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# Effect of two different temperatures on the biology of predatory flower bug *Orius similis* Zheng (Heteroptera: Anthocoridae) with two different aphid species as prey

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## Summary

The predatory flower bug ***Orius similis*** Zheng (Heteroptera: Anthocoridae) is an indigenous predator of aphids, thrips and spider mites from China. The present study investigated the effects of low and high temperatures (18 and 30°C) on biology of ***O. similis*** with ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) as prey in the laboratory. The duration of embryonic and nymphal development as well as total percentage mortality during the development decreased with ascending temperature between 18 and 30°C. Maximum longevity was recorded at 18°C with ***A. gossypii*** as prey with a mean of 100.1 days for mated females. The longevity of the predator was significantly longer on 10% honey emulsion than other nutritional sources. The daily oviposition was ranged from 1.0 (18°C) to 6.9 (30°C) eggs/day with ***A. gossypii*** and ***M. persicae*** as prey, respectively.

**Key words:** ***Orius similis***, development, longevity, reproduction, effect of different temperatures

**Anahtar sözcükler:** ***Orius similis***, gelişme süresi, ömür, üreme gücü, farklı sıcaklıkların etkisi

## Introduction

The predatory flower bugs ***Orius*** spp. (Heteroptera: Anthocoridae) have many characteristics of ideal biological control agents, i.e., high searching efficiency, an ability to increase more rapidly when prey is abundant, a density-

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dependent decrease in fecundity resulting from interference and the ability to aggregate in regions of high prey density (Hodgson & Aveling, 1988). They are generalist predators attacking a variety of small arthropods such as aphids, aleyrodids, young lepidopterous larvae, thrips and mites (Barber, 1936; Péricart, 1972). In the last years, several studies have conducted on the different biological parameters of different ***Orius*** species such as ***Orius albidipennis*** (Reuter) (Cocuzza et al., 1997b; Fritsche & Tamo, 2000), ***Orius insidiosus*** (Say) (Isenhour & Yeargan, 1981; Tommasini et al., 2004), ***Orius laevigatus*** (Fieber) (Cocuzza et al., 1997b; Tommasini et al., 2004), ***Orius majusculus*** (Reuter) (Tommasini et al., 2004), ***Orius minutus*** (L.) (Kakimoto et al., 2005), ***Orius niger*** (Wolff) (Tommasini et al., 2004), ***Orius sauteri*** (Poppius) (Kakimoto et al., 2005), ***Orius strigicollis*** (Poppius) (Kakimoto et al., 2005). ***Orius similis*** Zheng which a little known species originated from China is a common bug that preys on different aphid species, ***Frankliniella formosae*** Moulton (Thysanoptera: Thripidae), ***Tetranychus cinnabarinus*** (Boisduval) (Acarina: Tetranychidae) and on eggs or hatched larvae of ***Pectinophora gossypiella*** (Saunders) (Lepidoptera: Gelechiidae), ***Helicoverpa armigera*** (Hübner) (Lepidoptera: Noctuidae) and ***Anomis flava*** (Fabricius) (Lepidoptera: Noctuidae) as well as on other Lepidoptera pest and it can also feed upon plant pollen.

The ability of a natural enemy to adapt to different environmental conditions is an essential prerequisite for its successful utilization in biological control programmes. The biology of insects is influenced by various environmental factors and temperature is one of the most important and critical of the abiotic factors (Pedigo, 1989; Saleh & Sengonca, 2003). The efficiency of a predator for biological control purposes should be evaluated based on biological parameters at different temperatures before fieldwork is undertaken. It provide information on the biology and distribution of a species (Cocuzza et al., 1997b; Saleh & Sengonca, 2001; Sengonca et al., 2004), contributes knowledge that enhances the efficiency of mass rearing (Isenhour & Yeargan, 1981), is useful in predicting development and activity in the field (Omkar & Pervez, 2004), and is used in models to estimate insect growth, development, and reproduction (Zilahi-Balogh et al., 2003). These are the reasons why several studies on biology of ***Orius*** spp. at different temperatures have been conducted. The potential of a biocontrol agent is assessed not only in terms of its predatory potential but also in its adaptability to new surroundings deciphered through its ability to propagate itself under a given condition including the prey species and stages of prey.

Another one of the important features for a successful predator is to live for a long period on the prey species and also feed on the other nutritional sources (Al-Zyoud et al., 2006). Other nutritional sources feeding by predators is thought to contribute to the success of biological control because the alternative food source allows predators to colonize crops before the arrival of prey, and to persist during period of prey scarcity (Lalonde et al., 1999). The biological characteristics of some ***Orius*** species with different nutritional sources have been studied (Salas-Aguilar & Ehler, 1977; Kiman & Yeargan, 1985; Cocuzza et al., 1997a; Arijs & De Clercq, 2004). A few studies on biological characteristics and prey consumption of ***O. similis*** have been published (Zong et al., 1987; Zhang et al., 1994; Zhou & Lei, 2002; Ahmadi et al., 2008; Sengonca et al., 2008). However, there have been no studies on its biological parameters in response to low and high temperatures and nutritional sources.

Therefore, this study was undertaken to examine the effects of low and high constant temperatures on the development, mortality, longevity and reproduction of ***O. similis*** with ***Aphis gossypii*** Glover (Homoptera: Aphididae) and ***Myzus persicae*** (Sulzer) (Homoptera: Aphididae) as prey under laboratory conditions as well as influence of three different constant temperatures and different nutritional sources in the longevity of the predator. This investigation provides useful information about the performance of the predators at different temperature regimes.

## Materials and Methods

Laboratory colonies of ***O. similis*** were started in 2004 with a few individuals, which are originating from Fujian Academy of Agricultural Sciences (FAAS), in Fuzhou, PR China. They were reared on freshly excised broad bean leaf discs 2.5 cm in diameter which were placed upside down onto the round plastic petri dishes 3.5 cm in diameter and with a meshed hole in the lid. The round plastic petri dishes were partially filled with 0.5-cm-thick layer of 0.7% Agar gel. The colonies were fed on nymphs of ***Acyrthosiphon pisum*** (Harris) (Homoptera: Aphididae) and the round plastic petri dishes were held in a climate chamber at 25±1°C temperatures, 60±10 % relative humidity and a photoperiod of 16:8h (L: D) with an artificial light intensity of about 4.000 Lux. Few adult females were taken from the stock culture and then confined on broad bean leaf discs in the round plastic petri dishes as described above for 48h for oviposition. Broad bean leaves with eggs were incubated until egg hatching. These leaves and $N_1$ nymphs were placed into the Plexiglas cages (15×7.5×4.5 cm), with three mesh-covered holes in the lid, and offered nymphs of ***A. pisum*** as prey to start the pre-imaginal rearing. The Plexiglas cages were kept in an incubator under the same condition mentioned above until ***O. similis*** reached the desired stage for the experiments.

The cotton aphid, ***A. gossypii*** and the green peach aphid, ***M. persicae*** used in the experiments were originally obtained from INRES-Phytomedicine, University of Bonn and were cultured in the laboratory on cotton plants (***Gossypium hirsutum*** L.) and cabbage (***Brassica oleracea*** L.), respectively. In order to obtain the 1-2-day old nymphs of ***A. gossypii*** and ***M. persicae*** required, up to ten adult virginoparae aphid species females were placed on the freshly excised broad bean leaf discs (2.5 cm diameter) were placed upside down onto the Agar gel in the round plastic petri dishes with 3.5 cm in diameter for nymph laying. After 24 hours, the adults were gently transferred into new round plastic petri dishes and the laid nymphs were reared for 24h.

The effects of temperature on biological parameters of ***O. similis*** were evaluated in growth chambers at 18±1 and 30±1°C constant temperatures, 60±10 % relative humidity as well as 16:8h (L: D) photoperiod. The experiments were conducted on broad bean leaves as common host plant of ***A. gossypii*** and ***M. persicae*** in the round plastic petri dishes described above. In order to determine the duration of embryonic and nymphal development and mortality, the mated females that reared on ***A. gossypii*** or ***M. persicae*** were transferred into the round plastic petri dishes as described above for 24h for egg laying. After egg laying, ***O. similis*** females were removed and round plastic petri dishes with newly laid eggs were incubated and checked daily until the hatching of $N_1$ nymphs. At least 30 newly hatched $1^{st}$ instars were randomly chosen and transferred individual to round plastic petri dishes and 20 individuals of 1-2-day old ***A. gossypii*** or ***M. persicae*** as prey were supplied every day. The round plastic petri dishes were changed and checked daily for moulting and the mortality of ***O. similis*** nymphs. The development from one nymphal instar to the next was monitored by checking the exuviae with a stereoscopic microscope.

For recording the adult longevity and female oviposition, a pair of adults that had moulted within 12h were placed in a separate round plastic petri dishes within a period of 48h for mating and provided with an excess number (20 individuals) of 1-2-days old of ***A. gossypii*** or ***M. persicae*** as prey. Afterwards, to avoid aggressive interactions attacking, mated females and males were transferred singly to other round plastic petri dishes as described above and reared until death. In order to study unmated females longevity, the last nymphal instars were taken and placed singly in the round plastic petri dishes as described above. Newly emerged females were daily provided with a prey of ***A. gossypii*** or ***M. persicae*** and the experiments were continued until death.

The influence of different nutritional sources at different temperatures on longevity of ***O. similis*** was investigated in the round plastic petri dishes and offered whether 10 % honey emulsion, pollen (pine pollen), only broad bean leaf or left without food. Newly emerged adult females and males were kept individually in the round plastic petri dishes and they were checked daily and honey emulsion, pollen or new broad bean leaves were added whenever needed. There were at least twenty replications of each sex at each temperature and nutritional source. The experiments were continued till the last individual died and the longevity of both sexes was determined.

During the investigation of the longevity at low and high temperatures, the first and last day of egg laying of mated females were also recorded for evaluating the pre-oviposition, oviposition and post-oviposition periods. For the mean daily and total fecundity of ***O. similis*** females during their ovipostion period, the numbers of daily laid eggs were recorded and the round plastic petri dishes changed daily. During within the period of 48h for mating, the daily laid eggs were also recorded. The mean daily oviposition of each replication was calculated as mean total fecundity in oviposition period.

Effects of the different temperatures, aphid species and nutritional sources on above-mentioned characteristics were evaluated by one-way analysis of variance and means were separated using Tukey test. Statistical analyses were run in SigmaStat version 2.0 (SigmaStat, Jandel, Inc., Richmond, CA, USA).

## Results

### Development and mortality

The results of the experiment showed that ***O. similis*** was able to develop and reach the adult stage at both temperatures of 18 and 30°C tested. The mean duration of embryonic development of the predator decreased significantly ($P<0.001$) with ascending temperature between 18 and 30°C (Table 1).

Table 1. Mean duration of embryonic development and percentage mortality of eggs laid ***Orius similis*** Zheng females with feeding ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) nymphs as prey on broad bean leaves at two different temperatures

| Temp. (°C) | Prey species | n | Duration of egg stage (days) | | | Mortality (%) |
|---|---|---|---|---|---|---|
| | | | mean±SE | min | max | |
| 18 | ***A. gossypii*** | 58 | 13.0±0.1 b[*]B[**] | 11 | 15 | 37 |
| | ***M. persicae*** | 57 | 12.5±0.2 aB | 10 | 14 | 35 |
| 30 | ***A. gossypii*** | 59 | 4.2±0.1 bA | 4 | 5 | 32 |
| | ***M. persicae*** | 100 | 3.4±0.1 aA | 3 | 4 | 26 |

[*] Means in columns followed by different small letters indicate significant differences between the different prey species within the same temperature.

[**] Means in columns followed by different capital letters indicate significant differences between the different temperatures within the same prey species at $P\leq5\%$ (one-way ANOVA).

It was 13.0±0.1 and 12.5±0.2 days at 18 °C as well as 4.2±0.1 and 3.4±0.1 days, at 30°C, with ***A. gossypii*** and ***M. persicae*** as prey, respectively. Duration of egg stage was significantly longer with ***A. gossypii*** than with ***M. persicae*** at both temperatures ($P<0.05$). The mortality during the embryonic development of ***O. similis*** was influenced by temperature. The percentage mortality of eggs was low and ranged from 26% at 30°C with ***M. persicae***, to 37 % at 18°C with ***A. gossypii*** as prey. The mean developmental duration of nymphal instars of ***O. similis*** that fed on ***A. gossypii*** and ***M. persicae*** at the two constant temperatures are shown in Table 2. The duration of each nymphal instar reduced significantly with the elevation of temperature (P<0.001). A longer developmental duration was observed for the fifth instars with both aphid species as prey at the both temperatures.

Table 2. Mean developmental duration of nymphal instars of ***Orius similis*** Zheng by feeding with ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) nymphs as prey on broad bean leaves at two different temperatures

| Temp (°C) | Prey species | n | Sex | Duration of nymphal instars (days) N$_1$ mean±SE | N$_2$ mean±SE | N$_3$ mean±SE | N$_4$ mean±SE | N$_5$ mean ±SE | Total nymphal duration mean ±SE |
|---|---|---|---|---|---|---|---|---|---|
| 18 | ***A. gossypii*** | 7 | ♀♀ | 8.4±0.3 b[*]B[**] | 7.1±0.7 aB | 5.6±0.3 aB | 8.6±0.4 aB | 12.1±0.9 bB | 41.9±1.0 bB |
| | | 7 | ♂♂ | 8.1±0.7 aB | 7.0±0.4 bB | 6.4±0.5 aB | 7.0±0.4 aB | 12.6±0.5 bB | 41.1±1.5 bB |
| | ***M. persicae*** | 6 | ♀♀ | 6.8±0.4 aB | 6.0±0.3 aB | 6.2±0.3 aB | 7.3±0.7 aB | 11.2±0.2 aB | 37.5±1.1 aB |
| | | 7 | ♂♂ | 6.6±0.6 aB | 5.9±0.3 aB | 5.4±0.2 aB | 7.4±0.8 aB | 11.1±0.3 aB | 36.4±1.0 aB |
| 30 | ***A. gossypii*** | 7 | ♀♀ | 2.4±0.2 bA | 2.1±0.1 bA | 2.1±0.1 aA | 2.3±0.2 aA | 4.9±0.4 bA | 13.9±0.7 bA |
| | | 8 | ♂♂ | 2.2±0.2 aA | 2.6±0.2 bA | 1.9±0.3 aA | 2.6±0.4 aA | 4.4±0.3 aA | 13.7±0.6 bA |
| | ***M. persicae*** | 11 | ♀♀ | 2.0±0.0 aA | 1.6±0.2 aA | 1.9±0.2 aA | 2.6±0.3 aA | 3.8±0.1 aA | 12.1±0.2 aA |
| | | 7 | ♂♂ | 2.0±0.0 aA | 2.0±0.0 aA | 1.3±0.2 aA | 2.4±0.2 aA | 4.0±0.2 aA | 11.7±0.4 aA |

[*] Means in columns followed by different small letters indicate significant differences between the different prey species within the same sex and temperature.

[**] Means in columns followed by different capital letters indicate significant differences between the different temperatures within the same sex and prey species at P≤5% (one-way ANOVA).

The mean total nymphal development from N$_1$ to adult emergence of both sexes was significantly shorter at 30°C than 18°C with both aphid species as prey (P<0.001). It was ranged from 12.1±0.2 (♀♀), 11.7±0.4 (♂♂) days at 30 °C with ***M. persicae***, to 41.9±1.0 (♀♀), 41.1±1.5 (♂♂) days at 18 °C with ***A. gossypii*** as prey. Within the same temperature and sex of predator, aphid species as prey had influenced significantly the mean total developmental duration (P<0.05).

During nymphal development, the first nymphal instars suffered highest mortality, while N$_3$ had the lowest at both temperatures (Table 3). Total percentage mortality during the development from N$_1$ to adult emergence was higher at 18°C than 30°C with both aphid species as prey and it was higher with ***A. gossypii*** than ***M. persicae*** as prey at both temperatures.

Table 3. Percentage mortality of ***Orius similis*** Zheng during nymphal development by feeding with ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) nymphs as prey on broad bean leaves at two different temperatures

| Temp. (°C) | Prey species | N | Mortality during nymphal development (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ | Total |
| 18 | ***A. gossypii*** | 24 | 33.3 | 16.7 | 0.0 | 0.0 | 4.2 | 54.2 |
| | ***M. persicae*** | 22 | 13.6 | 4.5 | 4.5 | 9.1 | 9.1 | 40.1 |
| 30 | ***A. gossypii*** | 22 | 9.1 | 9.1 | 0.0 | 0.0 | 9.1 | 27.3 |
| | ***M. persicae*** | 21 | 4.8 | 4.8 | 0.0 | 4.8 | 4.8 | 19.1 |

## Longevity

The mean longevity of ***O. similis*** was significantly temperature dependent (Table 4). A significant decrease in the mean longevity of females (mated & unmated) and males was recorded with increase in temperature from 18 to 30°C ($P<0.001$).

Table 4. Mean longevity females (mated & unmated) and males of ***Orius similis*** Zheng by feeding with ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) nymphs as prey on broad bean leaves at two different temperatures

| Temp. (°C) | Prey species | Longevity of ***O. similis*** (days) | | | | | |
|---|---|---|---|---|---|---|---|
| | | ♀♀ (Mated) | | ♀♀ (Unmated) | | ♂♂ | |
| | | n | mean±SE | n | mean±SE | n | mean±SE |
| 18 | ***A. gossypii*** | 10 | 100.1±11.4 b*B** | 9 | 98.9±16.5 bB | 17 | 52.8±8.5 aB |
| | ***M. persicae*** | 8 | 40.7±7.4 aB | 14 | 89.5±10.1 aB | 14 | 59.1±4.6 aB |
| 30 | ***A. gossypii*** | 17 | 16.5±1.5 aA | 12 | 20.1±2.8 aA | 15 | 17.9±1.8 aA |
| | ***M. persicae*** | 10 | 17.4±2.2 aA | 13 | 27.8±3.1 aA | 16 | 22.7±2.4 aA |

* Means in columns followed by different small letters indicate significant differences between the different prey species within the same sex and temperature.
** Means in columns followed by different capital letters indicate significant differences between the different temperatures within the same sex and prey species at $P\leq5\%$ (one-way ANOVA).

Maximum mean longevity was 100.1±11.4 and 98.9±16.5 days for mated and unmated females, respectively; fed on ***A. gossypii*** at 18°C. Longevity of females (mated & unmated) was significantly longer with ***A. gossypii*** than ***M. persicae*** as prey at 18°C ($P<0.05$). Statistically, there were no significant differences in the mean longevity of males with both aphid species as prey at the same temperature ($P<0.05$). Moreover, longevity of females (mated & unmated) did not differ significantly at 30°C across both prey species treatments ($P<0.05$).

The effect of nutritional source and temperature on longevity of ***O. similis*** is summarized in Figure 1. The mean longevity of the predator varied substantially over the nutritional sources and temperatures. It was significantly longer on 10% honey emulsion than other sources with a mean of 29.1±4.9 (♀♀) and 15.7±1.8 (♂♂), 11.8±1.5 (♀♀) and 8.5±1.6 (♂♂) as well as 8.6±1.4 (♀♀) and 6.9±0.7 (♂♂) at 18, 25 and 30°C, respectively ($P<0.001$). Within the same nutritional source, the longevity of the predator was often influenced by temperature, increasing significantly with decreasing temperature between 18 and 30°C ($P<0.05$).

The mean period of pre-oviposition and oviposition of ***O. similis*** females varied according to the temperatures (Table 5).

Table 5. Mean periods of pre-oviposition, oviposition and post-oviposition of ***Orius similis*** Zheng females by feeding with ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) nymphs as prey on broad bean leaves at two different temperatures

| Temp. | Prey | | Duration of (days) | | | | | |
|---|---|---|---|---|---|---|---|---|
| (°C) | species | n | Pre-oviposition | | Oviposition | | Post-oviposition | |
| | | | mean±SE | min – max | mean±SE | min – max | mean±SE | min – ma |
| 18 | ***A. gossypii*** | 10 | 9.3±1.1 a*B* | 5 – 17 | 58.8±7.3 bB | 4 – 88 | 25.5±7.8 bB | 0 – 68 |
| | ***M. persicae*** | 8 | 6.9±0.6 aB | 5 – 11 | 29.5±7.1 aB | 5 – 51 | 8.6±7.2 aA | 0 – 59 |
| 30 | ***A. gossypii*** | 17 | 1.6±0.1 aA | 1 – 2 | 14.7±1.2 aA | 8 – 29 | 1.6±0.6 aA | 0 – 7 |
| | ***M. persicae*** | 10 | 2.1±0.1 aA | 2 – 3 | 14.3±1.7 aA | 6 – 24 | 3.4±2.0 aA | 0 – 20 |

* Means in columns followed by different small letters indicate significant differences between the different prey species within the same temperature.

** Means in columns followed by different capital letters indicate significant differences between the different temperatures within the same prey species at P≤5% (one-way ANOVA).

In general, an increase in the temperature caused a significant decrease in the period of pre-oviposition and oviposition ($P<0.001$). The mean of pre-oviposition period was ranged from 1.6±0.1 days at 30 °C to 9.3±1.1 days at 18 °C with ***A. gossypii*** as prey. At the same temperature, it did not differ significantly with both aphid species as prey ($P<0.05$). The mean of oviposition period was the longest with ***A. gossypii*** at 18 °C with a mean of 58.8±7.3 days. At 18 °C, aphid species as prey had influenced significantly the mean period of oviposition and post-oviposition ($P<0.05$).

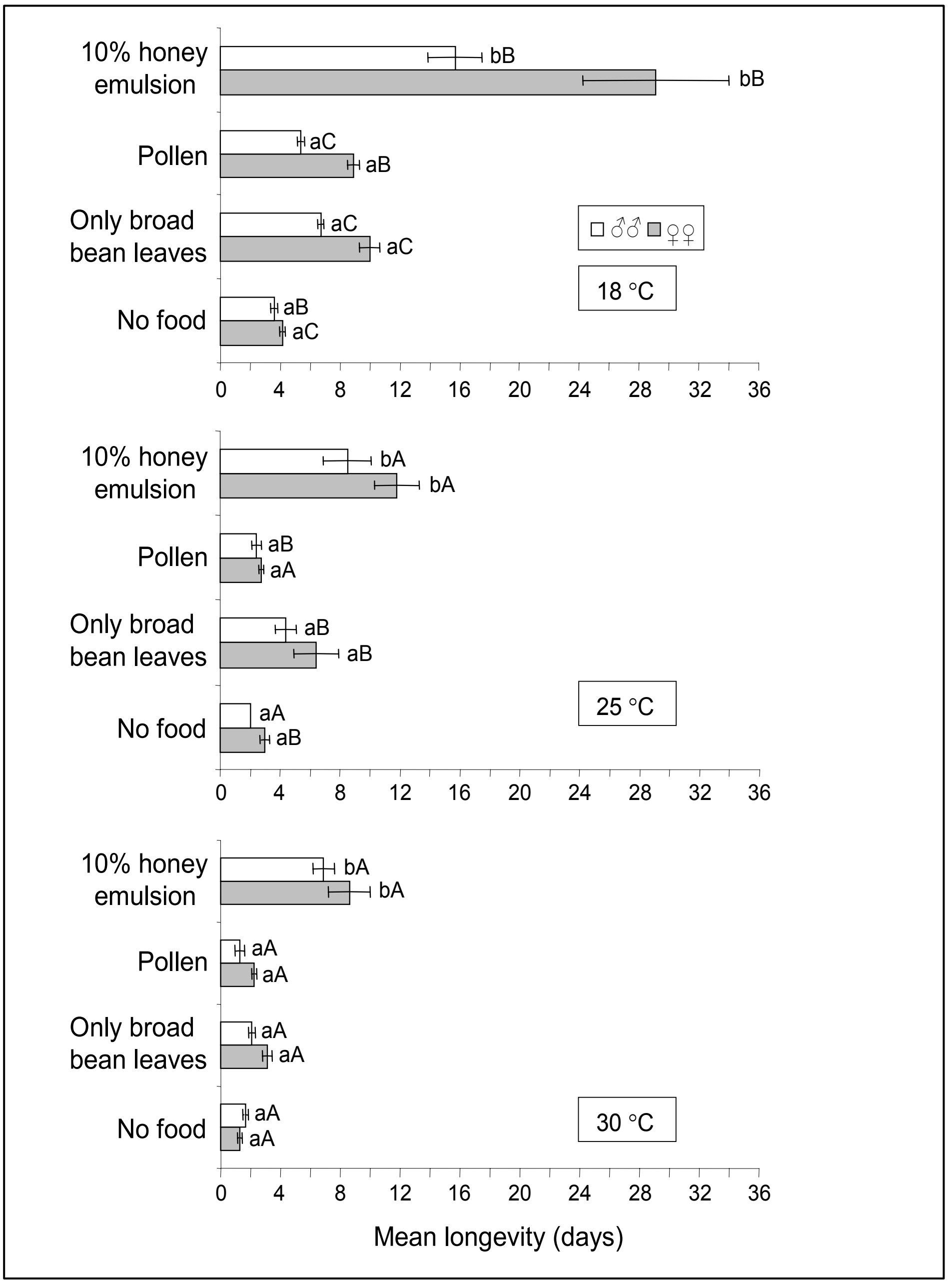


Figure 1. Mean longevity of ***Orius similis*** Zheng adult females and males by feeding on different nutritional sources at three different temperatures [Bars with different small letters indicate significant differences among the different nutritional sources within the same sex and temperature. Bars with different capital letters indicate significant differences between the different temperatures within the same sex and nutritional source at P≤5% (one-way ANOVA)].

**Fecundity**

Data on the daily and total fecundity of ***O. similis*** at two constant temperatures were illustrated in Figure 2. With ***A. gossypii*** as prey, adult females started oviposition 6 and 2 days after emergence, where the mean daily fecundity averaged 0.1 and 0.6 eggs/♀ at 18 and 30°C, respectively.

The mean daily fecundity increased hereafter to a maximum of 1.7eggs/♀ on the $12^{th}$ day (at 18°C) and 2.6 eggs/♀ on the $6^{th}$ day (at 30°C). After that the mean daily number of laid eggs began to decrease and fluctuated again until no eggs were laid after the $99^{th}$ (at 18°C) and $31^{st}$ (at 30°C) day. The first female died on the $19^{th}$ (at 18°C) and $9^{th}$ (at 30°C) day, while the last one on the $145^{th}$ (at 18°C) and $31^{st}$ (at 30°C) day. When ***M. persicae*** was offered, females started laying eggs on the $6^{th}$ and $3^{rd}$ day after their emergence, where they laid a mean of 0.9 and 9.3 eggs/♀ at 18 and 30°C, respectively. It directly reached a maximum of 3.0 eggs/♀ on the $8^{th}$ day (at 18°C) and 10.7 eggs/♀ on the $6^{th}$ day (at 30°C). After that, the mean daily number of laid eggs began to decrease, fluctuate and then decreased again gradually till it approached zero on the $58^{th}$ day (at 18°C) and $27^{th}$ (at 30°C) day. During the experiments with ***M. persicae*** as prey, the first female died on the $11^{th}$ (at 18°C) and $9^{th}$ (at 30°C) day, while the last one on the $68^{th}$ (at 18°C) and $30^{th}$ (at 30°C) day.

The mean daily oviposition of the females varied substantially over the two temperatures, from a mean of 1.0±0.3 eggs/day at 18°C to a mean of 6.9±0.9 eggs/day at 30°C with ***A. gossypii*** and ***M. persicae*** as prey, respectively. The mean daily oviposition was significantly higher with ***M. persicae*** than with ***A. gossypii*** as prey at both temperatures ($P<0.001$).

The total number of eggs laid per individual within a temperature also varied, but there were no significant differences in its mean at both temperatures with the same aphid species as prey ($P<0.05$). At 30°C, the mean total fecundity was significantly higher with ***M. persicae*** than with ***A. gossypii*** as prey ($P<0.001$). The maximum oviposition recorded was 102.4±15.6 eggs at 30°C with ***M. persicae*** as prey.

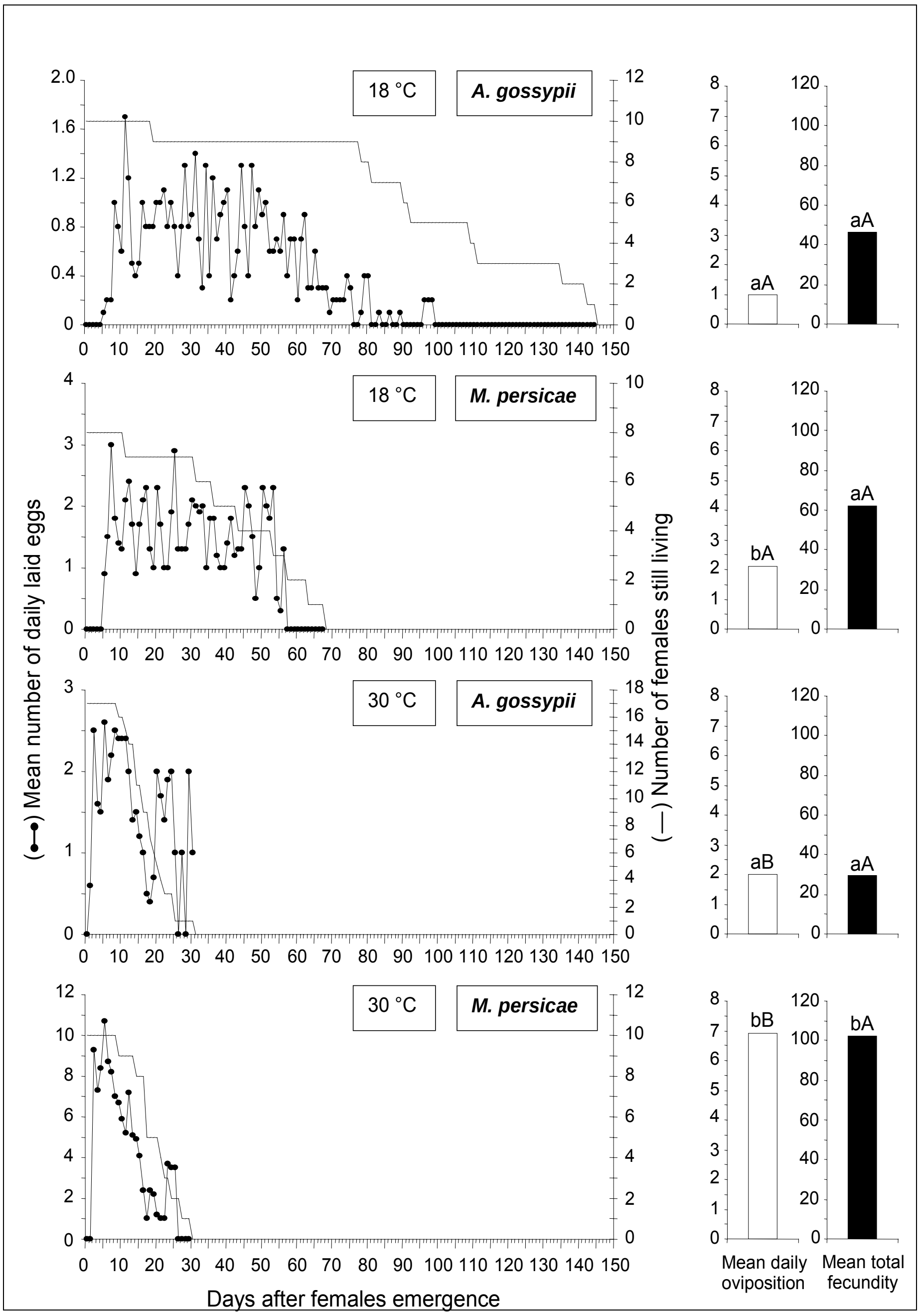


Figure 2. Mean number of daily laid eggs and total fecundity of ***Orius similis*** Zheng females during the oviposition period by feeding with ***Aphis gossypii*** Glover and ***Myzus persicae*** (Sulzer) nymphs as prey on broad bean leaves at two different temperatures [Bars with different small letters indicate significant differences among the different aphid species as prey within the same temperature. Bars with different capital letters indicate significant differences between the different temperatures within the same aphid species as prey at P≤5% (one-way ANOVA)].

## Discussion

***O. similis*** was able to develop at different low and high temperatures and prey on two different aphid species. However, the high temperature reduces the mean duration of embryonic and nymphal development of the predator. The percentage mortality of eggs was also influenced by temperature and aphid species as prey; the mortality was the lowest at 30°C with ***M. persicae*** as prey. Sengonca et al. (2008) showed that the embryonic developmental duration of ***O. similis*** was ranged from 5.1 to 5.6 days at 25°C with different aphid species as prey, while in the present study was 13 days at 18°C and 3.4 days at 30°C. Statistically, significant differences in the developmental duration of each nymphal instar suggest that all nymphal instars of ***O. similis*** were highly sensitive to changing of constant temperatures. This is also documented in the study of Cocuzza et al. (1997b), which the nymphal development of ***O. albidipennis*** fed with ***Frankliniella occidentalis*** (Pergande) (Thysanoptera: Thripidae) was 7.7 days at 35°C, but 58 days at 15°C. Developmental duration of all the nymphal instars was also significantly affected with aphid species as prey. This phenomenon was also observed in the studies of Kiman & Yeargan (1985) and Sengonca et al. (2008), where the duration of nymphal development and mortality of ***O. insidiosus*** and ***O. similis*** differed among the different foods supplied. The percentage nymphal mortality decreased with increase in temperature from 18 to 30°C. Of the various nymphal instars of ***O. similis***, $N_1$, i.e. neonates, suffered highest mortality between 18 and 30°C. Relatively high mortality of first instars as compared with other nymphal instars was also reported in ***O. laevigatus*** (Cocuzza et al., 1997b).

An inverse relation between longevity and temperature has been observed in ***Orius*** spp. The same trend of results was found in present study, where the longevity of the female (mated & unmated) and male adults of ***O. similis*** was significantly influenced by temperature. There was a reduction of this time with the increase of the temperature. Kakimoto et al. (2005) showed that the longevity of ***O. strigicollis*** females was longer at 23°C (73.1 days) than at 29°C (27.2 days). At 18°C, the mean longevity of females (mated & unmated) was significantly different with different aphid species as prey. The longevity of ***O. similis*** unmated females was significantly longer with ***A. gossypii*** than ***M. persicae*** as prey at 25°C (Sengonca et al., 2008).

Feeding on artificial nutritional sources is considered to be an adaptive strategy to sustain populations of this predator when prey numbers are low. ***O. similis*** females and males were able to survive for a considerable period of time on artificial nutritional sources. At different temperatures tested, the mean longevity period of females and males was significantly longer on 10 % honey emulsion than on other nutritional sources. According to Kakimoto et al. (2007), fresh honey was effective as a conventional diet in increasing the longevity of ***O. strigicollis*** adults, and fresh honey can be used as an alternative diet for the predator.

The length of pre-oviposition period decreased as the temperature rose from 18 to 30°C in ***O. similis***. This is in agreement with studies conducted by Kakimoto et al. (2005), which the length of pre-oviposition periods of ***O. strigicollis*** at 17 and 29 °C were 15.6 and 4.7 days, respectively. In studies of Cocuzza et al. (1997b), oviposition period of ***O. laevigatus*** averaged 54 as well as 20 days at 15 and 25°C, respectively, which agrees with the present results where the oviposition period varied according to temperature. The ages at the times of first oviposition, peak oviposition, and last oviposition became earlier in ***O. similis*** as temperature increased. As suggested by Sharpe & DeMichele (1977), an oviposition peak early in the oviposition period at high temperature probably is the expression of an increased metabolic rate. The mean daily oviposition of ***O. similis*** was significantly the highest at 30°C with both aphid species as prey. In studies of Kakimoto et al. (2005), the mean daily oviposition of ***O. strigicollis*** also increased significantly from 23 (0.9 eggs/day) to 29°C (5.0 eggs/day). At both temperatures, the mean daily oviposition of ***O. similis*** varied significantly according to aphid species as prey. According to Sengonca et al. (2008), the mean daily oviposition of ***O. similis*** was also greater with ***M. persicae*** (5.6 eggs/day) than with ***A. gossypii*** (2.9 eggs/day) as prey at 25°C. In the current study, the mean total fecundity was significantly affected with aphid species as prey at 30°C. Most authors confirmed that also in the fecundity of ***Orius*** spp. with different diet (Fritsche & Tamo, 2000; Tommasini et al., 2004; Sengonca et al., 2008). In total, the females of ***O. similis*** laid an average of 54.5 and 108.4 eggs with ***A. gossypii*** and ***M. persicae*** as prey at 25 °C, respectively (Sengonca et al., 2008).

The ability of ***O. similis*** to prey successfully on different aphid species and complete its development with this prey species at different temperature indicates that it is an efficient predator of aphids and an important biological control agent. With respect to biological potential, ***O. similis*** shows a good adaptation to the different climatic conditions. The basic biological measurements in the laboratory at different temperature were in favour of improving the biocontrol predictions of ***O. similis***. Temperature within a specific range affects the development, mortality, longevity and fecundity of the predator, which may be described using specific rate functions to predict the activity under field conditions and to determine optimal conditions for their mass multiplication. In addition, this information can be used to assess the suitability of ***O. similis*** as a natural enemy of aphid species under different environmental conditions in the world.

## Özet

**İki farklı sıcaklığın, iki değişik yaprakbiti türü ile beslenen avcı böcek** ***Orius similis*** **Zheng (Heteroptera: Anthocoridae)'in biyolojisi üzerine etkileri**

***Orius similis*** Zheng (Heteroptera: Anthocoridae), ana vatanı Çin olan ve çeşitli yaprakbitleri, thrips ve akarlarla beslenen önemli bir predatördür. Bu laboratuvar çalışması ile iki farklı sıcaklığın (18 ve 30°C) ***Aphis gossypii*** Glover ve ***Myzus persicae*** (Sulzer) ile

beslenen avcı böcek ***O. similis***'in biyolojisi üzerindeki etkilerinin araştırılması amaçlanmıştır. Elde edilen sonuçlara göre, avcı böceğin embriyo ve nimflerinin gelişme süresi, sıcaklığın 18°C den 30°C'ye yükselmesi ile kısalmış ve ölüm yüzdesi düşmüştür. ***O. similis***'in ömrü en çok ortalama 100,1 gün olarak, ***A. gossypii*** ile beslenen çiftleşmiş dişilerde bulunmuştur. Avcı böceğin ömrü, % 10'luk bal solüsyonu ile beslendiğinde, istatistiksel olarak önemli oranda artmıştır. ***A. gossypii*** ve ***M. persicae*** ile beslenen dişi avcı böceklerde günlük yumurta bırakma 18°C'de 1,0 yumurta/gün, 30°C sıcaklıkta 6,9 yumurta/gün olarak tespit edilmiştir.

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