Comparative Assessment of the Thermal Tolerance of Spotted Stemborer, Chilo partellus Swinhoe (Lepidoptera: Crambidae) and Its Larval Parasitoid, Cotesia sesamiae Cameron (Hymenoptera: Braconidae)

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Abstract : Under stressful thermal environments, insects adjust their behaviour and physiology to maintain key life-history activities and improve survival. For interacting species, mutual or antagonistic, thermal stress may affect the participants in differing ways, which may then affect the outcome of the ecological relationship. In agroecosystems, this may be the fate of relationships between insect pests and their antagonistic parasitoids under acute and chronic thermal variability. Against this background, we therefore investigated the thermal tolerance of different developmental stages of Chilo partellus Swinhoe (Lepidoptera: Crambidae) and its larval parasitoid Cotesia sesamiae Cameron (Hymenoptera: Braconidae) using both dynamic and static protocols. In laboratory experiments, we determined lethal temperature assays (upper and lower lethal temperatures) using direct plunge protocols in programmable water baths (Systronix, Scientific, South Africa), effects of ramping rate on critical thermal limits following standardized protocols using insulated double-jacketed chambers ('organ pipes') connected to a programmable water bath (Lauda Eco Gold, Lauda DR.R. Wobser GMBH and Co. KG, Germany), supercooling points (SCPs) following dynamic protocols using a Pico logger connected to a programmable water bath, heat knock-down time (HKDT) and chill-coma recovery (CCRT) time following static protocols in climate chambers (HPP 260, Memmert GmbH + Co.KG, Germany) connected to a camera (HD Covert Network Camera, DS-2CD6412FWD-20, Hikvision Digital Technology Co., Ltd, China). When exposed for two hours to a static temperature, lower lethal temperatures ranged -9 to 6; -14 to -2 and -1 to 4ºC while upper lethal temperatures ranged from 37 to 48; 41 to 49 and 36 to 39ºC for C. partellus eggs, larvae and C. sesamiae adults respectively. Faster heating rates improved critical thermal maxima (CTmax) in C. partellus larvae and adult C. partellus and C. sesamiae. Lower cooling rates improved critical thermal minima (CTmin) in C. partellus and C. sesamiae adults while compromising CTmin in C. partellus larvae. The mean SCPs for C. partellus larvae, pupae and adults were -11.82±1.78, -10.43±1.73 and -15.75±2.47 respectively with adults having the lowest SCPs. Heat knock-down time and chill-coma recovery time varied significantly between C. partellus larvae and adults. Larvae had higher HKDT than adults, while the later recovered significantly faster following chill-coma. Current results suggest developmental stage differences in C. partellus thermal tolerance (with respect to lethal temperatures and critical thermal limits) and a compromised temperature tolerance of parasitoid C. sesamiae relative to its host, suggesting potential asynchrony between host-parasitoid population phenology and consequently biocontrol efficacy under global change. These results have broad implications to biological pest management insect-natural enemy interactions under rapidly changing thermal environments.

Keywords : chill-coma recovery time, climate change, heat knock-down time, lethal temperatures, supercooling point
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