Distribution and photodegradation of fluorescent dissolved organic matter in the eastern Indian Ocean

*Shigenobu Takeda[1]

1. Nagasaki University

Dissolved organic matter (DOM) is one of the major carbon reservoirs in the ocean, and a fraction of DOM fluoresces blue light when excited by UV light. Two main components of fluorescent dissolved organic matter (FDOM) are protein- and humic-like fluorophores. The environmental dynamics of FDOM in the open ocean has been reported to include photodegradation at surface layers and production through microbial decomposition of organic matters in deeper layers. Humic-like FDOM may playing a role as natural organic ligands for several dissolved trace metals such as iron in intermediate and deep waters, and therefore studies on the distribution and dynamics of FDOM are also important for better understandings of trace-metal cycles in the ocean.

During a KH-18-6 cruise by the R/V Hakuho-maru in November 2018, observations were conducted along a transect at 88ºE in the eastern Indian Ocean, where changes in biological activities of organic matter production and decomposition are remarkable in the north-south direction. Vertical distributions of FDOM fluorescence intensity were obtained at 9 stations along the transect from 16.5ºN to 20ºS. Seawater samples collected using Niskin-X bottles on a CTD-Carousel system were filtered through a filter unit having 0.2 μm pore-size and fluorescence intensity of FDOM was measured onboard by Trilogy Laboratory Fluorometer (Turner Designs) equipped with UV module (7200-067W, Excitation 350/80 nm; Emission 410-450 nm) using the 4 ppb quinine sulfate solution as a standard. In order to evaluate photodegradation of FDOM, selected filtered seawater samples were placed in 500 ml quartz bottles and these bottles were exposed to sunlight in an on-deck running seawater tank. Changes in fluorescent intensity of FDOM were monitored every 24 hours for 5 days.

The vertical distributions of FDOM fluorescence intensity showed nutrient-type profile; very low values at the surface, enrichment at intermediate depth, and gradual decrease in deep layers. A distinct peak of fluorescence intensity was also observed at the oxygen minimum layer just below the subsurface chlorophyll maximum. Along the N-S transect, fluorescence intensity of FDOM in the water column was highest at 15ºN in the Bay of Bengal, and there was a decreasing trend to the southward direction. The FDOM fluorescence intensity generally correlated with apparent oxygen utilization (AOU) in the intermediate and deep layers. However, high fluorescence intensities deviate from the FDOM-AOU relationship were measured below the subsurface chlorophyll maximum layer in the Bay of Bengal, suggesting that characteristics of fluorophores produced by microbial decomposition of organic matters might varies depending on the depth and area of the sea. In the solar irradiation experiments, a significant photobleaching was observed within 24 hours followed by gradual decrease in FDOM fluorescence intensity during the remaining period of the experiments. It indicate the existence of fluorophores having different photolability in the FDOM. One of the experiments also showed control of FDOM photodegradation by the irradiation level. These results suggest that light field and vertical mixing process near the sea surface as well as vertical difference in quality and quantity of organic matter for decomposition by diverse microbial community could have a strong influences on dynamics of FDOM in the eastern Indian Ocean.

Keywords: Indian Ocean, FDOM, Photodegradation

