Inhibition of gut digestive proteases by cyanobacterial diets decreases infection in a Daphnia host-parasite system

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Abstract

1. Secondary metabolites produced by primary producers have a wide range of functions as well as indirect effects outside the scope of their direct target. Research suggests that protease inhibitors produced by cyanobacteria influence grazing by herbivores and may also protect against parasites of cyanobacteria. In this study we asked whether those same protease inhibitors produced by cyanobacteria also can influence interactions of herbivores with their parasites. 2. We used the Daphnia-Metschnikowia zooplankton host-fungal parasite system to address this question because it is well documented that cyanobacteria protease inhibitors suppress trypsin and chymotrypsin in the gut of Daphnia, and because it is known that Metschnikowia infects via the gut. We tested the hypothesis that Daphnia gut proteases are necessary for Metschnikowia spores to be released from their asci. We then also tested whether diets that decrease trypsin and chymotrypsin activity in the guts of Daphnia lead to lower levels of infection. 3. Our results show that chymotrypsin promotes release of the fungal spores from their asci. Moreover, a diet that strongly inhibited chymotrypsin activity in Daphnia decreased infection levels, particularly in the most susceptible Daphnia clones. 4. Our results support the growing literature that cyanobacterial diets can be beneficial to zooplankton hosts when challenged by parasites and uncover a mechanism that contributes to the protective effect of cyanobacterial diets. Specifically, we demonstrate that host chymotrypsin enzymes promote dehiscence of Metschnikowia spores; when cyanobacteria inhibit activity of chymotrypsin in hosts, this most likely traps the spore inside the ascus, preventing the parasite from puncturing the gut and beginning the infection process. 5. This study illustrates how secondary metabolites of phytoplankton can protect herbivores against their own enemies.

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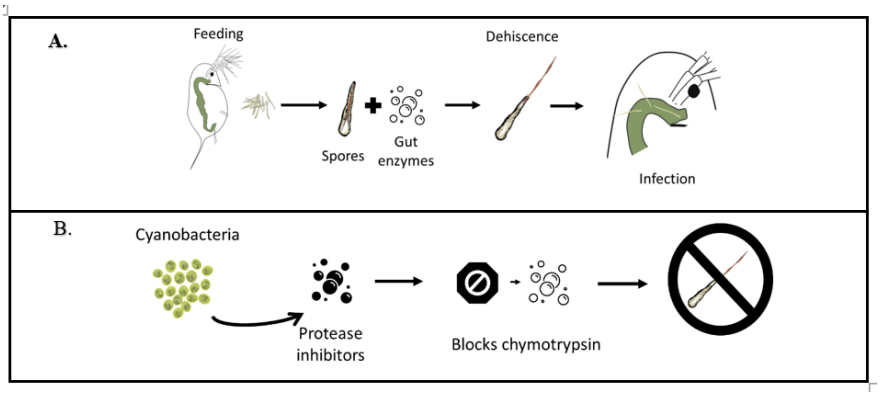

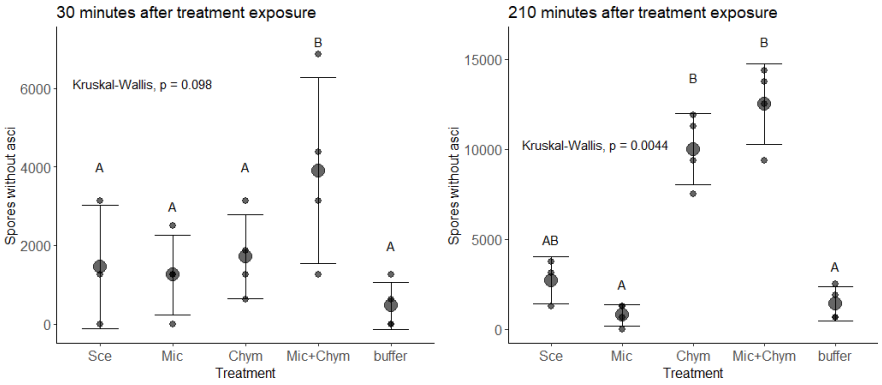

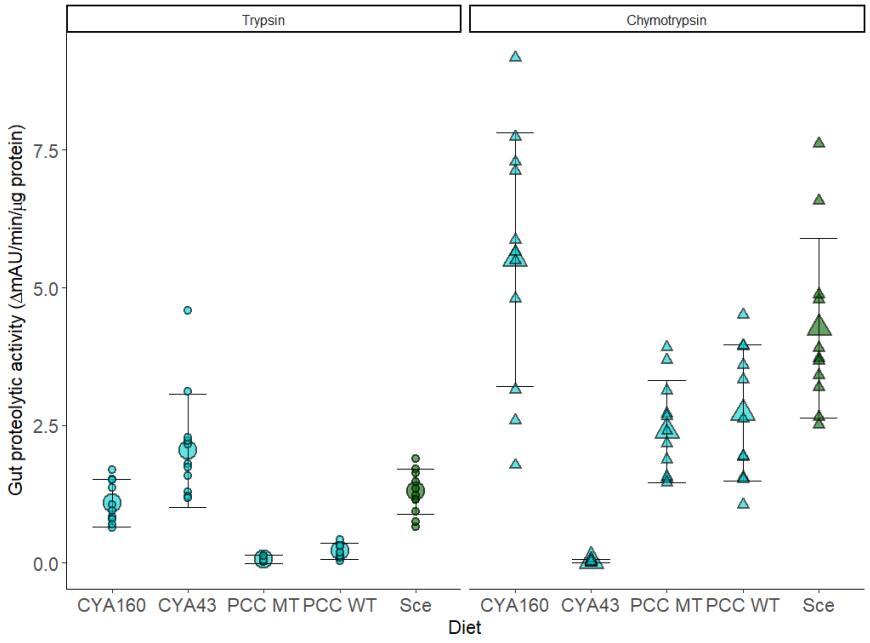

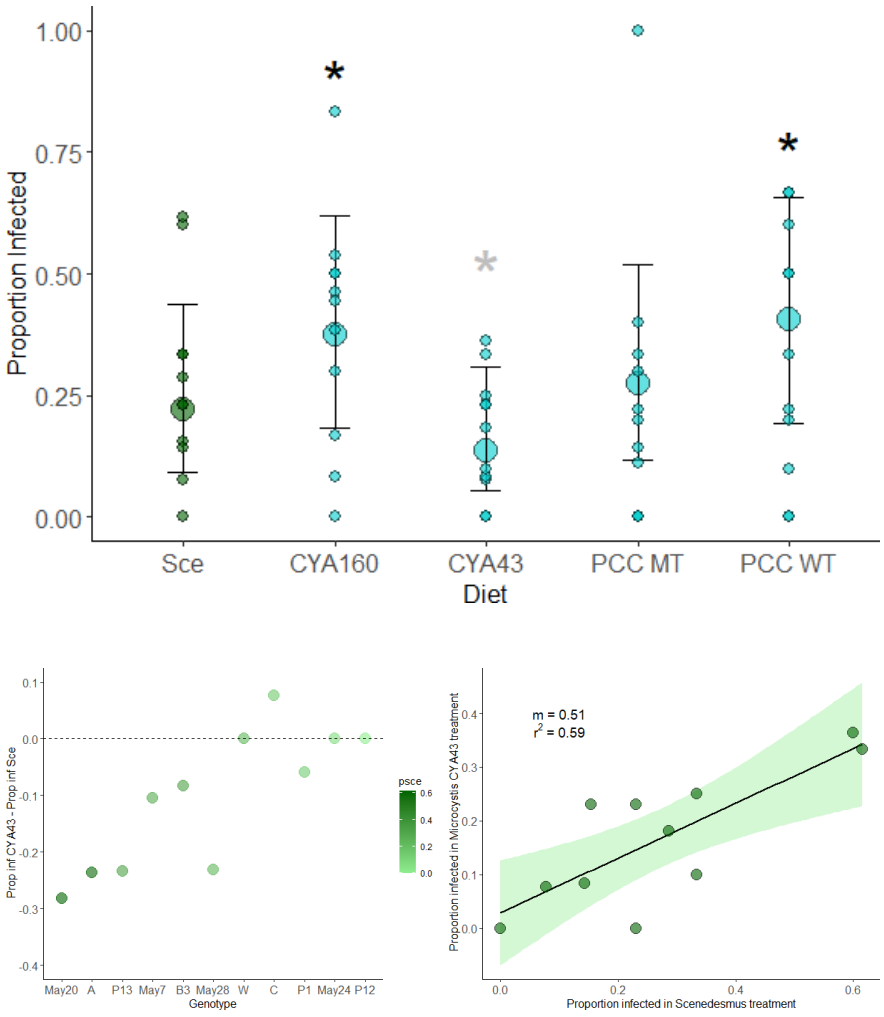

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