Rep. Res. Edu. Ctr. Inlandwat. Environ., *2* : 79-82 (2004)

Methane and zooplankton in the epilimnion of Lake Fukami-ike

Hiromi SUDA, Junko FUNAHASHI and Akihiko YAGI

Faculty of Life Environment, Nagoya Women's University, 3-40 Shiozi-cho Mizuho-ku Nagoya 467-8610, Japan

ABSTRACT: Accumulations of bubbled and dissolved methane concentrations in epilimnion have been frequently observed in Lake Fukami-ike. Based on the idea that the feeding activities of living zooplankton contribute to the methane concentrations in the lake, we examined whether investigate live zooplankton evolve methane as a consequence of their feeding activities. Dissolved methane concentrations were higher after 6 hours in the samples of zooplankton only. This result might be support the idea that the accumulated methane in the epilimnion is affected by the feeding activities of living zooplankton.

Key Words: methane, zooplankton, epilimnion

Introduction

Vertical and horizontal distributions of methane concentrations were studied since 1999 in eutrophic lake Fukami-ike, which has a maximum depth of 7.7 m. The accumulations of dissolved and bubbled methane were determined occasionally in the epilimnion through this study. These methane accumulations were unrelated to methane concentrations transferred from the lake's shoreline. This phenomenon suggests a close connection between living zooplankton and methane concentration in the epilimnion in the lake. There are reports that methane emitted from the digestive tracts of terrestrial animals such as ruminants (Hungate: 1966), and fishes (Oremland: 1979). In order to investigate whether live zooplankton evolve methane as a consequence of their feeding activities, an experimental studies of the CH_4 production from the zooplankton was conducted.

Materials and Methods

1. Field Observation

Observations were made on February 27 and March 25, 2002. Bubbled and dissolved methane concentrations were determined with a methane analyzer (KK Sencer-teck, GS-15). Date on transparency, water temperature (WT), dissolved oxygen (DO: HORIBA DO Meter OM-12), chlorophyll a (Holm-Hansen *et al.*, 1965), particulate organic carbon (POC: PERKIN-ELMER 2400 II CHNS/O) and phyto, and zooplankton collected by plankton net (NXX25: 63μm) were also recorded.

2. Laboratory experiments

February

A. A sample of filtered (GF/F: 0.7 μm) surface water (1000 ml) was blended with a active zooplankton collected by plankton net that was taken up by pipette(300 ml) after the phytoplankton had been deposited using a centrifuge (1000 RPM for 10 minutes) : zooplankton

B. The surface water was filtrated : blank

⇒ All samples were put into DO bottles, and then the dissolved methane concentrations were measured at 0, 6 and 12 hours later.

March

A. A sample of filtered (GF/F) surface water (700 ml) and was blended with a active zooplankton collected by plankton net that was taken up by pipette (300 ml) the phytoplankton had been deposit left to for a few hours : zooplankton

B. The surface water was filtrated : blank

⇒ All samples were aerated for 5 minutes and put into DO bottles. The concentrations of dissolved methane and the dissolved oxygen were then measured at 0, 6 and 12 hours later.

Results and Discussion

1. Field Observation

The vertical distributions of methane flux, dissolved methane, WT, DO, chlorophyll a and POC in February and March 2002 are shown in Figures 1 and 2.

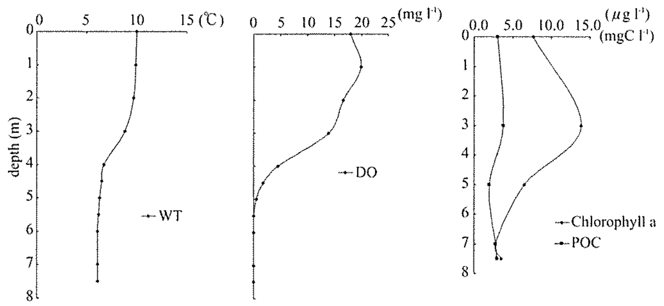

Fig. 1-1 Vertical distribution of water temperature, dissolved oxygen, chlorophyll a and particulated organic carbon on Feb. 27, 2002

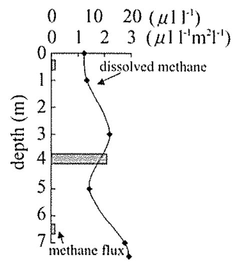

Fig. 1-2 Vertical distribution of methane flux and dissolved methane concentration on Feb. 27, 2002

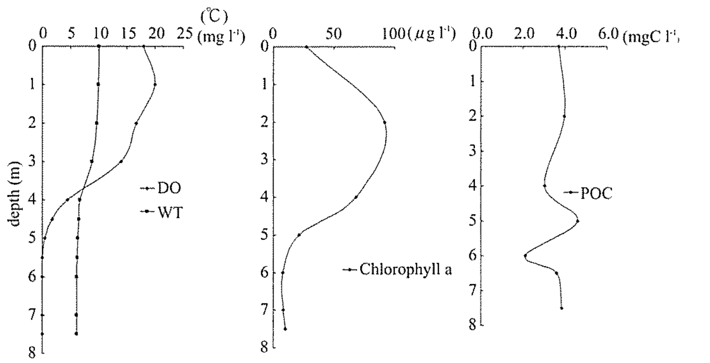

Fig. 2-1 Vertical distribution of water temperature, dissolved oxygen, chlorophyll a and particulated organic carbon on March 25, 2002

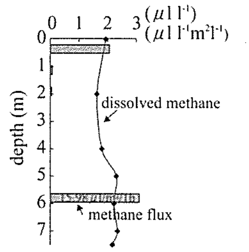

Fig. 2-2 Vertical distribution of methane flux and dissolved methane concentration on March 25, 2002

In February, the maximum values of dissolved methane concentrations and methane flux were obtained at a 3 m depth (0.017ml l^{-1}) and 4 m depth (11.587 ml m^2 h^{-1}), respectively. The maximum values of chlorophyll a and POC concentrations were consistently found at the same depth of 3 m. These vertical distributions of dissolved methane, chlorophyll a, and POC in the same layer of the epilimnion suggested that the methane accumulation might be due to the feeding activity of zooplankton on phytoplankton. The dominant species of zooplanktons in the layer were Cyclopoida (300 inds. l^{-1}) and *Daphnia ambigua* (60 inds. l^{-1}) (CRUSTACEAE), and *Keratella cochlearis* var. *tecta* f. *micracnatha* (460 inds. l^{-1}), *Trichocerca similis* (420 inds. l^{-1}), and *Asplanchna priodonta* (420 inds. l^{-1}) (ROTATORIA).

In March, the maximum values of bubbled and dissolved methane concentrations were obtained at a 5 m depth. The maximum values of chlorophyll a and POC concentrations were consistently found at the same depths of 2 m and 5 m. The dominant species of zooplanktons a depth of 2 m were *Daphnia ambigua* (860 inds. l^{-1}) and *Trichocerca similis* (670 inds. l^{-1}), *Asplanchna priodonta* (250 inds. l^{-1}).

2. Laboratory experiments

Changes in CH_4 production in the samples of zooplankton and blank in February 2002 are shown in Figure 3 and changes in the production and dissolved oxygen in the samples in March 2002 shown in Figure 4.

In February, the dissolved methane concentrations in the samples of zooplankton increased from 0 hours (5.043μl l^{-1}) to 6 hours later (6.674μl l^{-1}), and the CH_4 concentration had decreased 12 hours (1.733μl l^{-1}) later. *Daphnia ambigua* at the 3 m depth in the lake, and their intestines were observed under on optical microscope to be colored green from feeding on small green algae.

In March, the dissolved methane concentrations in the samples of zooplankton were increased from 0 hours (1.056μl l^{-1}) to 6 hours later (1.996μl l^{-1}), despite dissolved oxygen concentrations of 9～7 mg l^{-1}. This phenomenon occurred under an oxic condition and it might be due to the presence of other production environments, for example, in the intestines of zooplankton.

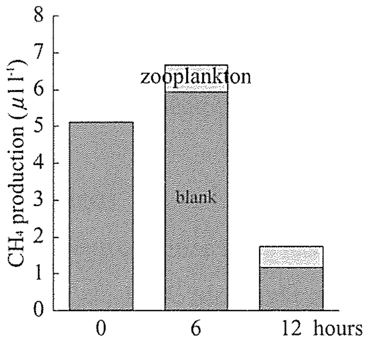

Fig. 3 Changes of CH_4 production in the sample of blank and zooplankton in Feb. 2002

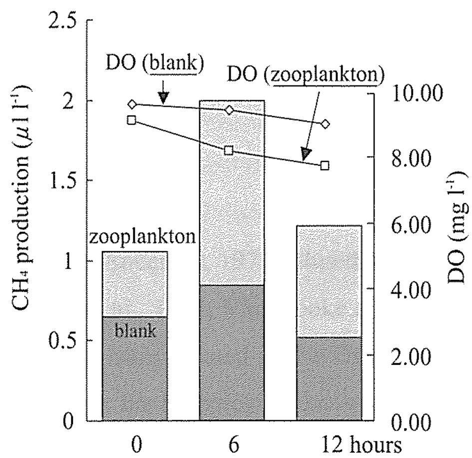

Fig. 4 Changes of CH_4 production and dissolved oxygen concentration in the sample of blank and zooplankton in March 2002

The CH_4 concentration was decreased after 12 hours (1.219μl l^{-1}). The reason the concentrations had decreased 12 hours later in the two experiments may be methane oxygenation under oxic conditions (Oremland and Culbertson 1992).

Therefore, it is suggested that living zooplankton in the epilimnion supplied the accumulations of methane gas in Lake Fukami-ike. However, no methanogenic bacteria in the intestines of zooplankton were found. Studies on the close relationship between bacteria and other organisms include one suggesting symbiosis between the bacteria and sapropelic protozoa (van Bruggen, Stumm, and Vogels: 1983). We intend to analyze the bacteria in intestines of zooplankton in the future.

References

Hungate, R. E. (1966) The rumen and its microbes. Academic.

Ronald S. Oremland (1979) Methanogenic activity in plankton samples and fish intestines: A mechanism for in situ methanogenesis in oceanic surface waters. *Limnol. Oceanogr.*, **24(6)**: 1136-1141.

Holm-Hansen, O., Lorenzen, C. J., Holms, R. W. and Strickland, J. D. H. (1965) Fluorometric determination of Chlorophyll. *J. Conseil. Perm. Intern. Explor. Mer.*, **30**, 3-15.

Oremland, R. S. and C. W. Culbertson (1992): Nature, **356**: 421-423

Johan J. A. van Bruggen, Claudius K. Stumm, and Godfierd D. Vogels (1983) Symbiosis of methanogenic bacteria and sapropelic protozoa. Arch Microbiol 136:89-95

Yamada Y., Koitabashi T., Ueda T., and Wada E., (2001) Distribution of CH_4 in the north basin of Lake Biwa and tributary rivers. Jpn Limnol 2:193-197