Effects of agricultural practices in rice crop systems on the diversity of periphyton and phosphorus dynamics in streams of the Yasu River watershed

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Phosphorus is an essential element for all living organisms, and its availability often limits the productivity of many freshwater ecosystems, such as streams, rivers, and lakes. However, human activities often influence the phosphorus loading to freshwater ecosystems, which may exceed the threshold level that triggers the regime shift from oligotrophic to eutrophic conditions in the systems. Moreover, human-induced excess phosphorus can impact both the community structure and physiological P demand of aquatic organisms, thereby affecting the ecosystem function (e.g., P uptake) of those systems. However, knowledge on effects of human-induced P loading on the community structure and ecosystem function in streams is still limited.

We performed a field study in the Yasu River watershed to clarify the effects of agricultural practices on the diversity of periphyton and phosphorus dynamics in streams during May and June 2016. The Yasu River watershed is mainly composed of three lithological classes: accretionary complex, granite, and sedimentary rock. In the sub-watersheds where sedimentary rock predominates, a large amount of particulate phosphorus originated from rice paddy fields is exported with muddy water to nearby streams during the surface soil paddling period. In contrast, agricultural practices in rice crop systems seem to have relatively minor influences on phosphorus loading to adjacent streams in the sub-watersheds where the other lithological types predominate. We established sampling sites in streams of both sub-watersheds to analyze the P concentration and the community structure of periphyton attached on the streambeds. In addition, we performed the enzyme-labeled fluorescence (ELF) assay for periphyton samples to determine the cell-associated alkaline phosphatase activity (a common marker of P demand) in response to phosphorus loading from rice paddy fields.

In this presentation, we show that the rice crop practices in sedimentary rock areas greatly influenced the total phosphorus but not soluble reactive phosphorus concentrations in streams. The results suggest that agricultural practices (e.g., soil paddling) interacted with geological characteristics to affect the transport of particulate phosphorus (PP) from rice paddy fields. The present study also show how such human activities influence the diversity and community structure of stream periphyton, as well as their physiological P demand. The results will clarify the effects of agricultural practices in rice crop systems with contrasting geological types and the resultant consequences for ecosystem structure and function in streams of agricultural watersheds.

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