# Effect of temperature on the development of *Trichogramma ostriniae* (Hymenoptera: Trichogrammatidae)

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**Abstract**: *Trichogramma ostriniae* Pang et Chen emergence, development time, longevity, fecundity and sex ratio were examined at constant temperatures of 17, 21, 25, 29, 33 ℃, 14∶10 (L∶D) and 75% relative humidity, developed in *Corcyra cephaloica* (Stainton) eggs in the laboratory. The percentage of emergency was the highest at 17—25 ℃, while the lowest was recorded at 33 ℃ followed by 29 ℃. The development time of the parasite decreased with increases in temperature. Mean female longevity of the adults ranged from 219 h at a constant temperature 17 ℃ to 19.20 h at 33 ℃. The highest fecundity was observed at 21—25 ℃. Females outnumbered males at all temperatures. The female percentage peaked at 17—29 ℃ and declined at 33 ℃.

**Key words**: *Trichogramma ostriniae*; *Corcyra cephaloica*; temperature; development; effect
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# 温度对玉米螟赤眼蜂发育的影响

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摘要: 在实验室内以米蛾卵作寄主, 观察了玉米螟赤眼蜂在 5 个恒温条件下(17, 21, 25, 29, 33 ℃)的发育羽化情况及成蜂寿命、产卵量和后代性比, 实验中光照为 14∶10 (L∶D), 相对湿度控制为 75%. 结果表明, 玉米螟赤眼蜂完成一代所需的发育时间随温度的升高而减少, 在 17 ℃时完成一代需要 25.12 d, 而在 33 ℃时仅需要 8.11 d; 在 17～25 ℃成蜂羽化率最高, 33 ℃时最低, 其次是 29 ℃; 雌蜂的寿命在 17 ℃ 时最长为 219 h, 但随温度的升高而缩短, 在 33 ℃时仅为 19.20 h; 在 21～25 ℃范围内, 雌蜂产卵量达到最高; 所设定的 5 个温度条件下发育的雌蜂, 其所产的后代中雌性均超过雄性, 后代雌性百分率在 17～29 ℃达到高峰, 但在 33 ℃时有所下降.

关键词: 玉米螟赤眼蜂; 米蛾; 温度; 发育; 影响

The European corn borer (ECB), *Ostriniae nubilalis* (Hubner), is a major pest of corn throughout the world and is known to feed on about 250 kinds of plants[1]. It over-winters as a diapausing 5th instar within crop residues and pupate in the spring[2]. Adults lay egg masses on the underside of corn leaves 1—3 d after emergence while early instars feed in the whorl and tassel[2]. Late instars bore into the corn stalks and ears. Ear damage of corn caused by borer infestation may reach as high as 70%[3]. Various methods for managing ECB have been practiced[4]. The use of chemicals creates a number of problems such as development of resistance in the pests, disturbance natural balance by killing parasites and predators, nonselective killing of other forms of life, stability in the environment, water, mutagenic and carcinogenic effects and resurgence of treated pest population and outbreak of secondary pest

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etc[5].

Biological control is a very effective pest control strategy[6]. Releasing the egg parasitoid, *Trichogramma ostriniae* Pang et Chen to control ECB is one of the successful biological control methods[7]. Hoffman et al.[8] recently has demonstrated that early seasonal inoculative releases show promise. Release of 30 000 *T. ostriniae* per acre have resulted in season long parasitism of corn borer eggs masses. The relatively few released wasps, successfully reproduced and dispersed in sweet corn. Wang et al.[9] reported that releases of *T. ostriniae* in sweet corn in Massachusetts were adversely affected by high or low temperatures and that more ECB eggs were parasitised in the lower two-thirds of the sweet corn plant than in the upper one-third. Smith[10] reported that the activity of *Trichogramma* spp. was greatly reduced when temperatures were below 17 ℃. Laboratory studies have shown that the longevity of *T. ostriniae* adults was less than one day when temperature was over 32 ℃.

This study was undertaken to augment our existing knowledge of the effect of selected constant temperatures on different parameters: development time, emergence rate, longevity, fecundity and sex ratio of *T. ostriniae*. These data will aid in the decision on which time for *T. ostriniae* would be appropriate to release. Further more these findings will contribute for model development and for rearing these parasitoids for use in augmentation.

## 1 Materials and methods

*Corcyra cephaloica* (Stainton) eggs were used as host for the parasitoids throughout the study. Eggs were obtained from the Biological Control Laboratory of the Department of Entomology of South China Agricultural University, Guangzhou, P. R. China. Eggs of *C. cephaloica* were sprinkled over fine gum film on hard paper strips and were exposed for 1 h to UV-Sterilization treatment. All these egg cards were exposed to the adult parasitoids for 3 h at 25 ℃. The adults were removed and the test egg cards were placed in separate vials of size 32 mm × 100 mm. All vials were plugged with cotton and were placed in each of five constant temperature cabinets at (17±1), (21±1), (25±1), (29±1), and (33±1) ℃, 14∶10 (L∶D) photoperiod and relative humidity 75 % within each cabinet.

When the eggs has become black, the egg cards in each of the temperature regime were cut into five equal pieces of having equal number of black eggs, to make five replications for each temperature. Every piece of egg card of each temperature was put into a separate vial of size 32 mm×100 mm, plugged with cotton and placed in their respective temperature cabinets.

Temperature-dependent development of *T. ostriniae* from sting (parasitoid oviposition) to adult emergence was determined by checking each host egg every 12 h for *T. ostriniae* emergence. The number of adult parasitoids emerged was recorded every day.

The same type of experiment was run concurrently for the determination of fecundity, longevity and sex ratio of the parasitoid. Newly emerged females 6-hour old ($n=20$ per temperature regime) were confined individually in vials of size 32 mm × 100 mm. and were exposed to the same constant temperatures. Sufficient number of eggs ($n=800$ per female) was exposed to the parasitoids. Fecundity was derived by calculating the number of parasitoids emerged and total number of eggs parasitised until the female had died.

Similarly, longevity of adults was also recorded after emergence up to the death of the female parasitoid.

The sexes were distinguished primarily on the basis of male parasitoids having large number of long hairs on their antennae as compared with the female parasitoids.

SAS 6.12 version was used for data analysis. When statistical differences existed within a data set, Duncan's Multiple Range Test (DMRT) was used to separate the means[11].

## 2 Results

Table 1 shows the effect of different five constant temperatures on the emergence percentage, development time, longevity, fecundity and sex ratio of the parasitoid, *T. ostrinae*. The temperature significantly influenced parasitoid emergence from parsitized eggs. Emergence tended to be lower at the highest temperature (33 ℃), followed by the second highest temperature i.e. 29 ℃ ($P<0.05$). The lower temperatures (17－25 ℃) showed higher emergence percentage of the parasitoid ($P<0.05$). However no significant difference was observed ($P>0.05$) in the emergence percentage of the parasitoid in these lower temperatures (17－25 ℃). The daily emergence percentage of the parasitoid also showed the same trend (Fig. 1).

The development time from sting to adult emergence decreased as the temperature increased from 17 ℃ to 32 ℃ ($P<0.05$).

**Tab. 1　Emergence percentage, development time, longevity, fecundity and sex ratio of parasitoid *Trichogramma ostrinae* Pang et Chen at five constant temperatures**[1)]

| temperatures/ ℃ | emergence/ % | development time/ d | longevity/ h | fecundity | sex ratio(female)/ % |
|---|---|---|---|---|---|
| 17 | 87.89±2.20 a | 25.12±0.05 a | 219.00±31.61 a | 60.75±3.92 b | 72.49±4.47 a |
| 21 | 84.57±1.82 a | 14.23±0.05 b | 93.60±3.99 b | 71.90±3.53 a | 65.84±1.88 ab |
| 25 | 88.82±3.73 a | 10.10±0.04 c | 88.50±2.53 b | 75.30±2.60 a | 65.18±0.27 ab |
| 29 | 54.40±3.40 b | 8.64±0.50 d | 32.70±2.73 c | 39.80±4.46 c | 64.69±2.01 b |
| 33 | 30.55±2.17 c | 8.11±0.57 d | 19.20±0.55 c | 19.90±3.16 d | 51.27±3.07 c |

1) Means±SE followed by the same letter within a column are not significantly different from each other ($P<0.05$, DMRT)

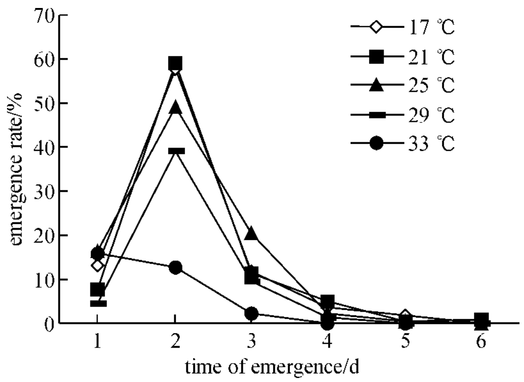


Fig. 1　Daily emergence percentage of the parasitoid, *T. ostriniae* at five constant temperatures

Significant differences in the adult female longevity at different temperatures were observed ($P<0.05$). Table 1 shows that overall longevity of female parasitoid declined with increasing temperature. Female lived the longest at 17 ℃, averaging 219 h, but lived about 19 h at a constant 33 ℃. The daily survival pencentage of the parasitoid is shown in Fig. 2. It also represents that almost in all cases the survival rate of the parasitoid was high at the lower temperatures as compared with the higher ones.

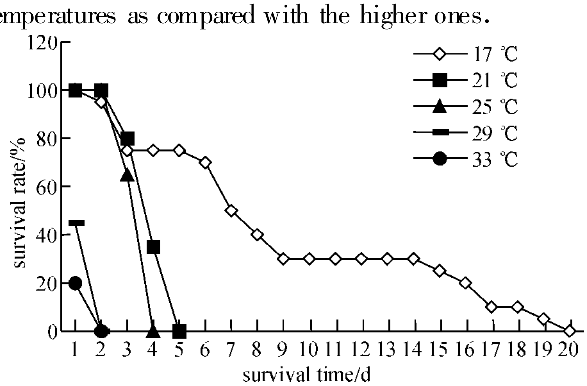


Fig. 2　Daily survival percentage of the female parasitoid, *T. ostriniae* at five constant temperatures

The highest mean fecundity per female was observed at 21 and 25 ℃ as compared with all other temperatures ($P<0.05$). However the figures for these two temperatures were not significantly different from one another ($P>0.05$). These were followed by the mean fecundity recorded at 17 and 29 ℃. The lowest figure was obtained at 33 ℃.

At each temperature, the sex ratio was dominated by female, ranging from 72.49 % female at 17 ℃ to 51.27 % female at 33 ℃.

## 3　Discussion

The lowest emergence percentage of the parasitoid was recorded in the present study at 33 ℃ followed by 29 ℃. This is consistent with previous studies of Hirashima et al.[12]. They also found that at 32 ℃ the adult emergence percentage of *Trichgramma* spp. was lower than that at other temperatures. Temperature as high as 32 ℃ seemed unsuited for *Trichogramma* development.

The rate of development accelerated as the temperature increased. This pattern agrees with previous studies on *Trichogramma* spp.[13-15]. Longevity of the parasitoid decreased with increase in temperature. Same types of studies have been reported by several authors[16,17]. The highest fecundity was recorded at 21 and 25 ℃. No significant difference was detected within these temperatures ($P>0.05$). Significantly the lowest fecundity was recorded at the highest temperature (33 ℃) ($P<0.05$). Pak et al.[18] and Russo et al.[19] studied the fecundity of several *Trichogramma* spp. at various temperatures and found maximum values at 20—25 ℃. Such type of work has also been published for various species of *Trichogramma*[20,21]. The overall offspring sex ratio was female biased at all five temperatures. The proportion of female offspring was initially higher and decreased with increasing temperature. The general observation of decreasing proportion of female with increasing temperature supports other previous work[22-24].

All these studies can be used to evaluate the suitability of the natural enemy and to design optimal strategies for the introduction of the parasitoid (*Trichogramma*) for the control of different types of lepidopterous insects in the field. Further more these findings will contribute for model development and for rearing these parasitoids for use in augmentation.

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