Effects of Temperature on Development and Survival of the Egg Parasitoid

Telenomus triptus NIXON
(Hymenoptera: Scelionidae)
in Two Pentatomid Hosts¹

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Telenomus triptus NIXON is a major egg parasitoid of the pentatomid *Piezodorus hybneri* (GMELIN) (TAKASU and HIROSE, 1985, who referred to *T. triptus* as *Telenomus* sp.; HIGUCHI, 1993), which is a serious pest of soybean in Japan (KOBAYASHI, 1972; HIRASHIMA, 1977). Eggs of another pentatomid *Eysarcoris guttiger* (THUNBERG) were also parasitized by *T. triptus* in soybean fields in Japan (TAKASU and HIROSE, 1985; HIROSE et al., unpublished). Knowledge of the effect of temperature on the development and survival of this parasitoid on the two pentatomids is essential for predicting its reproductive success through the estimation of the number of parasitoid generations per year on both hosts. For these reasons, we examined the influence of the temperature on the development and survival of *T. triptus* reared on *P. hybneri* and *E. guttiger* eggs.

The effects of the following five temperatures on the rates of development and survival of *T. triptus* were determined: 20°C, 22.5°C, 25°C, 27.5°C and 30°C. All treatments were maintained in a bioclimatic chamber at L : D 16 : 8 h photoperiod.

Eggs from laboratory colonies of *P. hybneri* and *E. guttiger* were used as hosts. The laboratory host colonies of *P. hybneri* and *E. guttiger* were established from field-collected adults in Kushira town (Kagoshima Pref.) and Fukuoka city in mid August 1989 and mid July 1992, respectively. Host egg masses laid on jute strings 12 to 36 h before parasitization were divided into experimental masses of 20 eggs each. Twenty

host egg masses of each host species were used at each temperature.

Parasitoids used in the experiments were reared on *P. hybneri* eggs. A preliminary experiment did not show that the parasitoid rearing has any effect on parasitism of *E. guttiger*. Initial stocks of *T. triptus* were obtained from parasitized *P. hybneri* egg masses which were collected at the same sites and time as the host culture stock. Each host egg mass was exposed to an individual mated female parasitoid (2-day-old) for 3 h. The parasitized host egg masses were each maintained in a glass tube (1.8 × 10.5 cm) plugged with cotton in a bioclimatic chamber at each temperature until parasitoid emergence. During the periods of parasitoid emergence, host egg masses were observed twice daily. The emergence date and the number and sex of emerged parasitoids for each host egg mass were recorded. Survival rate of the parasitoid progeny for each temperature was calculated by dividing the number of emerged parasitoids by the total number of parasitoids which developed to mature larvae but failed to emerge (inside host eggs). Host eggs from which parasitoids did not emerge were dissected to determine if they developed to mature larvae, but it was impossible to determine the possible death of parasitoid progeny at younger stages.

The duration of developmental time of male and female *T. triptus* at different temperatures on *P. hybneri* and *E. guttiger* eggs is given in Table 1. Male parasitoids emerged earlier than female parasitoids at all the temperatures in both host species. Developmental time from egg to adult emergence of parasitoids of each sex was significantly shorter in *P. hybneri* eggs than in *E. guttiger* eggs at all the temperatures.

The regression equations describing the relationship between temperature and rate of development for *T. triptus* in both host species, its estimated developmental thresholds (*t*) and thermal constants (*K*) are presented in Table 2. Determination of thermal requirements of this parasitoid is important in estimating the possible number of generations in a year. *T. triptus* is active during the three month period, between mid July and early October in soybean fields in Fukuoka city (TAKASU and HIROSE, 1985; HIGUCHI, 1993; HIROSE et al., unpublished). Degree-day accumulations were determined from the meteorological data recorded in Fukuoka city from mid July to early October during 1983–1992. The mean cumulative

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Table 1. Developmental times from egg to adult emergence of *T. triptus* reared on eggs of *P. hybneri* and *E. guttiger* at various constant temperatures

Temperature (°C)	Mean developmental time (days) ^a			
	<i>P. hybneri</i>		<i>E. guttiger</i>	
	Male	Female	Male	Female
20.0	19.3 a	20.9 c	21.1 b	22.9 d
22.5	15.1 a	15.8 c	16.7 b	17.3 d
25.0	11.0 a	11.8 c	12.6 b	13.1 d
27.5	9.5 a	10.2 c	10.7 b	11.1 d
30.0	8.5 a	9.0 c	9.8 b	10.6 d

^a The figures were based on 20 males and 20 females for each host species at each temperature. To obtain these males and females, 1 male and 1 female were randomly sampled from parasitoid progeny of each of the 20 tested females. Means followed by different letters significantly ($p < 0.05$) differed between the two host species for the same parasitoid sex at each temperature by *t*-test.

Table 2. Developmental thresholds (*t*) and thermal constants (*K*) from egg to adult emergence of *T. triptus* reared on eggs of *P. hybneri* and *E. guttiger*

Host	Parasitoid sex	Regression equation ^a	r^2	<i>t</i> (°C)	<i>K</i> (degree-days)
<i>P. hybneri</i>	Male	$Y = 0.0071X - 0.0910$	0.991	13.0	138.6
	Female	$Y = 0.0064X - 0.0800$	0.990	12.5	154.5
<i>E. guttiger</i>	Male	$Y = 0.0057X - 0.0666$	0.984	11.7	174.6
	Female	$Y = 0.0052X - 0.0596$	0.966	11.5	187.1

^a All slopes of the regression equations of developmental rate (*Y*) to rearing temperature (*X*) are significant ($p < 0.01$).

degree-days calculated for *T. triptus* females when reared in *P. hybneri* and *E. guttiger* were 1239.8 and 1331.8, respectively. Thus, it follows that this parasitoid may produce 8.0 and 7.1 generations annually when developed in *P. hybneri* and *E. guttiger*, respectively.

The period that host eggs are available to parasitism by *T. triptus* in soybean fields is limited, varying according to host species; ca. 30 days for *P. hybneri* (HIGUCHI, 1993; HIROSE et al., unpublished) and ca. 50 days for *E. guttiger* (HIROSE et al., unpublished). Thus, the number of *T. triptus* generations produced during this period is estimated to be 3.0 in *P. hybneri* and 4.4 in *E. guttiger*. This suggests that peak reproductive activity of this parasitoid in soybean is probably attained during the relatively short period of host availability.

There was no difference in host effects on parasitoid survival at any temperature (Table 3). Survival of *T. triptus* was slightly but significantly lower at 20°C and 30°C in both hosts, but averaged over 85% at the three intermediate temperatures. The sex ratio

Table 3. Percentages of survival from egg to adult emergence of *T. triptus* progeny reared on eggs of *P. hybneri* and *E. guttiger* at various constant temperatures

Temperature (°C)	% survival of progeny ^a	
	<i>P. hybneri</i>	<i>E. guttiger</i>
20.0	82.1 a	81.1 a
22.5	88.5 b	86.3 b
25.0	89.7 b	87.7 b
27.5	91.5 b	89.3 b
30.0	78.8 a	79.0 a

^a Percentages followed by different letters in the same column are significantly ($p < 0.05$) different by TUKEY's test after ANOVA using arcsine-transformed data.

and head width of emerged parasitoids did not differ significantly ($p > 0.05$, by TUKEY's test) with temperature or host species (Table 4). These results show that *T. triptus* develops normally between 20°C and 30°C

Table 4. Sex ratios of *T. triptus* and head width of males when reared on egg masses of *P. hybneri* and *E. guttiger* at various constant temperatures

Temperature (°C)	Sex ratio (% males) ^a		Head width (mm) ^b	
	<i>P. hybneri</i>	<i>E. guttiger</i>	<i>P. hybneri</i>	<i>E. guttiger</i>
20.0	10.1	8.8	0.425	0.424
22.5	9.0	8.2	0.423	0.425
25.0	8.6	8.4	0.424	0.424
27.5	7.6	8.4	0.423	0.422
30.0	9.5	8.7	0.423	0.423

^a Means are not significantly ($p > 0.05$) different by TUKEY's test after ANOVA using arcsine-transformed data.

^b For each host species at each temperature, head width of 20 males was measured. Each male was randomly sampled from parasitoid progeny of each of the 20 tested females. Means are not significantly ($p > 0.05$) different by TUKEY's test after ANOVA.

in both hosts. The average temperatures recorded in Fukuoka city between 1983–1992 (10-days averages) range from a maximum of 28.6°C in late July to a minimum of 20.5°C in early October, all within the normal range of development of *T. triptus*.

The full range of temperatures for normal development of *T. triptus* is not known since we did not investigate the survival and development of this parasitoid below 20°C and above 30°C. Studies on other scelionid species parasitic on pentatomid eggs (YEARGAN, 1983; ORR et al., 1985) demonstrated that the ranges of temperatures for normal development of *Trissolcus euschistis* (ASHMEAD) and *Telenomus chloropus* THOMSON were 21–27°C and 24–30°C, respectively, but that the range of *Trissolcus basalis* (WOLLASTON) was 18–33°C. Although the survival rates of *Tr. euschistis* were underestimated because the rates were based on total number of parasitoids which developed to adult stage inside host eggs (YEARGAN, 1983), some temperatures below 20°C and above 30°C should be tested to de-

termine more exact range of temperature for normal development of *T. triptus*.

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