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## 学位論文内容の要旨

博士 (環境科学)

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### 学位論文題名

A linkage between the underground and the land: insect-mediated resource fluxes and dispersals from the hyporheic zone of a gravel-bed river (地下と地上のつながり : 扇状地河川河床間隙水域からの昆虫を介した物質移送およびその分散)

The hyporheic zone, located below the riverbed, is a habitat for aquatic insects. The insects that spend most of their lives as larvae in the hyporheic zone and have a terrestrial adult stage are known as amphibitic insects. Amphibitic insects bring out the resources originating from the hyporheic zone. The amphibitic insects, *Alloperla ishikariana* (order: Plecoptera, family: Chloroperlidae), were used as a conduit of resources to estimate how much resources the hyporheic zone could supply to the terrestrial ecosystem. The study also described the dispersal of insect-mediated resource in the terrestrial ecosystem.

The Chapter 2 investigated where the most hyporheic originating resources could be reached. It estimated mean daily flux as dry biomass, carbon, and nitrogen during the early-summer to summer periods. In 2017 and 2018, Malaise traps were set to catch the lateral and longitudinal directional dispersing winged adults of *A. ishikariana*, and other taxa from the river and estimated the directional fluxes of them. *Alloperla ishikariana* was similar to other Plecoptera species and differed clearly from Ephemeroptera and Trichoptera in directional characteristics of resources flux, suggesting that the extent and directions of hyporheic zone derived resource transfer depends on taxon-specific flight behaviors of hyporheic insects. Contributions of *A. ishikariana* to the riparian zone reached the highest in July (52-70%).

The Chapter 3 examined how adult aquatic insects could disperse after reaching the riparian forest. The samples for this part of the study were collected in the period of June from 2017 to 2019. Six dominating taxa among Ephemeroptera, Plecoptera and Trichoptera were chosen based on their greater abundances. Chloroperlidae was one of the dominating taxa in which *A. ishikariana* comprised more than 95% in abundance. Most of Chloroperlidae and Hydrobiosidae reached the riparian forest rather than stayed on the open spaces of the river and the gravel-bar. After arriving in the riparian forest, most of the dominating taxa dispersed to the upstream direction. For upstream dispersal of Chloroperlidae the riparian forest is essential.

The Chapter 4 examined how far *A. ishikariana* could disperse away from the channel and along upstream or downstream in the riparian forest. Malaise traps were set in June 2018 at various distances from the channel towards the riparian forest to estimate lateral dispersal distances. An elevated stable nitrogen isotope ratio in downstream larvae, was used to assess longitudinal dispersal by identifying and

tracking adult movements. Laterally, they flew over several 10 meters where they flew longitudinally over several kilometers. A higher number of adults demonstrated upstream movement, suggesting an upstream bias in the longitudinal dispersal of *A. ishikariana*.

The findings supported an improved visualization of a multi-dimensionally connected river ecosystem in terms of material flow, including vertical connectivity. This study also showed the importance of the riparian forest edge for longitudinal dispersal of the hyporheic origin insects along the river. Furthermore, the importance of the hyporheic zone as a supplier of aquatic resources to the terrestrial ecosystem revealed that it could demand worthiness in the freshwater resource management plan.