EFFECTS OF RIVER DISCHARGE ON GROWTH OF PERIPHYTON IN SAND RIVER

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Periphyton is known to be one of major primary producer for river ecosystem, and it develops bio-film type communities on solid surface submerged in water (MacIntire (1973), Minshall (1978), Saravia et al. (1998)). In natural streams, the periphyton communities are usually seen on the surface of gravel stone of shallow river bed and/or on the surface of submerged structures. The growth of periphtyon is expected to be rarely observed in sand river reach because of high mobility of bed materials and shortage of solar illumination due to relatively large water depth compared with gravel reach. Nevertheless the large growth of periphyton is sometimes seen even in sand river where river discharge and water depth are small enough to provide the stable habitat for periphyton. In the present study, field observations and numerical simulations were performed to know the growth of periphyton in sand river.

In the field observation, the growth of periphyton on fixed sand bed was measured during summer in 2004 and winter in 2004 and 2005. The periphyton biomass was measured in terms of chlorophyll a by using a spectrophotometer. The results of the field observations show that the large growth of periphyton occurs in sand river until the bed material sands have not moved. It was also found that the growth of periphyton is not affected by the gain size of bed material sands as long as the sands have not moved.

An integrated numerical simulation model is presented to describe the growth of periphyton at the observed river reach. The model consists of the analysis of frequency of bed material movements and the simulation of growth of periphyton during the period that the bed material sands have not moved. In the computation of frequency of bed material movements, the tractive force on river bed τ_* is estimated under the uniform flow assumption by using the observed data of river discharge and cross-sectional geometry, and the critical tractive force τ_{*c} is calculated by using Iwagaki formula (Iwagaki (1956)). Comparing between τ_* and τ_{*c}, the amount of periphyton M is estimated to 0 during the period of $\tau_*>\tau_{*c}$, and it is calculated by the numerical integration of logistic type growth equation during the period of $\tau_*<\tau_{*c}$. Fig. 1 shows the computational results of the temporal variation of periphyton biomass at the observed river reach. It was found that the large periphyton growth exceeding 4.0 mg.chl.a/m^2 occurs 2 or 3 times/year. Integrating the net production of periphyton biomass during the computational period, the net primary production by periphyton is estimated to be 0.19 mg.chl.a/m^2/day. The concentration of chlorophyll a of phytoplankton in the observed river reach varies between 0.5 and 3.0 mg.chl.a/m^3, and the rate of primary production of phytoplankton typically takes the value between about 0.3 and 1.0 day^{-1}. Multiplying these 2 values, the primary production by phytoplankton is estimated to about 0.15 to 3.0 mg.chl.a/m^2/day. This result indicates that the primary production of periphyton is comparable to that of phytoplankton in the observed river reach.

In order to know the effect of river discharge on the primary production of periphyton, the series of the numerical tests were performed under the various river discharges. It was found that the net primary production gradually decreased until the increased river discharge is about 10 m^3/s. After that, the net production rapidly decreases with the increased discharge. These results infer that the reduction of river discharge at ordinary water stage strongly affects the primary productivity of periphyton even in sand river, and the excess intake of river water may induce the increase of primary production in sand river.

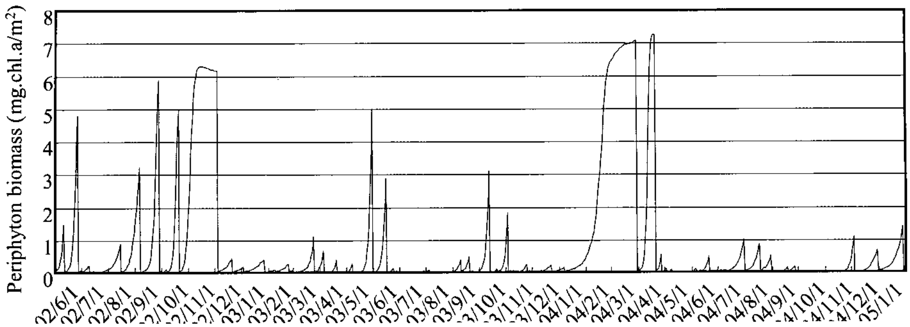

Fig. 1 Temporal variation of periphyton biomass computed

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