International Journal of Biology Research
ISSN: 2455-6548; Impact Factor: RJIF 5.22
Received: 01-01-2021; Accepted: 20-01-2021; Published 23-02-2021
www.biologyjournal.in
Volume 6; Issue 1; 2021; Page No. 11-13

Temperature dependence of parasitization and oviposition by parasitoid, *Habrobracon Hebetor*

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Abstract
Temperature is the most significant ecological factor that limits and regulates the biological activity in arthropods. The efficacy of parasitoid *Habrobracon hebetor*, as biological control agent, was assessed for temperature dependence of Parasitization and Oviposition on *Corcyra cephalonica*. Although, both parasitoids and predators represent interacting communities with closely linked life histories, their temperature responses were varied. The suitable temperature range for parasitization and oviposition by the parasitoid was found to be from 20 to 35°C. Parasitization ceased at cooler temperatures of 15°C. Parasitization occurred at 40°C with no oviposition, however, they died of thermal stress. 45°C was fully lethal for them. Lower temperatures tend to make insects sluggish with delayed response, while high temperatures quickly became lethal. Temperature, as an ecofactor, strongly influences and may even override the interactions between parasitoids and their hosts. For a successful pest control strategy, the importance of this abiotic factor should be always considered.

Keywords: parasitoid, *Habrobracon*, *Corcyra*, temperature, biocontrol

Introduction

Temperature deviations from optimum may limit and regulate the biological activity in arthropods, their population dynamics and seasonal occurrence of insect pests and their parasitoids [1]. Among all abiotic factors, temperature exerts the most significance influence on life history and developmental parameters, and thus the efficacy of parasitoid species as biological control agents [2, 3]. Although, both parasitoids and predators are helpful in regulation of pest population, because of being lethal and density-dependent mortality factor, the former is more frequently used in pest suppression programmes [4]. Braconids have been used as important biological control agent for several insect pests [5, 6] and in various studies related to host-parasitoid interactions due to its high reproductive rate, short generation time, and considerable range of host species [7]. Parasitoid, *Habrobracon hebetor* attacks many Lepidopteran pest larvae, mainly moths in the family Pyralidae, and thus act as potent biocontrol agent against stored grain Lepidopteran pests, like *Corcyra cephalonica*, the Rice Moth [8]. This moth is a primary pest of all cereals, particularly rice, but is also capable of damaging all kind of other food stuffs, causing huge economic damage [9]. Parasitoids-hosts interactions are strongly influenced by temperature. Even in such interacting communities with closely linked life histories, they may not share the same optimal temperature ranges for their various system variables [10]. Temperature extremes may reduce survival, retard development or suppress reproduction and negatively influence the successful use of parasitoids [11]. So, in this study the oviposition and parasitization efficacy of *H. hebetor* on *C. cephalonica* is being considered under the influence of various constant temperatures.

Materials and methods

The insects were obtained from Central Integrated Pest Management Centre (CIPMC), Gorakhpur; and cultures were maintained [12]. The experiments were conducted at 70 ± 10% relative humidity and 12:12hr L: D photoperiod. Ten *C. cephalonica* 4th instar larvae were kept in 500mL beakers with 10g diet and allowed to be parasitized by a single gravid female *H. hebetor* at 15, 20, 25, 30, 35, 40 and 45°C constant temperatures. There were 10 replicates each. The beakers were observed for any larval mortality/ parasitization; afterward, the parasitized host larvae were incubated at the same temperatures for any parasitoid progeny life stages and adult emergence [13].

Results and Discussion

The suitable temperature range for parasitization and oviposition by parasitoid *H. hebetor* on *C. cephalonica* was observed to be from 20 to 35°C (Table. 1). Towards the extremes, at 15°C the cooler temperatures caused the parasitoid to stop parasitization. The host larvae were not paralyzed and they survived. However, there was parasitization but no oviposition by the parasitoid at 40°C, later they died within few hours. The paralyzed larvae also died sooner as compared to the ones at milder temperatures. 45°C was fully lethal and they died shortly without any obvious interactions.

Table 1: Descriptive data of the effect of temperature on parasitization and oviposition by parasitoid *Habrobracon hebetor* on *Corcyra cephalonica*

Temperature	Effect			
	***Habrobracon hebetor* (Parasitoid)**		***Corcyra cephalonica* larvae (host)**	
	Parasitization	**Oviposition**	**Paralyzation**	**Survival**
15°C	No	No	No	Yes
20°C	Yes	Yes, delayed	Yes	No
25°C	Yes	Yes	Yes	No
30°C	Yes	Yes	Yes	No
35°C	Yes	Yes	Yes	No
40°C	Yes	No, died later	Yes	No, died later
45°C	No	No, died shortly	No	No, died shortly

Organism have optimal thermal ranges for all optimal physiological functions, and any extremes cause negative effects [14]. Body temperature represents a balance between the heat gained from metabolic activities and from the environment and heat lost by evaporation and convection [12]. Insects are poikilothermic so their temperature varies with ambient temperature. This fluctuation is important because it affects nervous system and enzyme activity through change in body temperature. Within the wide limits set by the upper and lower lethal temperatures, enzyme regulated metabolic process can proceed. The normal increase in metabolic rate with increasing temperature reflects the general trend. There is a general tendency of insects to be more active at higher temperatures [13]. Lower temperatures tend to make insects sluggish with delayed response, while very high temperatures seem to be quickly lethal for them. Therefore, the parasitization and ovipositing activities occur only within a limited range of temperature, with the latter being more stringent with respect to temperature range. The range is characteristic of the species and they are killed by the extremes outside this range [15].

Conclusions

Although, the life histories of parasitoids and their hosts are closely linked, they may not share the same optimal temperature ranges, development curves, and upper thermal tolerances, etc., [10]. Parasitoids can directly and indirectly impact their hosts through lethal and non-lethal effects [16], and in turn, their hosts can also directly and indirectly impact the parasitoid through host quality, size, instar and age-class-specific antipredator defences [10, 17]. Therefore, change in temperature strongly influences and can even override the interactions between parasitoids and their hosts. Temperature affects the parasitoid in several ways directly or indirectly, so for a successful pest control strategy the importance of this abiotic factor cannot be underestimated, and therefore, should be always considered.

Acknowledgments

The authors thank Dr. J.K. Lal, Secretary and Principal, St. Andrew's College, Gorakhpur; and DDU Gorakhpur University, Gorakhpur, for providing laboratory and library facilities during the PhD work, on which this article is based.

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