Changes of flow rates during floods are closely related to the formation of stream morphology and material transfer. Organisms that inhabit streams have evolved adapting to the environment and mutually support the life of others. Recently, the need to investigate changes in flow rate during floods has been noticed, and various attempts have been made. In the US, the gates of the Glen Canyon Dam were opened to artificially produce a large-scale flood in March 1996. In Japan, attempts have been made since 1997 to temporary discharge a large amount of water from dams (flexible management of dams), and the effects of these discharges are being investigated.

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of each flow level by scraping away areas of 5×5 cm using a brush. We determined the dry weight, chlorophyll a content (value showing the amount of living algae and production), ignition loss, and pheophytin (shows the amount of dead algae) of the specimens, identified alga species, and counted the number of cells.

Results and Discussion

The results are shown in Figure 1 as the mean and standard deviation. The figure shows the values just before increasing the flow to 0.25 and 0.5 m^3/s as values of the 24th hour of the previous flow rate. Values accompanied by "⋆" and "⋆⋆" showed a significant difference among a,b,and c ($P<0.05$ and $P<0.01$, respectively) by one-way ANOVA.

At 0.1 m^3/s, both the dry weight and the amount of inorganic materials neither decreased nor increased but fluctuated, and no exfoliation was observed. At 0.25 m^3/s, the values decreased at the 3rd hour, but the reduction was likely to be the accumulation during 0.1 m^3/s. The values did not change thereafter up to the 24th hour. At 0.5 m^3/s, all of the dry weight, the amount of inorganic materials and chlorophyll a decreased. This suggests that a flow rate of at least 0.5 m^3/s, which is equivalent to more than 7.1 cm/s in friction velocity, is needed to remove the alga layers. Even at the termination of the experiment, there was still a large amount of algae on the rocks. The dominant algae species were: *Achnanthes subhudsonis*, *Melosira varians*, and *Navicula minima* (diatoms), and *Chamaesiphon* sp. (Cynophyceae) before the flood. After the flood, only *Navicula minima* was reduced to approximately 13% of that found before the test, but the other species were not affected. The flood did not cause reductions in species other than these dominant species either. This suggests that the flood conditions used in the experiment were insufficient to exfoliate and remove algae from the rock surfaces, and so it is necessary to increase either the size or the duration of flood.

Species that grow on rock surfaces vary depending on hydrological conditions such as flow rate and water quality, and so the adhering state varies. To overcome the problem of accumulation of fine sediments on riverbed rocks, washing-out conditions must be determined based on the actual state of the site. More experiments will be conducted using various conditions so as to cope with various states.

■ Table 1 Experimental conditions

Flow rate (m^3/s)	0.05	0.1	0.25	0.5
Water depth (cm)	6	14.3	20.4	25.9
Flow speed (at 60% depth) (cm/s)	12.7	32.4	48.8	73.9
Friction speed (cm/s)	3.4	5.3	6.3	7.1

■ Results 1

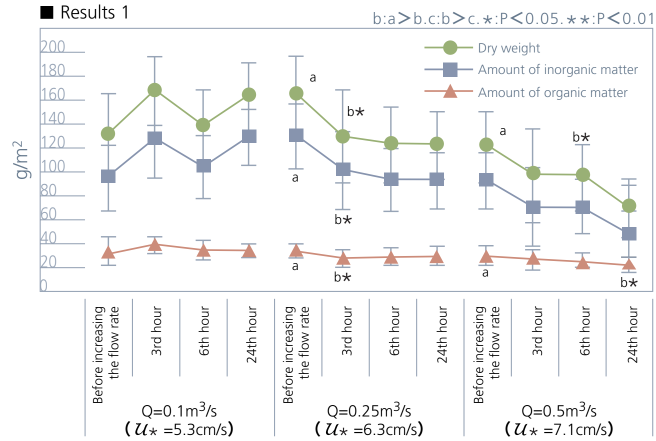

Figure 1

■ Results 2

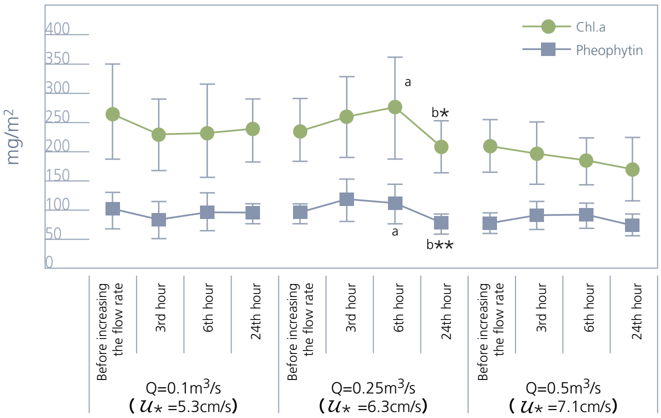

Figure 2

Column

River renaturalization projects, which started in 2001, involve not only the rehabilitation of habitat structures on the scale of reaches and segments, but also restoration of the inherent natural system of rivers which is closely correlated with their watershed characteristics. Several types of project have been attempted to naturalize inherent natural systems in rivers. For example, typical projects which focused on the flow and sediments for renaturalization included: increasing the maintenance discharge for aquatic organisms, flexibly operating dams to restore part of the natural flow regime, and artificially supplying sediment to the downstream segments of dams. However, the relationships between physical and biological phenomena are not well understood, and thus we should clarify the relation via experiments and field surveys in order to effectively incorporate those solutions into a framework for watershed management.