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SHORT COMMUNICATION

Belowground rhizobia positively affect abundances of aboveground sap feeding and leaf chewing herbivores

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Symbiotic belowground microbes (mycorrhizal fungi and/or nitrogen-fixing bacteria) provide nitrogen and phosphorus to host plants, and plants in return provide photosynthetic carbon to microbial symbionts. Plants use these nutrients for their growth, reproduction, and defense. Therefore, belowground microbes have the potential to determine the abundance of aboveground arthropod herbivores. Recently, there is a growing body of evidence that mycorrhizal fungi positively or negatively affect the performance of aboveground arthropods. In a meta-analysis using 34 studies, Koricheva et al. (2009) showed that mycorrhizal fungi increased the abundance or body weight of sap feeders, but decreased those of leaf chewers. However, to date we know little about the effects of nitrogen-fixing bacteria on aboveground arthropods.

We examined the effects of rhizobia on the abundance of the aboveground sap feeding and leaf chewing arthropod herbivores on host plants, using a close-related root-nodulating soybean strain (*Glycine max* L, cv. Fujimishiro: R+) and a non-nodulating strain (cv. Touzan No 90: R−). In a previous study, Katayama et al. (2010) showed that the number of root nodules of the R+ plants were 82.4 ± 8.6 (mean $\pm$ SE, $n = 15$), but there were no nodules on the roots of the R− plants ($n = 24$). Also, foliar nitrogen and phenolics of the R+ plants were 50% higher and 12% lower than those of the R– plants. In this study, we placed 28 pots of R+ plants and 48 pots of R– plants in a common garden of Center for Ecological Research of Kyoto University (34°58′17″N, 135°57′32″E, Otsu, Japan) in June 2006. From June 21 to September 28 we conducted 27 censuses at 3–4 day intervals on average to measure arthropod abundance on the plants.

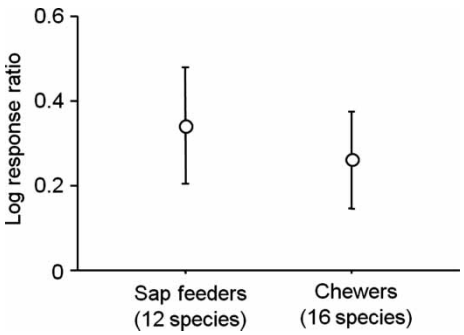

Figure 1. Log response ratio of abundance of sap feeders and chewers. Bars show 95% CI. There was no significant difference between sap feeders and chewers (*t*-test, $P > 0.05$).

During the season, we observed 27 and 20 herbivorous species on R+ and R− plants, respectively. These species were classified into sap feeders (12 species), and leaf chewers (16 species). For each arthropod species, the number of individuals on each plant was summed for all 27 census data, and then, we calculated the log response ratio of the abundance of each herbivore species to compare the strength of rhizobia effects on sap feeders and chewers. Log response ratio is widely used to compare effect sizes in manipulation experiments (Hedges et al. 1999). When the value is < 0, the effect is negative relative to the control, and when the value is > 0, the effect is positive.

The log response ratios of the abundance of both sap feeders and leaf chewers were significantly greater than 0 ($P < 0.05$), but no difference was found between them (*t*-test, $t_{26} = 0.68$, $P = 0.500$; Figure 1). This indicates that rhizobia increased the abundance of not only sap feeders and but also leaf chewers, and the strength of the positive effect of rhizobia did not differ between the two feeding guilds. Thus, our result clearly demonstrated that belowground rhizobia strongly affected the abundance of aboveground arthropods.

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