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The double symbiotic life: plant-associated Burkholderia are also associated with bordered plant bugs (Heteroptera: Largidae)

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Diverse animals and plants possess symbiotic microorganisms in their bodies, many of which maintain the association by acquiring the symbionts from ambient environments every generation. Despite recent findings, symbionts' lifestyles outside of these particular associations (hosts?) have been scarcely understood in many symbiotic systems. Here we characterize the bacterial gut symbiosis in the bordered plant bugs (Heteroptera: Largidae), thereby showing a possibility that symbiotic bacteria of the insects are also intimately associated with plants. Members of the family Largidae develop a number of tubular outgrowths in the midgut posterior region, the lumen of which is densely populated by symbiotic bacteria. Based on the array of results from whole-mount fluorescence in situ hybridization (wFISH), cloning analysis, and illumina deep sequencing, it is revealed that the bordered plant bugs are consistently associated with Burkholderia species that belong to the “plant-associated beneficial and environmental (PBE)” clade. In the bacterial phylogeny, the insect-associated, rhizobacterial, and nodule-forming species/strains are clustered as inseparable groups, suggesting frequent transmissions of the Burkholderia symbionts between insect- and plant-hosts; this may imply its unique “double symbiotic life.” Furthermore, this bordered plant bugs-Burkholderia symbiotic system sheds light on the evolutionary process of the bacterial symbiosis in the Heteroptera.

keywords:symbiosis,*Burkholderia*,bordered plant bugs,double symbiotic life