

Seasonal variation of phytoplankton primary production and settling flux of the organic particles in the southern part of the Yatsushiro Sea (Minamata Bay)

*Tomohiro Komorita¹, Futaba Nakamura¹, Tomoki Tanaka¹, Mutsuo Ichinomiya¹, Katsumasa Yamada³, Gen Kanaya⁴, Kenji Yoshino²

1. Faculty of Environmental and Symbiotic Sciences, Prefectural University of Kumamoto, 2. National Institute for Minamata Disease, 3. Center for Water Cycle, Marine Environment and Disaster Management, Kumamoto University, 4. National Institute for Environmental Studies

The Yatsushiro Sea, located in western Kyushu, is a closed inner bay surrounded by the Kyushu mainland and the Amakusa Island. The northern part of the sea is influenced by the Kuma River, a first class river, and the southern part is influenced by the open sea water from the Tsushima Warm Current flowing in from the Uchibuka Nagashima Strait and Kuro Seto Strait. In the Yatsushiro Sea, fish farming is particularly important as an industry, and development of a method to predict the occurrence of red tides, which cause damage to fisheries, has been promoted. In order to elucidate the mechanism of occurrence and maintenance of red tides, it has been pointed out that it is necessary to develop an ecosystem model that takes into account both biological and physical processes in the lower trophic levels. In the Yatsushiro Sea, however, there is a lack of knowledge on primary production, which is necessary for the development of an ecosystem model. Furthermore, there is limited knowledge on material circulation, such as the amount of organic matter deposited on the seafloor in areas not affected by fish farms. Basic information on the above mentioned processes is necessary for sustainable utilization of ecosystem services in coastal areas.

In this study, water quality was observed from March 2021 to July 2022 in Minamata Bay, which is located in the southern part of the Yatsushiro Sea and is not used for fish farm. The primary production of phytoplankton was measured in laboratory experiments using seawater from the field, and the sedimentation flux was determined using a sediment trap. From these results, seasonal changes in primary production, sedimentation flux, and the origin of sedimentation particles in Minamata Bay are clarified, and the characteristics of the material circulation in the southern part of the Yatsushiro Sea are discussed. In this study, field surveys were conducted once a month from March 2021 to July 2022 using vessels. At the study station, water temperature, salinity, chlorophyll fluorescence, dissolved oxygen (DO), and photosynthetically active radiation (PAR) were measured at 0.1 m intervals using a multitem water quality meter. Water samples were subsequently collected at 0 m, 2 m, 5 m, and 1 m directly above the seafloor using clean buckets and Niskin water samplers. Water samples were used to quantify nutrient, dissolved inorganic carbon (DIC), and chlorophyll-a (Chl-a) concentrations, as well as for culture experiments for primary production. Subsequently, sediment traps with six acrylic cores (inner diameter 3.6 cm, height 30 cm), one at each site, were placed at a depth of 2 m directly above the seafloor for approximately 24 hours to collect sedimentation particles. Samples collected in the traps were filtered through glass fiber filter paper and used to measure particulate organic carbon (POC), particulate nitrogen (PN), Chl-a, and stable isotope ratios of carbon and nitrogen. For the primary production experiment, samples obtained from each layer were divided into polycarbonate culture bottles, NaH¹³CO₃ was added to a final concentration of approximately 200 μ M, and the bottles were incubated at four light conditions (100, 10, 1, 0 %) for approximately 3 hours at field water temperature. After filtration of the culture samples, primary production was calculated based on Hama et al. (1981).

Primary production tended to be higher in winter and rainy season at both sites, with a maximum of $675 \pm$

24 mgC m⁻² d⁻¹ in June at Minamata Bay and 303 ±4 mgC m⁻² d⁻¹ in December at Fukuro Bay. The POC fluxes in Minamata Bay and Fukuro Bay showed the same trend, with a maximum of 1,806 mgC m⁻² d⁻¹ and 1,104 mgC m⁻² d⁻¹ in November and a minimum of 862 mgC m⁻² d⁻¹ and 607 mgC m⁻² d⁻¹ in April and November, respectively. ($r^2 = 0.602$, $p < 0.01$) and 54.4 ($r^2 = 0.504$, $p < 0.02$) in Fukuro Bay. The obtained C/Chl-a was multiplied by the Chl-a flux to obtain the phytoplankton POC flux, and the phytoplankton sedimentation flux accounted for 7% to 52% of the POC flux. This indicates that phytoplankton contributes little to the POC flux to the seafloor in Minamata Bay. The ratio of the phytoplankton POC flux to the primary production on the same day was about 1. This indicates that most of the primary production by phytoplankton in the inner bay located in the southern part of the Yatsushiro Sea settles on the seafloor.

Keywords: Primary production, sedimentation flux, Yatsushiro Sea