

Dynamic Changes in Distribution of Particulate Organic Matter and Benthos Communities within Seigyu-created Habitats in the Kizu River

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Riffle habitats and benthos communities in the Kizu River, a tributary of the Yodo River System, have changed historically from “Diverge type riffles” of smaller bed materials with a high abundance of mayflies to “Converge type riffles” of larger bed materials with a high abundance of net-spinning caddisflies⁽¹⁾. However, we found distinctive two types of habitats: *i.e.*, pale color and dark color parts within a riffle in the Kizu River. This paper aims to show their hydraulic conditions, benthos communities, and trophic sources of benthic particulate organic matter based on field surveys and to discuss the ecological functions of the “Seigyu” (a kind of Japanese traditional river works, called also “Hijiri-Ushi” in Japanese and “Crib Spur” in English) constructed for nature restoration by altering the reach-scale habitat structure.

Study area and methods

The study was conducted along a gravel bar, where four units of Seigyu works were installed, at

15.2-15.6 km in the lower reaches of the Kizu River. The areas of pale and dark parts in the river channel were detected by the color difference of the picture images taken by the UAV: *i.e.*, the whitish pale color and the dark color parts, respectively (Fig. 1). Physicochemical measurement and benthos sampling were conducted in the pale color part (n=4) and dark color part (n=4) in the bar head riffle and bar tail riffle, respectively, on 14th-15th Dec 2022 (Fig. 1). In addition, a series of seasonal samplings were conducted at various sites (n=1 for each site) on Sep 9th, Sep 14th to 16th, Sep 25th and Nov 5th - 6th 2022.

Density of benthic particulate organic matter (BPOM) and benthos were collected using an enclosure net (75 μ m in mesh size) with 10*20cm in area and a survernet (500 μ m in mesh size) with 25cm *25cm quadrat, respectively at the sampling sites. The dry weight and ingestion loss (AFDW: ash free dry weight) of BPOM samples were measured. The benthos were identified into family, genus or species level and the number of individuals were counted.

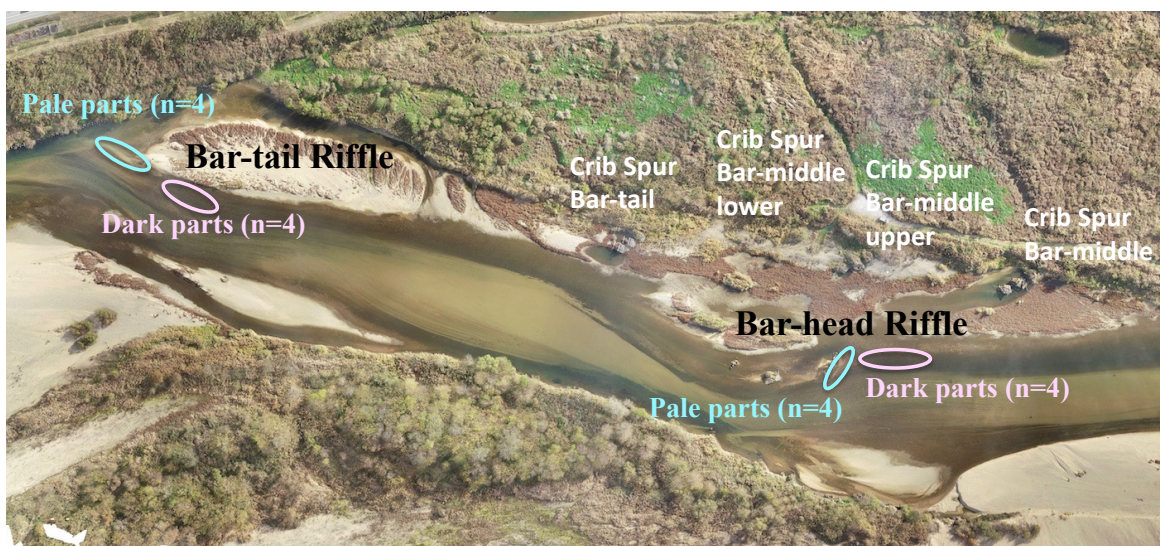


Fig.1 A UAV image of the study area in the Kizu River taken on 15 Dec 2022.

Relations among physicochemical factors and the benthos community parameters were analyzed using principal component analysis (PCA), redundancy analysis (RDA), the ANOVA test, and t-test.

Results

Color patterns of the river bed were rather uniform with monotonous pale brown and on Sep 9th, Sep 14th to 16th, and Sep 25th, the pale and dark parts were indistinctive after the peaks of discharge in September. It became distinctive gradually during the low flow conditions as shown in (Fig. 1).

The pale parts had less BPOM density (mean=3.2 g/m³) and shallower depth (mean=16.6 cm). And the dark parts had more BPOM density (mean=20.8g/m³) and deeper depth (mean=26.2 cm) (Fig. 2).

As to the benthos communities, the pale color part had less taxonomic richness (mean=252 individuals/m²) than the dark (mean=366.4 individuals/m²). However, benthos abundance was more in the pale part (mean=564 individuals/m²) than the dark (mean=3,146 individuals/m²).

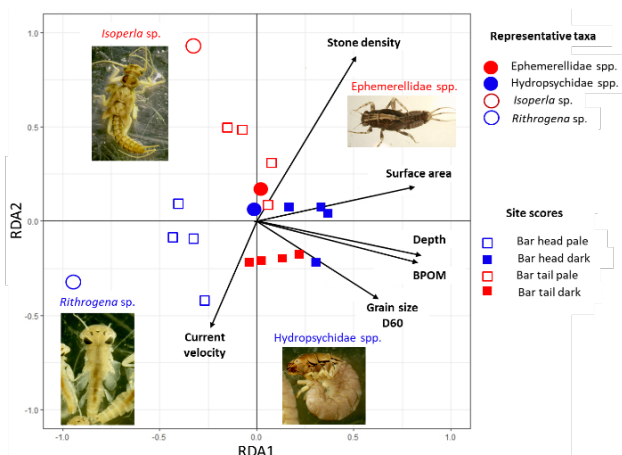


Fig. 2 Redundancy analysis (RDA) biplot of species scores and site scores. Different symbol colors correspond to sites of the pale and dark parts.

Abundance of an ephemeropteran (mayfly) species *Rithrogena* sp. was more in the pale than the dark part and was the most abundant in the bar head

(mean=3,984 individuals/m²). Abundance of a plecopteran (stonefly) species *Isoperla* sp. was more in the pale than the dark part but was the most abundant in the bar tail (mean = 3,132 individuals/m²). On the other hand, abundance of the mayfly Ephemeroptera (6 species included) was more in the dark part and bar tail than in the pale part and bar head respectively, and was the most abundant at the dark part in bar head (mean=220 individuals/m²). In addition, Hydropsychidae (4 species included) caddisfly had more abundance at the dark part in the bar head than other sites (mean=588 individuals/m²).

The RDA plot of the taxonomic richness score and site score showed that both *Isoperla* sp. and *Rithrogena* sp. preferred the pale parts but *Rithrogena* sp. preferred sites of higher current velocity and *Isoperla* sp. preferred sites of higher stone density (Fig.2).

Discussions and Future work

Two types of riffle habitats (pale part and dark part) detected in this study are expected to correspond to a movable gravel substrates and an immovable cobble substrates, respectively under a particular flow regime. During the process of reducing discharge after the peaks in September, movable grain size would be restricted to gravel and smaller ones which may create pale-colored belts on the river bed as shown in Fig 1. As to the cobble substrate, the filtering efficiency of the organic matter might increase because of immovability and this may lead to create the dark-colored belt on the riverbed. These processes should be tested using the two-dimensional numerical simulations in near future.

REFERENCE

- (1) Kobayashi S & Takemon Y (2013) Historical changes of riffle morphology for benthic invertebrate habitats in the Kizu River. *Annals of Disas.Prev.Res.Inst.Kyoto Univ.* 56B: 681-689.