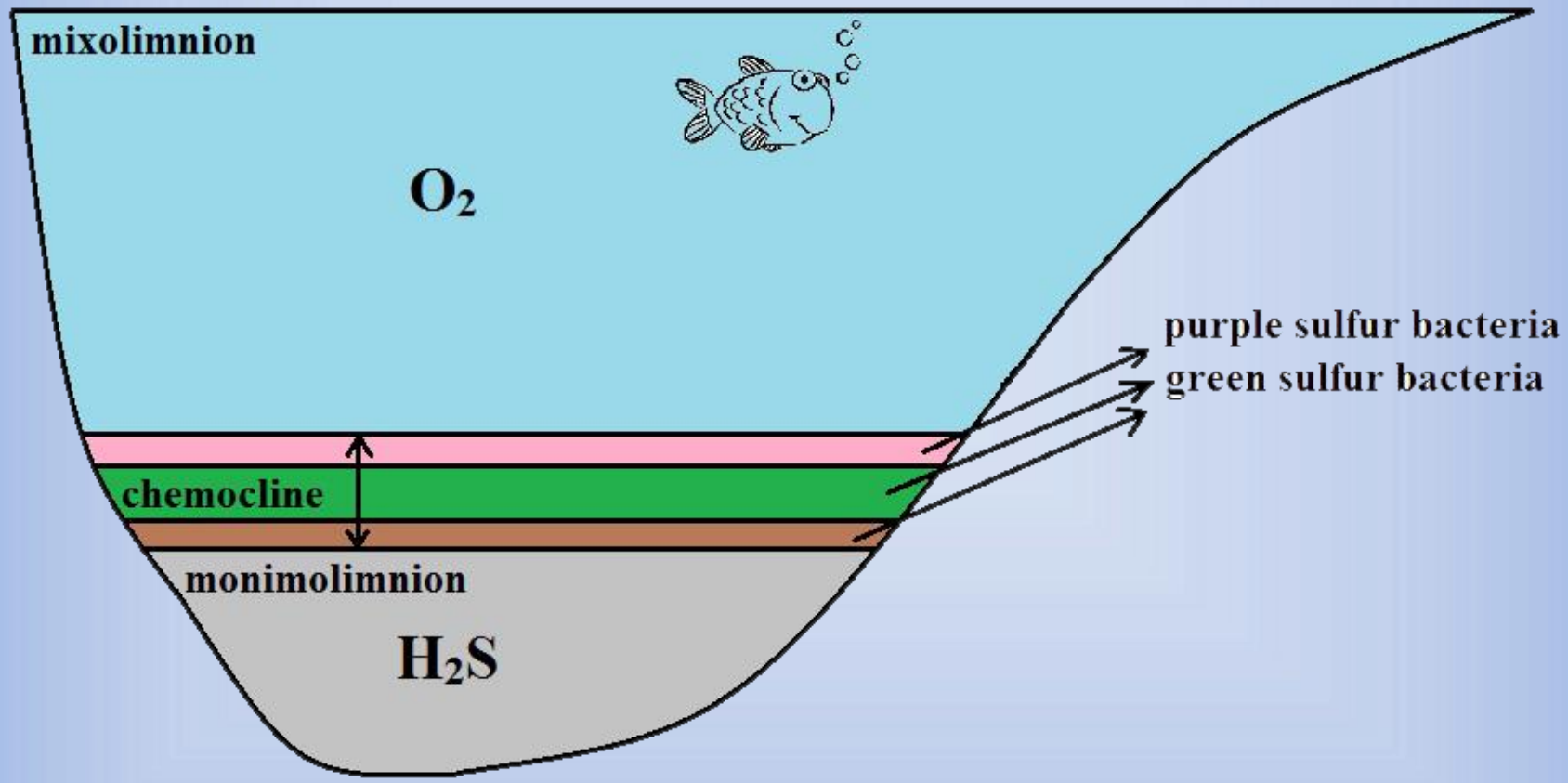
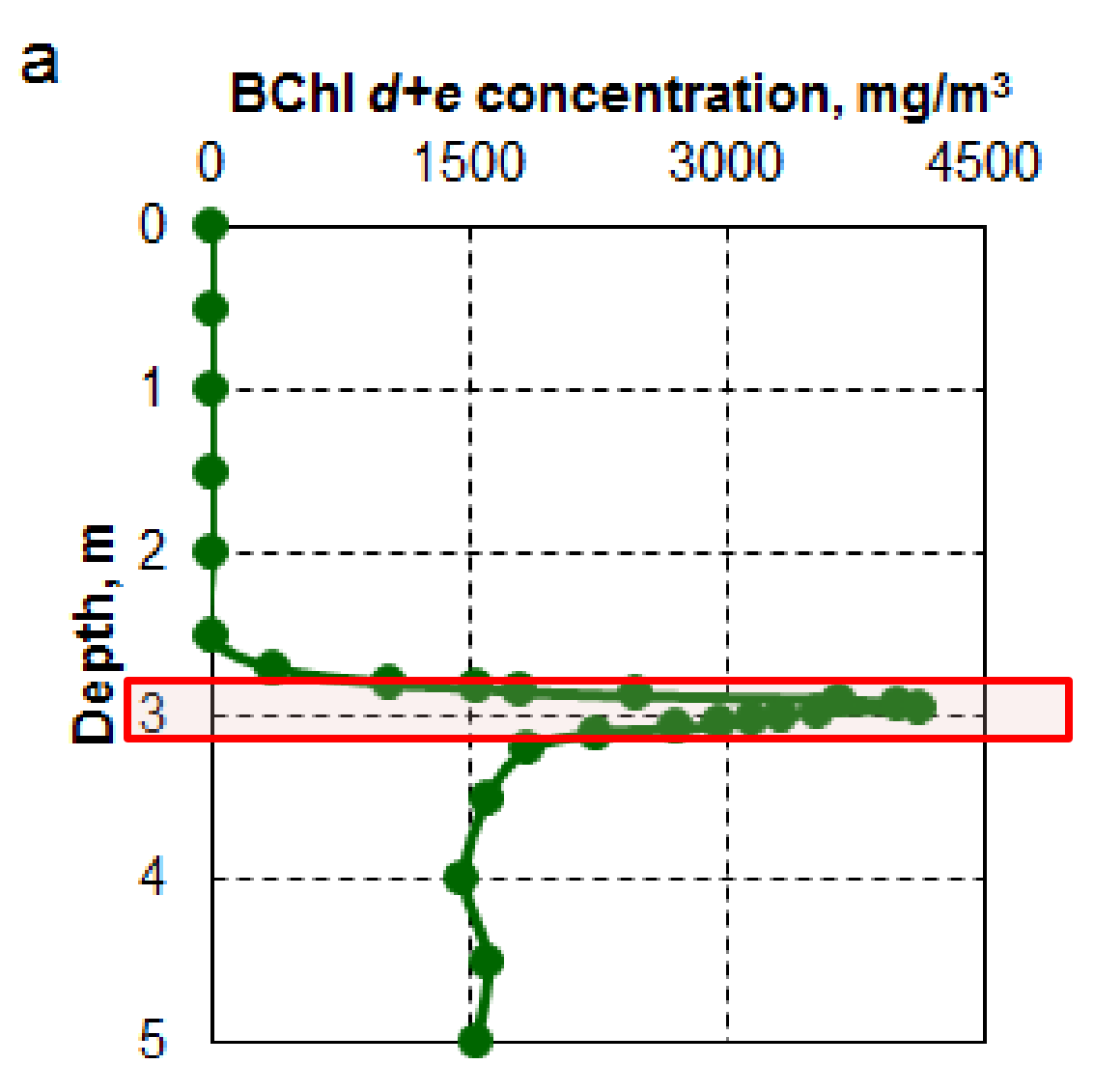
Kandalaksha Bay of the White Sea

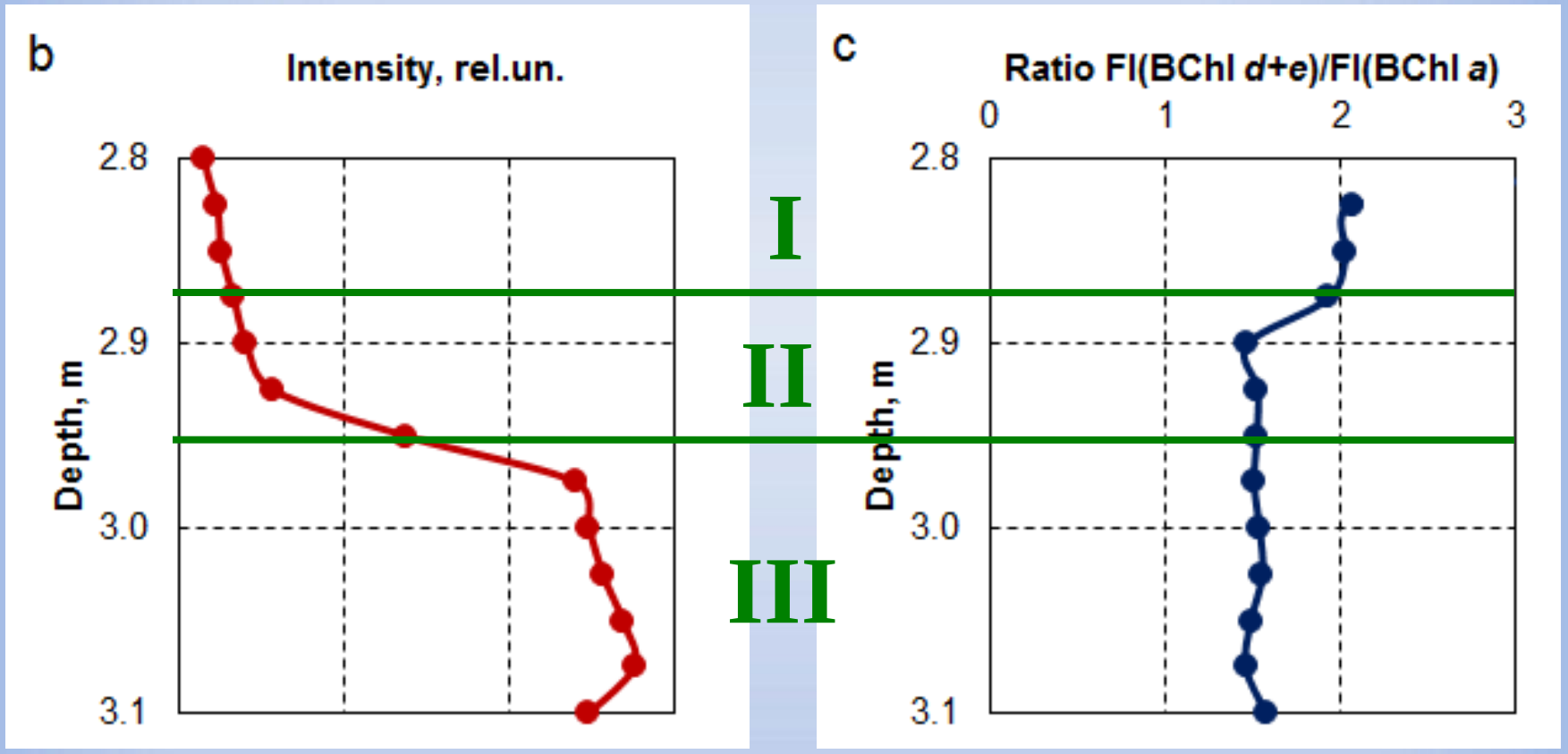
Separated water basins scheme



Absorbance spectra of water samples



Vertical distribution of bacteriochlorophyll concentration



DEPTH DISTRIBUTION OF BACTERIOCHLOROPHYLL FLUORESCENCE IN CHEMOCLINE OF ELOVOE LAKE (WHITE SEA REGION)

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Introduction

Over the past decades the scientific interest is growing to the impacts of climate change and human activities on the Arctic ecosystems. Exploration of Arctic resources promotes regional economic activities, expansion of the transport network and construction of the tidal power plants. Due to these factors some water areas will be artificially separated from the sea, undergoing changes in their ecological status including stagnant phenomenon and hydrosulfuric accumulation. In order to environmental monitoring of water bodies with the disturbed water circulation mode spectral monitoring methods can be applied.

In chemocline of six studied stratified lakes two strains of green sulphur bacteria can be found varying in spectral-fluorescent characteristics due to presence of different types of bacteriochlorophyll (BChl): green-colored strain contains BChl d, brown-colored – BChl e. Fluorescence spectra of green sulfur bacteria have two bands in infrared region: at wavelength 740-770 nm (BChls d+e fluorescence) and at 815 nm (BChl a fluorescence)

Lake Elovoe

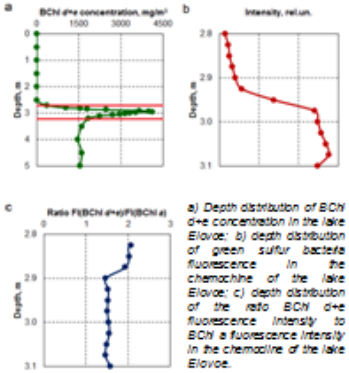
The object of the study was water samples from the lake Elovoe located in the Kandalaksha Bay of the White Sea, with the lake depth of about 6 m. This water body previously being the part of marine system was completely separated from the White Sea. It has a precise vertical stratification: *mixolimnion* (fresh surface layer in which mixing takes place by the influence of the external environment), *monimolimnion* (bottom layer with water salinity close to marine water) and *chemocline* (the middle layer containing the anoxic phototrophic microorganisms). The maximum concentration of the green sulfur bacteria was localized in chemocline using spectral methods. In this lake brown-colored green sulfur bacteria dominate. Samples were collected in July 2016 by a submersible pump with depth interval of 0.5-1.0 m and a multisyringe water sampler from layers with dense population of green sulfur with depth interval of 2.5 cm.

Spectral measurements

Fluorescence spectra of water samples were measured in a laboratory using luminescence spectrometer Solar CM 2203. Acetone-methanol (7:2) extracts were prepared to calculate concentration of BChls d+e from absorption spectra of extracts registered using spectrophotometer Unico.

Results and conclusions

Green sulfur bacteria in the lake Elovoe were located at the depth of 2.7m and deeper (Fig. 1a). The highest abundance of BChls d+e was detected at the depth of 2.8-3.1 m. Depth distribution of BChls d+e fluorescence intensity within the chemocline is shown on the Fig. 1b. Fluorescence intensity sharply increased by the depth of 2.975 m and remained constant below it. Ratios of BChls d+e (740-770 nm) to BChl a (815 nm) fluorescence intensities were calculated from fluorescence spectra. This value was 1.5 in the upper layer with green sulfur bacteria and 2 at the bottom of the lake (fig. 1c). The chemocline zone can be divided into three sub-layers according to fluorescence properties of green sulfur bacteria: a) upper chemocline (2.800-2.875 m) characterized by low concentration of BChl, low BChl fluorescence intensity, ratio FI(BChls d+e)/FI(BChl a) equals 2; b) middle chemocline (2.900-2.950 m) with the highest concentration of BChl, low BChl fluorescence intensity, ratio FI(BChls d+e)/FI(BChl a) is 1.5; c) lower chemocline (2.900-2.950 m) where BChl concentration decreases, the highest BChl fluorescence intensity is registered, and ratio FI(BChls d+e)/FI(BChl a) equals 1.5. Presence of three sub-layers in the chemocline can be explained by different photosynthetic activity of green sulfur bacteria, redox-dependent fluorescence quenching or photoinhibition in upper layers.



a) Depth distribution of BChl d+e concentration in the lake Elovoe; b) depth distribution of green sulfur bacteria fluorescence in the chemocline of the lake Elovoe; c) depth distribution of the ratio BChl d+e fluorescence intensity to BChl a fluorescence intensity in the chemocline of the lake Elovoe.

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