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Comparative Biology and Life Tables of *Trichogramma Brassicae* and *Trichogramma Cacoeciae* With *Ephestia Kuehniella* as Host at Three Constant Temperatures

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COMPARATIVE BIOLOGY AND LIFE TABLES OF TRICHOGRAMMA BRASSICAE AND TRICHOGRAMMA CACOECIAE WITH EPHESTIA KUEHNIELLA AS HOST AT THREE CONSTANT TEMPERATURES

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ABSTRACT

Egg parasitoids of the genus *Trichogramma* (Hymenoptera: Trichogrammatidae) have been successfully utilized for biocontrol of several lepidopteran pests world-wide. The age specific fecundity of *Trichogramma brassicae* Bezdenko and *Trichogramma cacoeciae* Marchal using *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) as host were determined at 20, 26, and 30 °C and 60-70 % R.H. in the laboratory. Both *T. cacoeciae* and *T. brassicae* demonstrate high parasitism ability and intrinsic rates of increase on *E. kuehniella* and had a similar response to increasing temperature.

Egg parasitoids of the genus *Trichogramma* (Hymenoptera: Trichogrammatidae) are important biological control agents that have been used successfully against several lepidopteran pests, especially through inundative releases (Hassan, 1993). World-wide, over 32 million hectares of agricultural and forest land are treated annually with *Trichogramma* for controlling various insect pests (Stinner et al. 1974). Parasitoid releases in China, Switzerland, Canada and the former USSR have all shown consistently high levels of parasitism, which result in reduced pest damage on wheat, cole crops, corn, and sugarcane (Lý 1994). These egg parasitoids have low host specificity and so can be mass-reared easily in large quantities on natural or artificial hosts (Smith 1996, Wajnberg and Hassan 1994).

The main objectives when developing an augmentative biological control program are to select effective natural enemy species and to develop adequate mass production systems including rearing and storage to ensure availability in sufficient numbers when needed (Hassan 1994, Smith 1996). Developmental time, survival, fecundity, host preference, and temperature response are frequently used to estimate the control capability and performance of natural enemies. The importance of these pre-release studies is still questioned despite the significance and value of the information they yield for the selection of potential biological control candidates (Pratissoli and Parra 2000, Schöller and Hassan 2001, Haile et al. 2002, Botto et al. 2004, Pratissoli et al. 2004).

The purpose of this work was to evaluate the parasitization potential and the population growth parameters of two *Trichogramma* species, *T. brassicae* Bezdenko and *T. cacoeciae* Marchal, at three constant temperatures.

MATERIALS AND METHODS

Source of parasitoids and rearing procedures. Parasitoids originally collected from *Archips rosanus* L. (Lepidoptera: Tortricidae) eggs in Tekirdað, Turkey were identified as *T. cacoeciae* (N. Kilinçer, University of Ankara, Faculty of Agriculture, Department of Plant Protection). *T. brassicae* were obtained from the Plant Protection Research Institute in Izmir (Turkey). The *T. brassicae* and *T. cacoeciae* used had been raised in the laboratory mainly on

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eggs of Mediterranean flour mouth, *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) since 1998. Both parasitoids were reared at 25 ± 1 °C, 60-70 % R.H, and a photoperiod 16:8 L:D.

Reproductive capacity and adult longevity. Parasitization capacity was evaluated at three temperatures (20, 26, and 30 °C). For each temperature, 20 one-day-old *T. brassicae* and *T. cacoeciae* were isolated in 13 cm × 1.5 cm glass tubes, containing honey droplets on the inner walls for food. Fresh eggs (approximately 50-60) of the Mediterranean flour moth were provided to each individual female daily until she died. Parasitized host egg batches were removed daily and incubated at the respective temperatures until emergence of offspring.

The following parameters were evaluated: duration of the development cycle, number of eggs parasitized daily, cumulative parasitism percentage, total number of eggs parasitized by females, and female longevity. For each species, data were evaluated using a 1-way ANOVA and differences among temperatures were tested at the $\alpha = 0.05$ level using the Tukey test.

Life-table parameters. Parameters used to construct the life table [i.e., net reproduction rate (R_0), intrinsic rate of increase ratio (r_m), geometric rate of increase (λ), doubling time (DT) and mean generation time (T)] were calculated using the methods of Birch (1948) and Vargas et al. (2000).

RESULTS

Reproductive capacity and adult longevity

Trichogramma brassicae. The parasitization potential of *T. brassicae* is presented in Table 1. There were significant differences at each temperature between adult female *T. brassicae* longevity ($F = 25.94$, df = 2, $P < 0.05$) and oviposition period ($F = 42.58$, df = 2, $P < 0.05$). Both decreased with increasing temperature.

Age specific fecundity and adult female survivorship curves for *T. brassicae* are shown in Figures 1A and 1B, respectively. At all temperatures, the age-specific fecundity rates were similar and the highest fecundity occurred in the first 1-3 days of the oviposition period. Total number of eggs deposited per female was lower at 30 °C than at the other temperatures.

Trichogramma cacoeciae. The parasitization potential of *T. cacoeciae* is presented in Table 1. For female *T. cacoeciae*, there were significant differences at each temperature between longevity ($F = 10.806$, df = 2, $P < 0.05$) and oviposition period ($F = 6.36$, df = 2, $P < 0.05$). Both decreased with increasing temperature.

Table 1 Mean (±SD) total fecundity, oviposition period and longevity of *T. brassicae* and *T. cacoeciae* at different constant temperature.

Species	Temperature	Adult longevity (d)	Oviposition period (d)	Total Fecundity
T. brassicae	20 °C	15.00 ± 3.96 a	14.00 ± 1.31 a	80.75 ± 31.24 a
T. brassicae	26 °C	21.20 ± 4.83 b	15.00 ± 1.41 a	101.80 ± 6.55 a
T. brassicae	30 °C	8.90 ± 2.23 c	7.90 ± 2.46 b	83.30 ± 11.91 a
T. cacoeciae	20 °C	15.30 ± 2.54 a	11.30 ± 4.27 ab	91.00 ± 14.10 a
T. cacoeciae	26 °C	17.60 ± 2.72 a	13.80 ± 1.931 a	88.60 ± 15.59 a
T. cacoeciae	30 °C	12.50 ± 2.06 bc	9.10 ± 2.026 b	80.20 ± 11.13 a

For each species, means followed by the same letter in the same column are not significantly different at $P < 0.05$ (Tukey test).

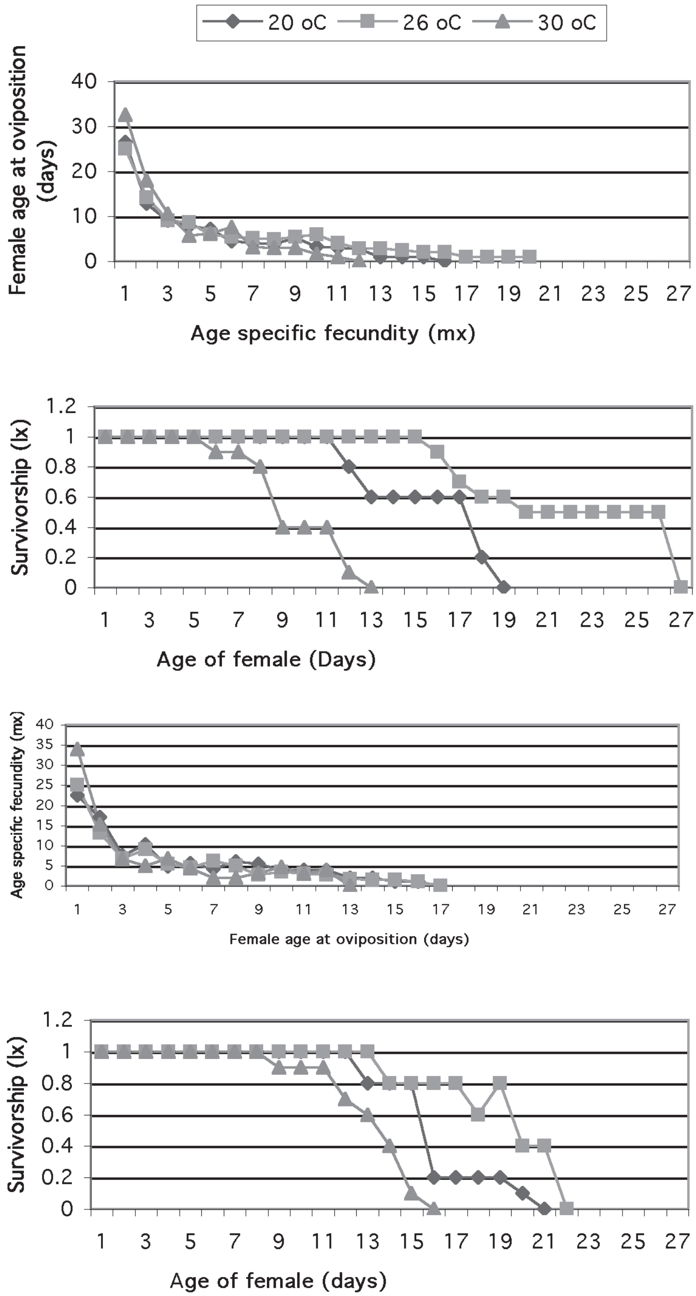

Fig. 1 Age-specific fecundity and survivorship curves for *Trichogramma brassicae* (A and B, respectively) and *Trichogramma cacoeciae* (C and D, respectively) females at three temperatures.

Table 2 Life table parameters (±SD) of *T. brassicae* and *T. cacoeciae* females at three constant temperatures.

Species	Parameter	Temperature (°C)		
		20	26	30
T. brassicae				
	Net reproductive rate (R_o)	91.67 ± 1.705	107.93 ± 1.284	87.35 ± 2.919
	Intrinsic rate of increase (r_m)	0.22 ± 0.016	0.40 ± 0.013	0.55 ± 0.022
	Finite rate of increase (λ)	1.25 ± 0.004	1.49 ± 0.003	1.73 ± 0.006
	Mean generation time (T) (day)	20.53 ± 0.530	11.61 ± 0.516	8.12 ± 0.316
	Doubling time (DT) (day)	3.15 ± 0.732	1.72 ± 0.124	1.26 ± 0.106
T. cacoeciae				
	Net reproductive rate (R_o)	99.65 ± 1.485	91.96 ± 1.519	88.8 ± 2.633
	Intrinsic rate of increase (r_m)	0.25 ± 0.016	0.40 ± 0.012	0.56 ± 0.013
	Finite rate of increase (λ)	1.28 ± 0.003	1.49 ± 0.003	1.75 ± 0.005
	Mean generation time (T) (day)	18.40 ± 0.520	11.30 ± 0.480	8.01 ± 0.470
	Doubling time (DT) (day)	2.77 ± 0.529	1.73 ± 0.848	1.23 ± 0.140

Age specific fecundity and adult survivorship curves for *T. cacoeciae* are shown in Figure 1C and 1D, respectively. At all temperatures, the age-specific fecundity rates tended to be highest on the first 1-3 days of the oviposition period. Total number of eggs deposited per females tended to be lower at 30 °C.

Life-table parameters. The net reproduction rate (R_o) varied from 87.35 to 107.93 eggs for *T. brassicae* and from 88.8 and 99.65 eggs for *T. cacoeciae* (Table 2). The net reproductive capacity was reached at 26°C. The values for intrinsic rate of increase (r_m) and geometric rate of increase (λ) increased linearly with temperature while the generation time (T) decreased for both parasitoid species. Both species were capable of ovipositing large number of eggs in a relatively short time at 30 °C (DT = 1.26days) (Table 2).

DISCUSSION

Temperatures had an affect on both host acceptance and initiation of female oviposition. Russo and Voegele (1982) determined the upper and lower thresholds for oviposition for four species of *Trichogramma* were between 11 to 15 °C and 32 to 34 °C, respectively. Optimum temperatures of approximately 25 °C have been published for various species (Pak and Oatman 1982, Pratissoli and Parra 2000, Schöller and Hassan 2001, Haile et al. 2002). Hassan (1993) indicates that the optimum rearing conditions for mass production of *Trichogramma* is 27 °C temperature and 70 % relative humidity. The responses of T. brassicae and T. cacoeciae to temperature were similar to those previously reported for other *Trichogramma* species.

The highest parasitism rate occurred within the first 24 h after female emergence. For both species, maximum progeny produced per day decreased with increasing age of females at all temperatures evaluated (Figure 1C). This is in agreement with the findings for other *Trichogramma* species (Hirashima et al. 1990, Haile at al. 2002, Özder 2004).

The highest value for l (numbers of females added to the population per female) occurred at 30 °C due in part to the shorter generation time at this temperature. Both species had the same geometric rate of increase of ($\lambda = 1.49$) and intrinsic rate of increase ($r_m = 0.40$) at 26 °C. Similar studies (Schöller and Hassan 2001) have shown the intrinsic rate of natural increase was higher for *T. evanescens* than for *T. cacoeciae*.

Trichogramma cacoeciae and *T. brassicae*, therefore, demonstrate high parasitism ability and intrinsic rates of increase on *E. kuehniella*. *T. cacoeciae* could also be a candidate for use in biological control of the more thermopile moths that infest stored products because of its tolerance of high temperatures.

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