Diversities of endosymbiont Wolbachia and parasitoids affect species assemblages under climate change: Implications for biological control

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Thesis Summary

The endosymbiotic *Wolbachia* infect about a half of arthropod species and are known to influence the biological and ecological functions of their hosts. The thermal environment can alter endosymbiont biology and ecology. In addition, anticipated climate change can affect insects' fitness, affecting each species directly and their interactions indirectly. However, the combined effect of temperature and CO_2 concentration rise as well as the interplay of endosymbiont diversity and parasitoid diversity on host insects are not yet fully understood. This study aimed at the combined effects of *Wolbachia* and parasitoid diversities under climate change, that is, elevated temperature and CO_2 concentration, on species assemblage consisting of the host *Callosobruchus chinensis* and its parasitoids (*Heterospilus prosopidis* [Hp] and *Anisopteromalus calandrae* [Ac]). Three lines were established; a line infected with two *Wolbachia* strains (*w*BruCon [Con] and *w*BruOri [Ori]), a line infected with Con only (cured of Ori), and an uninfected line (cured of both). The fitness of individuals, population densities and assemblage persistence were examined in host-only system and host–parasitoid(s) systems (with one parasitoid, Ac or Hp, or with both two parasitoids) by performing single- and multiple-generation experiments under control and climate change (+ 2℃ and a doubled CO_2). Relative *Wolbachia* abundance in infected hosts was quantified using qPCR. Single-generation experiments revealed that higher diversity, but not relative abundance, of *Wolbachia* incurs a cost on the host's fitness traits, and climate change imposed additional stress, except for development time. The fitness of parasitoids was lower in uninfected hosts and was increased by climate change only in Hp. Multiple-generation experiments with a constant supply of beans as the resource for the host showed that the host population level was higher in the uninfected line for the host-only system and that the uninfected host population drastically decreased with Ac with/without its competitor (Hp). With Hp present, the host population size was smaller under climate change. This outcome was partly associated with the host female ratio that decreased with decreasing *Wolbachia* diversity and with increasing parasitoid diversity. The population size of host and Ac was decreased by climate change but unaffected by its competitor (Hp), while Hp population size was unaffected by climate change but was smaller with its competitor (Ac) present. The extinction of a species was earlier with higher parasitoid diversity. On the other hand, the proportion of bean mass uninfested was higher under climate change and with increasing parasitoid diversity but unaffected by *Wolbachia* diversity. These results suggest that endosymbiotic diversity and parasitoid diversity can affect the dynamics of the higher trophic and organization levels via the host in a complex way, but that indirect effect of endosymbiotic diversity on the dynamics of the lower trophic level might be relatively small.