Transfer Rate of Radionuclides between Chemical Species in Sea Water, and Incorporation into Phytoplankton

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Abstract

Radionuclides, which are released from nuclear industry facilities and deposited on the surface of water expanses such as lakes and oceans, are considered to be initially in ionic forms, and then the radionuclides are removed from the water system as particulates after various chemical and biological reactions. This study aims to clarify the transformation rate of ionic radionuclides to various chemical forms and the effects of environmental parameters, such as salinity and microorganism activities, on the rate. The effect of phytoplankton on the transformation was investigated by adding target elements in ionic forms to f/2 culture seawater medium of a phytoplankton, *Skeletonema costatum* or *Nitzschia sp*., which are predominant species of brackish Lake Obuchi and the Rokkasho seacoast.

An aliquot of solution containing ionic lanthanoids and Th was added to the medium sample. After standing for a predetermined period from 1 to 7d, the medium samples were separated into the particulate fraction, which was collected with a filter which had a pore size of 0.22μm, and the dissolved fraction. Most of the added light lanthanoids and Th were found in the particulate fraction less than 1 d after their addition.

An aliquot of ^{125}I solution in the form of I^- or IO_3^- was added to the medium sample of the phytoplanktons, and incubated for 12 d. The plankton cells sorbed ^{125}I in an amount up to about 10% of the added $^{125}I^-$, while they did not apparently sorb ^{125}I added in the form of IO_3^-. In the medium samples of *Skeletonema costatum*, valences of both added $^{125}I^-$ and $^{125}IO_3^-$ did not change significantly. However, the concentration of $^{125}I^-$ added to the medium samples of *Nitzschia sp*. was gradually decreased, suggesting that $^{125}I^-$ was oxidized to $^{125}IO_3^-$ or bound to organic compounds, while some of the $^{125}IO_3^-$ was reduced to $^{125}I^-$ during the incubation. Since the cell numbers of the phytoplanktons varied during the experiments, the effect of the growth stage of the phytoplanktons should be examined further.

The chemical forms of iodine of both phytoplanktons incubated in the medium with 500 mg I L^{-1} added in the form of I^- or IO_3^- were examined by using K-XANES in the large synchrotron radiation facility, SPring-8. The incubated phytoplankton cells were separated from the medium by filtration, and then dried by lyophilization. The iodine sorbed to both phytoplanktons grown in the media with added I^- remained as I^- with no valence change of iodine. Both I^- and IO_3^- were detected for both phytoplanktons grown in the medium with added IO_3^-, and it showed that the added IO_3^- was reduced to I^- on/in the planktons and/or in the medium. The percentage of I^- to the total iodine of the phytoplankton cells of *Nitzschia sp*. was 61% and larger than the 28% of *Skeletonema costatum*.

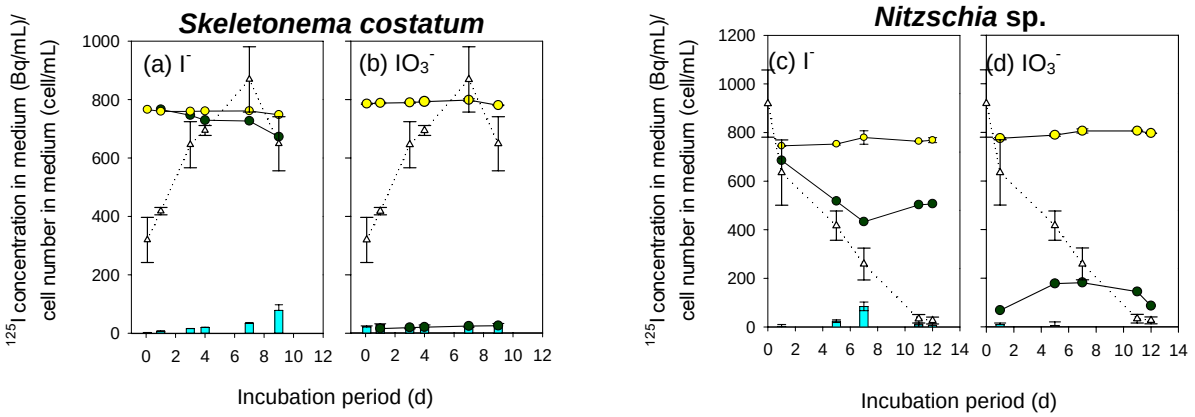

Fig. 1 Total ^{125}I (●), ^{125}I in the form of I^- (●), and ^{125}I accumulated by phytoplankton cells (■) in medium. (a) $^{125}I^-$ was added to the medium of *Skeletonema costatum*, (b) $^{125}IO_3^-$ was added to the medium of *Skeletonema costatum*, (c) $^{125}I^-$ was added to the medium of *Nitzschia* sp, (d) $^{125}IO_3^-$ was added to the medium of *Nitzschia* sp.

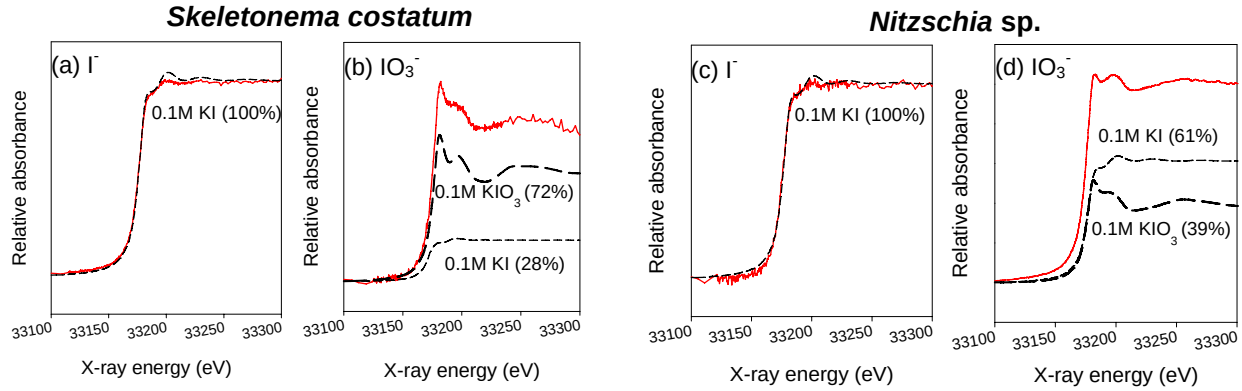

Fig. 2 K-XANES spectra of I sorbed by phytoplanktons (red solid line) in f/2 medium containing 500 mg I L^{-1}. Short-dashed lines represent the K-XANES spectra of standard I^- (0.1 M KI solution), and long-dashed lines represent those of standard IO_3^- (0.1 M KIO_3 solution). Percentages shown in the parentheses were obtained by spectrum resolving. (a) *Skeletonema costatum* grown in the medium with added I in the form of I^-. (b) *Skeletonema costatum* grown in the medium with added I in the form of IO_3^-. (c) *Nitzschia* sp. grown in the medium with I added as I^-. (d) *Nitzschia* sp. grown in the medium with I added as IO_3^-.