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Decomposition process of labile DOC derived from phytoplankton

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Dissolved organic carbon (DOC) is one of the largest carbon pools in lakes. The elucidation of its source is very important for our understanding of the lacustrine carbon cycle. One of the sources of DOC is phytoplankton. Phytoplankton supplies DOC to water column directly through extracellular release and cell lysis, and indirectly via bacteria. In order to estimate the contribution of phytoplankton to lake DOC, the production and decomposition processes of DOC derived from phytoplankton need to be well understood. These processes, however, are difficult to investigate because DOC accumulation during phytoplankton decomposition is generally too small. In order to detect and examine this small amount of DOC, we have conducted decomposition experiments using ^{13}C tracer in which products by natural phytoplankton communities were decomposed. Previous studies revealed the production process of refractory (R-) DOC. These studies showed that 1.3% of newly fixed carbon by phytoplankton became R-DOC and remained in water column for long time. In the present study, the production and decomposition processes of labile (L-) DOC derived from phytoplankton were investigated.

Phytoplankton communities were collected monthly for a year from Lake Kasumigaura, one of the most eutrophic lakes in Japan. The collected samples were incubated *in-situ* for 24h to label the newly fixed carbon with ^{13}C. The samples were subsequently incubated in the dark for 100 days (20°C). The subsamples were collected from the cultures at intervals of 1 to 30 days. The concentration and ^{13}C atom% of DOC in each subsample was measured and used for the calculation of the residual amount of newly fixed carbon.

An example of the change in newly fixed carbon is shown in Fig. 1 as an example. Most of newly fixed carbon was particulate organic carbon (POC) at the end of *in-situ* incubation (i. e. the start of dark incubation). The POC concentration, however, decreased drastically as soon as the sample has transferred into the dark condition, while the concentration of DOC showed increase until day 12. The DOC concentration showed gradual decrease after that, but a part of it remained until day 100. We tried to simulate the change in DOC concentration by the consecutive reaction shown in Fig. 1, where k_a is the decay constant of L-POC (d^{-1}), k_b is the decay constant of L-DOC (d^{-1}), a is the conversion efficiency from L-POC to L-DOC and b is the conversion efficiency from L-DOC to R-DOC. The values of a and k_b are especially important to understand the dynamics of L-DOC derived from phytoplankton. Using the least-squares method, a and k_b were estimated to be 0.069 and 0.037 d^{-1}, respectively, in the examination shown in Fig. 1. We also estimated these parameters in the other examinations and revealed that a ranged from 0.030 to 0.13 and k_b ranged from 0.016 to 0.058 d^{-1}. The relationships between these two parameters and phytoplankton community composition were not clear.

The amount of L-DOC derived from phytoplankton in a system can be estimated from primary productivity, a, k_b and water residence time. The values of a and k_b obtained from the present study indicate that the most of L-DOC in water column is derived from phytoplankton in L. Kasumigaura.

Keywords: phytoplankton, labile DOC, decomposition

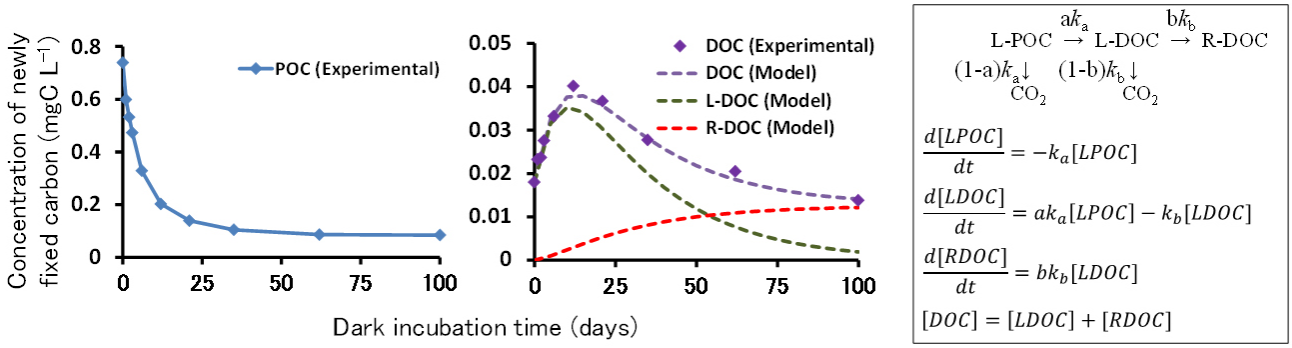

Fig. 1. Change in newly fixed carbon during experiment (Result from Oct. 2010 exam.). Equations used to simulate the DOC change are shown in the box.