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Synergistic effects of temperature and plant quality, on development time, size and lipid in *Eccritotarsus eichhorniae*

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Abstract

Body size is an important biotic factor in evolutionary ecology, since it affects all aspects of insect physiology, life history and, consequently, fitness in ectothermic insects and how species adapt with their environment. It has been linked to temperature, with lower temperatures resulting in larger size. In this study, we tested the combined impact of temperature and plant quality on the body size, and development time from egg to adult of *Eccritotarsus eichhorniae* (Hemiptera: Miridae), an herbivorous insect used as a biological control agent against the invasive aquatic weed, water hyacinth *Eichhornia crassipes* (Pontederiaceae). We quantified insect size in individuals exposed to three temperatures (20, 25 and 30°C) combined with three qualities of host plant (high, medium and low) by calculating development time and measuring four traits: tibia length, forewing length, dry body mass and lipid content, and we also determined the wing loading index. The development time, dry body mass and lipid content decreased linearly with increasing temperature and decreasing plant quality. The decrease in size was the greatest when high temperature interacted with low plant quality. Smaller individuals had proportionately less lipid content. Wing loading decreased significantly with lower quality of host plant, resulting in individuals likely to have theoretically higher flight ability. The results support the temperature-size rule (TSR) and that plant quality could influence the relationship between development time and the TSR. Results also provide novel evidence for a possible food quality-size rule for both sexes.

KEYWORDS

absolute energy demand, dispersal, interaction, mirid, size

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1 | INTRODUCTION

The capacity of ectothermic insects to establish in specific environments depends on their abundance and distribution, and this is to some extent governed by the abiotic and biotic factors of the environment, and to a large extent by phenotypic plasticity with respect to life history traits and fitness of the insect individuals (Beukeboom, 2018; Chown & Terblanche, 2006; Gaston & Lawton, 1988). The fitness of an insect is a function of individual survivorship and fecundity in the environment in which it lives (Mitchell, 1981). Fitness traits have been positively linked to the size of individuals under normal, non-stressful conditions, implying that bigger individuals have higher reproductive outputs (Chown & Gaston, 2010; Stearns, 1992). Examples of this relationship have been demonstrated in insect parasitoids for both females (Ellers et al., 1998) and males (Lacoume et al., 2006). Body size affects all aspects of physiology and biological processes (Honek, 1993; Kingsolver & Huey, 2008; Stearns, 1992), and thus, it is a key consideration in ecology and evolutionary theories (Angilletta et al., 2004; Kraushaar & Blanckenhorn, 2002). Larger body size is known to

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