Ecological Significance of the First Year-Sea Ice in the Marine Ecosystem of the High Latitudes

Satoru Taguchi[1]
[1]*Soka University*

Apparent responses of the marine ecosystem to the recent global warming can be recognized distinctly in the both high latitudes. Although the maximum extent in the Arctic Ocean is restricted by the continents except for the Atlantic sector, the extent in recent years was has been less than the maximum limit. In the Arctic Ocean, the first year-sea ice extents increase with year at the rate of 0.051 million km2 per year during the period from 1980 to 2013. In the summer, the average decreasing rate of sea ice can be as high as 51,100 km2 per day. Assuming the mean chlorophyll a concentration of ice algal community of 10 mg Chl a m–2 and ice algal carbon to Chl a ratio of 50, 25.6 x 103 ton g C per day are assumed to be released into a water column. During the formation of new sea ice, approximately 0.02 % of ice algal biomass is assumed to be released to a water column from the undersurface of sea ice, corresponding 5.11 x 103 ton g C per day. The extent of sea ice in the Southern Ocean is not limited by the continents as the Arctic Ocean but the physical structure of water column. In the Antarctic Ocean, the first year-sea ice extents increase with year at the rate of 0.029 million km2 per year during the period from 1980 to 2013, which is approximately 57% of the estimates in the Arctic Ocean. The extent of the first year sea ice in the Southern Ocean has been increasing with time recently, which is approximately 15.4 million km2, which is 1.7 times larger than those in the Arctic Ocean. Assuming the similar mean chlorophyll a concentration and ice algal carbon to Chl a ratio, 42.8 x 103 ton C per day are estimated to be released into a water column. During the new sea ice formation, the amounts of released ice algal cells are assumed to be 8.56 x 103 ton C per day in the Antarctic Ocean. The annual release of ice algal cells could be less than 10 % of the total primary production in both the Arctic and Antarctic Ocean. The released ice algal cells tend to either sink out of a water column and settled on the sea bottom or trapped in the stratified upper water column. The trapped ice algal cells may grow to relatively high concentrations under the extremely low irradiance condition. Although a high biomass under the sea ice in the Antarctic Ocean has not been observed yet, a new model should be constructed to understand a role of ice algal cells in the first year-sea ice in the Antarctic Ocean as well as the Arctic Ocean in relation to the responses to the recent global warming as shown in Fig. 1.

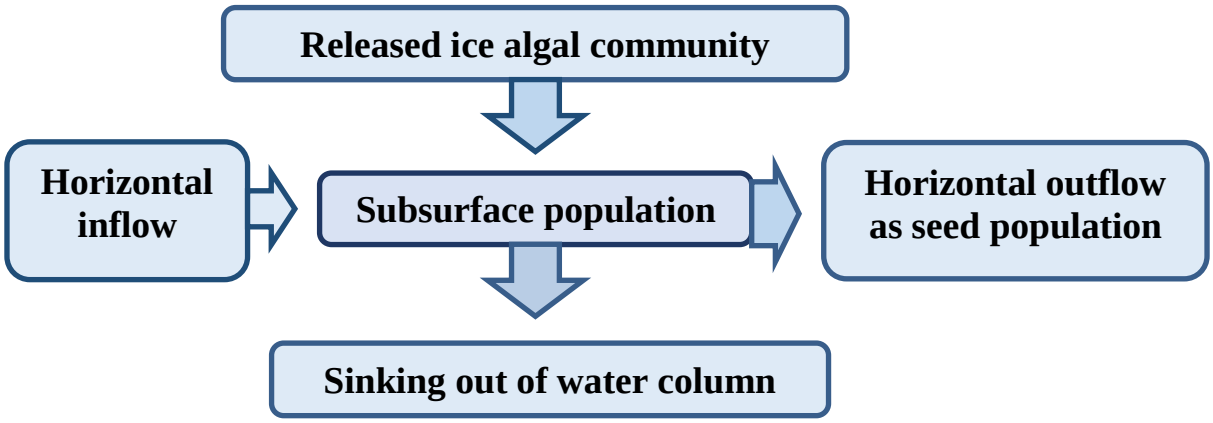

Fig. 1. Model for the fate of released ice algal community during the ice formation and at the retreat of sea ice during a summer.