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Influence of Two Different Pre-Imaginal Stages of *Bemisia tabaci* on Development, Life Table parameters, and Predation Rate of the Predatory Mite, *Euseius scutalis* (Acari: Phytoseiidae)

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ABSTRACT

The predatory mite, *Euseius scutalis* (Athias-Henriot), was studied in terms of its development, survival, and life table parameters on two preimaginal stages (egg and first instar nymph) of its prey, *Bemisia tabaci* (Gennadius) (Hem.: Aleyrodidae). The first instar nymphs of *B. tabaci* were found to be the preferred food for *E. scutalis*, resulting in decreased developmental time from egg to adult, as well as a shorter pre-oviposition period and a higher rate of oviposition. The intrinsic rate of increase (r) was found to be 0.1503 day^{-1} on first instar nymphs and 0.0843 day^{-1} on eggs of the prey. On average, females *E. scutalis* consumed 16.30 eggs and 29.40 nymphs from their emergence to death. When first instar nymphs of *B. tabaci* were provided, *E. scutalis* showed a higher net predation rate (C_0) and finite predation rate (ω) compared to feeding on eggs. On average, it consumed 3.52 eggs or 2.76 first instar nymphs of *B. tabaci* to produce a single egg of *E. scutalis*. In terms of the progeny sex ratio of the progeny, predatory females that fed on first instar nymphs produce more females.

Keywords: Phytoseiidae, *Euseius scutalis*, predation rate, growth rate, *Bemisia tabaci*.

INTRODUCTION

The agricultural pest known as the cotton whitefly, *Bemisia tabaci* (Gennadius) (Hem.: Aleyrodidae) is one of the major global threats to different crops. *B. tabaci* damages greenhouse vegetables and ornamental plants by sucking sap from the plants, which can reduce production (De Barro *et al.*, 2011). This is primarily due to their direct damage to host plants through leaf piercing, sap sucking, and honeydew secretion (Jones, 2003). It has a high reproductive capacity and is capable of causing significant damage through the secretion of honeydew, which promotes

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the rapid growth of molds (Gangwar and Gangwar, 2018). The use of insecticides to eliminate this pest raises production costs and contributes to the development of pest resistance.

The crucial role of predatory mites of the family Phytoseiidae in biological control is widely recognized (McMurtry *et al.*, 2013). These efficient predators play a significant role in managing pest mites and other small arthropods in crops grown in both greenhouses and open fields worldwide. With over 2,700 species reported on all continents except Antarctica, the mites from this family make up 60% of the global biological control market (Momen *et al.*, 2020). They are considered a vital solution for sustainable plant protection and for promoting integrated pest management against spider mites, thrips, and whiteflies (Yazdanpanah and Fathipour, 2022).

Euseius scutalis (Athias-Henriot) is common phytoseiids in Middle East and North Africa (Bounfour and McMurtry, 1987). This predatory mite is one of the most dominant predator on economic crops in Iran (Kamali *et al.*, 2001), and it is one of the pollen-feeding generalist species of the Phytoseiid mite (McMurtry *et al.*, 2013). It is a significant predatory mite in biological control due to its ability to effectively manage pest populations. Although this predatory mite has the highest reproductive capacity when feeding on pollen, it is also capable of consuming a variety of small insects and mites, such as eriophyid, tenuipalpid and spider mites, eggs, and immature stages of whiteflies, thrips and scale insects (Abou-Elella *et al.*, 2013; Stathakis *et al.*, 2021). *E. scutalis* exhibits optimal life cycle parameters and fecundity when feeding on *Tetranychus turkestani* (Ugarov & Nikolskii), followed by date palm pollen, making it a versatile and effective biocontrol agent (Shishehbor *et al.*, 2022). Previous studies have shown a close association between this species and *B. tabaci* (Meyerdirk and Coudriet, 1986). The use of *E. scutalis* in integrated pest management programs can reduce reliance on chemical pesticides, promoting a safer and more sustainable agricultural ecosystem.

While some researchers have provided information on the life table of *E. scutalis* when fed on *B. tabaci* compared to other prey species or pollen grains (Nomikou *et al.*, 2001, Nawar 2017), there is a lack of data regarding the life table of this predatory mite in relation to the different growth stages of *B. tabaci*. Therefore, this study aimed to assess the influence of two different developmental stages (eggs and first instar nymphs) of the *B. tabaci* on the biological characteristics and predation rate of *E. scutalis*, which plays a vital role in biological control.

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MATERIAL AND METHODS

Mite Rearing

The population of *E. scutalis* was obtained from a laboratory-grown culture at the Faculty of Agriculture, Shahid Chamran University of Ahvaz, Iran. The initial population, identified by Dr. Farid Faraji from Mitox (Amsterdam, The Netherlands), was collected in February 2021 from marshmallow plants (*Althea officinalis* L.) infested with *T. turkestani* on the university campus. For laboratory rearing, we used plastic green sheets measuring 3 cm in diameter, placed on a water-saturated sponge in a Petri dish measuring 6 cm in diameter and filled with water. The edges of the sheet were surrounded by strips of tissue paper. Cotton threads were placed on the plastic sheets to provide egg-laying sites and shelter for the predators (Walzer and Schausberger, 1999). As a food source, we provided date palm pollen (*Phoenix dactylifera* L.) on the plastic sheets. The mites were fed this pollen grain for approximately one month before starting the experiments. Date palm pollen was chosen because it has been recommended as one of the most suitable alternative diet sources for the easy and cost-effective rearing of *E. scutalis* (Shishehbor *et al.*, 2022). The rearing units were held in a growth chamber at 25±1 °C, 60± 10% RH, and a photoperiod of 16:8 (L:D).

Whitefly Rearing

A number of mature cotton whiteflies were collected using an aspirator from infested plants in the greenhouse at Shahid Chamran University of Ahvaz, Faculty of Agriculture. The whiteflies were then reared on cucumber plants inside cages (60 × 60 × 120 cm). Identification of this species was carried out using the taxonomic keys of Martin (1987). The cucumber plants (Var. Negin) used for colony maintenance were reared at 25±1°C, 60%±10% RH, and a photoperiod of 16L:8D. Every week, a new cucumber plant with at least eight fully developed leaves was added to each cage.

Experimental Setup

Leaves of a cucumber plant infested with *B. tabaci* were carefully selected and cut into smaller pieces. Each piece was then examined under a stereomicroscope to confirm the presence of only 10 fresh *B. tabaci* eggs. For first instar nymphs, the same procedure was repeated, but the leaves were cut after the eggs had developed to the first instar nymph stage (10 first instar stable nymphs). The test units were prepared the same as units used for mite rearing except using a piece of

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cucumber leaf (3 cm in diameter) containing whitefly eggs or first instar nymphs pad instead of using plastic sheet.

Effect of *B. tabaci* Immature Stages on the Development, Prey Consumption and Survival Rate of the Predatory Mite *E. scutalis*

About 50 females of *E. scutalis* were separated from the rearing unit using a fine brush and transferred to a new experimental unit. After 24 hours, the eggs that were less than 24 h old were placed individually in petri dishes containing one of the two pre-adult stages of *B. tabaci*. The petri dishes were checked daily to record survival and developmental durations until adulthood. Once they became adults, the females and males were paired and transferred to a new petri dish. Each day, we checked the experimental units to confirm oviposition and note the consumption. The leaf in each arena was replaced daily with a new piece of fresh food. The number of prey consumed by each pair of predatory mite was recorded daily. Additionally, the number of eggs laid by each female was recorded daily until all the females died. The survival of both females and males was monitored daily until all individuals had died. Each experiment was repeated 60 times. The tests were conducted in a controlled-temperature cabinet at 25± 1 °C, 60± 10% RH, and a photoperiod of 16:8 (L:D). *E. scutalis* eggs collected daily and were transferred to new petri dishes containing a piece of cucumber leaf containing whitefly eggs or first instar nymphs. This procedure was repeated on all days when oviposition occurred. After they matured, the gender of the predators was determined to estimate the daily sex ratio.

Data Analysis

The computer programs TWOSEX-MSChart and CONSUME-MS Chart were utilized for analyzing the life history and the daily consumption of *E. scutalis* on the two stages of *B. tabaci*, respectively (Chi and Liu, 1985; Chi, 1988; Chi, 2023a, b). The age-stage-specific survival rate (s_{xj}), age-stage-specific fecundity (f_{xj}), age-specific survival rate (l_x), age-specific fecundity (m_x), age-stage life expectancies (e_{xj}), and age-stage reproductive value (v_{xj}), and along with population growth parameters were calculated using TWOSEX-MS Chart program (Chi, 2023a). Based on Chi and Yang (2003), net predation rate (C_0), transformation rate (Q_p), stable predation rate (ψ), and finite predation rate (ω), were computed using CONSUME-MS Chart program (Chi and Yang, 2003; Chi, 2023b). Means and standard errors of the all parameters were calculated by bootstrap

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method with 100000 resamplings. Paired bootstrap test using the TWOSEX-MS Chart program (Chi, 2023a) was used for mean comparisons.

RESULTS

Immature Developmental Time and Survival

Individuals of *E. scutalis* successfully developed from larvae to adults when fed on eggs and first instar nymphs of *B. tabaci* (Table 1). The time spent by *E. scutalis* in each developmental stage was affected by the immature stage of *B. tabaci*. Development from egg to adult was significantly faster for both females and males when feeding on first instar nymphs of *B. tabaci* compared to eggs. While the adult longevity and total lifespan of female *E. scutalis* when fed on first instar nymphs of *B. tabaci* were not different from those reared on eggs, these parameters for males were significantly longer on first instar nymphs of *B. tabaci* than on its eggs (Table 1). Additionally, here were no significant differences between the sexes in terms of immature development on either food item. When *B. tabaci* eggs were the food source, males exhibited shorter adult longevity and total lifespan compared to females (Table 1).

The overlapping observed in Figure 1A can be explained by the fact that individuals at different stages have varying development rates. *Euseius scutalis* exhibited high survivorship during the immature development stage. Females that were fed eggs and first instar nymphs of *B. tabaci* survived for 39 and 32 days, respectively. The males lived for 24 days when fed on the eggs of *B. tabaci*, while they survived for 31 days when fed on first instar nymphs.

Fecundity and Life Table Parameters

The consumption of the first instar nymphs of *B. tabaci* resulted in a shorter average pre-oviposition period (APOP) of *E. scutalis* compared to its eggs (Table 1). Similarly, significant differences in the total pre-oviposition period (TPOP) were observed between the different immature stages of *B. tabaci*. When the predator was fed first instar nymphs of *B. tabaci*, the adult females laid eggs more rapidly (2.67 ±0.15 days) compared to when eggs of this prey were offered (3.92 ±0.35 days). *Euseius scutalis* that fed *B. tabaci* eggs had a shorter oviposition duration compared to those that used *B. tabaci* first instar nymphs.

Figure 1B summarizes the age-specific survival rate (l_x), the age-specific fecundity rate (m_x), and female age-specific fecundity (f_x) for *E. scutalis* reared on different life stages of *B. tabaci*. The

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maximum values of f_x for *E. scutalis* on the first instar nymphs and eggs of *B. tabaci* were 2.54 and 2 eggs/individual/day, respectively, which occurred on the 13th and 33rd days, respectively. All the population parameters of *E. scutalis* were significantly influenced by the prey stage, except for the gross reproductive rate (*GRR*) (Table 2). When *B. tabaci* first instar nymphs were offered as food, R_0, r, and λ of the predator mite were higher compared to when whitefly eggs were offered. Similarly, the mean generation time of *E. scutalis* on the former stage of prey was shorter than on the latter stage (Table 2).

The age-stage life expectancies (e_{xj}) of *E. scutalis*, which represent the expected lifespan of individuals at age x and stage j after age x, are illustrated in Figure 2A for two different life stages of *B. tabaci*. As age increased, the *exj* values gradually decreased. Notably, e_{xj} was higher for nymphs compared to eggs (Figure 2A), indicating that *E. scutalis* feeding on nymphs of *B. tabaci* lived longer than those that fed on eggs. The age-stage reproductive value (v_{xj}), which indicates the contribution of an individual at age x and stage j to the future population, increased significantly when adults emerged and the peak of v_{xj} for the predator occurred at ages 28 and 12 days on the egg and nymph stages of *B. tabaci*, respectively (Figure 2B).

Sex Ratio

During the first days of oviposition, sex ratio was males-based (Figure 3). The percentage of female to male progeny per female parent reared on *B. tabaci* eggs during the initial three 24-hour periods were 00:00, 40:60 and 44:55 (on the first day, all collected eggs died before adult emergence). For *E. scutalis* females reared on *B. tabaci* first instar nymphs, similar measurements were 0:100, 61:38, and 36:63.

Consumption Rate

The larval stage of *E. scutalis* did not prey on the eggs and first instar nymphs of *B. tabaci*. The amount of prey consumed by *E. scutalis* immatures when *B. tabaci* eggs were provided did not differ from that obtained when *B. tabaci* first instar nymphs were offered (Table 3). The predation rate of *E. scutalis* adults and their total life span were significantly affected by the prey stage. The consumption rate of both female and male *E. scutalis* was higher when they were fed on the first instar nymphs of *B. tabaci* rather than its eggs. When the first instar nymphs of *B. tabaci* were provided, *E. scutalis* showed a higher net predation rate (C_0) and finite predation rate (ω) compared

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to when its eggs were provided. On average, it takes either 3.52 eggs or 2.76 first instar nymphs of *B. tabaci* to produce a single egg of *E. scutalis*, respectively (Table 3).

The age-specific predation rate (k_x) refers to the average number of *B. tabaci* consumed by *E. scutalis* at age *x* (Figure 4). The highest value of this parameter was 2.08 and 1.62 on first instar nymphs and eggs of *B. tabaci*, respectively, which was observed at age 10. The age-specific net predation rate (q_x) can be determined by taking into account the survivorship (Figure 4). Its highest value was estimated to be 1.88 and 1.40 on the aforementioned prey stages.

DISCUSSION

In our study, we found that the different immature stages of *B. tabaci* as prey had a significant impact on the duration of *E. scutalis'* pre-adult stages and its total lifespan. We observed that motile prey stage (nymph L1) was more conducive to the growth of *E. scutalis*. Regardless of previous studies showing that the type of prey influences the fecundity and reproductive parameters of *E. scutalis* (Momen and Hussein, 2011), our research has revealed that the developmental stage of the prey can also impact these parameters. Female *E. scutalis* that fed on first instar nymphs of *B. tabaci* had a shorter pre-oviposition period, longer oviposition period, and produced more eggs than those reared on eggs of *B. tabaci*. This suggests that prey on first instar nymphs are more favorable to this predator than prey on eggs.

Prey stage preferences vary considerably among generalist and specialist phytoseiid predatory mites, with specialists typically preferring the egg stage over other stages of their prey (Blackwood *et al.*, 2001). According to the literature, some other predators, including *Macrolophus caliginosus* (Wagner) (Hem.: Miridae) and *Serangium parcesetosum* Sicard (Col.: Coccinellidae) also preferred the nymph stage of *B. tabaci* for optimal reproductive success (Bonato *et al.*, 2006; Firas and Sengonca, 2007). However, our findings differ from those reported by Meyerdirk and Coudriet (1986), who found that eggs, followed by first instars of *B. tabaci*, were the most suitable whitefly host stage for *E. scutalis*, while the second instar nymph was the least suitable stage. The predation of *E. scutalis* on the eggs and first instar larvae of *B. tabaci* was not significantly different (Nomikou *et al.*, 2004), which contrasts with our results. This discrepancy can be explained by the fact that Nomikou *et al.* (2004) reported the predation rate over only one day, while we examined the predation rate throughout the lifespan. Additionally, variations in predator and prey strains, as well as the previous food source of the predatory mite, can also account for this difference.

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Furthermore, it appears that insect nymphs have a higher nutritional content compared to insect eggs. Shah *et al.* (2022) indicated that insect nymphs can contain a protein content ranging from 40-73% of their body weight, depending on the species. Additionally, higher concentrations of fatty acids are found in insect nymphs compared to their eggs. However, information on the nutritional value of insect eggs is not as extensively covered in the literature. It has been noted that the hardness of the egg's chorion and the length of time required for handling them may pose difficulties for the mites when feeding (Meyerdirk and Coudriet, 1986; Carrillo and Pena, 2012; Ganjisaffar and Perring, 2015). Furthermore, it is evident that there is a difference in size and biomass between the eggs and nymphs of *B. tabaci*. The nymphs were found to be larger than the eggs. However, the potential benefits of this size difference are somewhat diminished by the fact that the nymphs are active stages, requiring the predator to exert energy and time in capturing them. Nevertheless, due to the smaller size of the leaf discs compared to normal leaves and the high density of prey, the predator females did not have to exert much energy in searching for active prey (Bruce-Oliver and Hoy, 1990).

Similar to previous studies on *E. scutalis* (Bounfour and McMurtry, 1987; Bazazzadeh *et al.*, 2025), the pre-adult development for male was incomparable to that of females in our study. This developmental similarity can be attributed to some biological and genetic factors. Research indicates that the sex-lethal gene (Ppsxl) plays a role in sex determination and reproductive processes, but its influence on sexual differentiation in *Phytoseiulus persimilis* Athias-Henriot is not as pronounced as in insect (Li *et al.*, 2023). This suggests that both sexes may share similar developmental pathways during their immature stages. While the similarities in immature development are evident, it is important to consider that environmental factors and specific ecological roles may also influence the developmental trajectories of these mites, potentially leading to variations not solely explained by genetic mechanisms.

Based on the results of the current study and regardless of the tested immature stages, most of the eggs give rise to male offspring at the beginning of the oviposition period and to female offspring throughout the rest of the oviposition period. A similar trend has also been reported for a Morocco (Marrakech) strain of *E. scutalis* (Bounfour and McMurtry, 1987) and for other phytoseiid such as *Typhlodromus caudiglans* Schuster (Putman, 1962), *Phytoseiulus persimilis*, *Amblyseius bibens* Blommers (Schulten *et al.*, 1978), *Galendromus helveolus* (Chant) (Caceres and Childers, 1991), and *Kampimodromus aberrans* (Boroufas *et al.*, 2007). Sabelis (1985) stated that increased male

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offspring production at the beginning of the oviposition period could result in the early insemination of females that would afterwards start to search for suitable food.

The predatory mite *E. scutalis* showed a higher *r*-value when preying on first instar nymphs of *B. tabaci* compared to its predation on *B. tabaci* eggs. The *r*-value estimated in this study was lower than the *r*-value of *E. scutalis* on *B. tabaci* (0.191 day^{-1}) (Fouly *et al.*, 2013). By contrast to our study, when *Amblyseius orientalis* Ehara was fed on *B. tabaci*, the *r* was negative, indicating that this prey is not a sufficient food source for sustaining *A. orientalis* populations (Zhang *et al.*, 2015). In contrast, when *Typhlodromus negevi* Swirski and Amitai was fed on *B. tabaci* eggs, the intrinsic rate of increase (0.271 day^{-1}) was higher than our study (Momen *et al.*, 2009), indicating that this prey is more suitable for *T. negevi* than *E. scutalis*.

Conclusions

The pre-immature stage of the prey appears to be a crucial factor in developing an integrated pest management program for *B. tabaci* using *E. scutalis*. Our results demonstrate that *E. scutalis* has the potential to control *B. tabaci* due to its ability to feed on both eggs and first instar nymphs of the prey. Predators that can consume multiple life stages of their prey are more effective at controlling pest populations. Furthermore, *E. scutalis* showed a preference for feeding on nymphs rather than eggs. Field evaluations should be conducted to further assess its biological control potential, particularly with strategies aimed at enhancing its population establishment and long-term control efficiency, such as providing supplementary food.

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Table 1. Comparative duration (Mean ± SE) of developmental time, adult longevity, total life span, APOP, TPOP, and oviposition days (days), as well as, fecundity and sex ratio of females and males of *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia tabaci*.

Parameter	Prey stage	
	Egg	Nymph (L1)
Female Egg	2.17 ±0.10 a A	2.07 ±0.05 a A
Male Egg	2.27 ±0.19 a A	2.26±0.10 a A
Female Larva	1.50 ±0.09 a A	1.13 ±0.06 b A
Male Larva	1.64 ±0.15 a A	1.21±0.12 b A
Female Protonymph	1.90 ±0.12 a A	1.57 ±0.09 b A
Male Protonymph	2.00 ±0.13 a A	1.53 ±0.12 b A
Female Deutonymph	2.17 ±0.14 a A	2.10 ±0.13 a A
Male Deutonymph	2.36 ±0.24 a A	1.68 ±0.17 b A
Female Developmental time	7.73 ±0.21 a A	6.87 ±0.15 b A
Male Developmental time	8.27 ±0.24 a A	6.68 ±0.19 b A
Female Adult longevity	12.80 ±1.29 a A	14.93 ±0.85 a A
Male Adult longevity	9.45 ±1.27 b B	14.74 ±1.27 a A
Female Total life span	20.53 ±1.40 a A	21.80 ±0.86 a A
Male Total life span	17.73 ±1.28 b B	21.42 ±1.25 a A
APOP	3.92 ±0.35 a	2.67 ±0.15 b
TPOP	11.73 ±0.45 a	7.87 ±2.00 b
Oviposition days	5.42 ±0.83 b	8.93 ±0.54 a
Fecundity (eggs/Female)	6.50 ± 1.09 b	15.67 ± 1.47 a
Sex ratio (Nf/N)	0.67 ± 0.07 a	0.56 ± 0.07 a

Means (± SE) within rows followed by lowercase different letters are significantly different (100000 resamplings, paired bootstrap test, $P < 0.05$). Mean values followed by different capital letters shows the significant difference between female and male for each parameter ($P < 0.05$), based on paired bootstrap test with 100,000 samples.
APOP: Adult pre-oviposition period, TPOP: Total pre-oviposition period. Nf/N: number of females to number of individuals.

Table 2. Population parameters of *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia tabaci*.

Parameter	Egg	Nymph (L1)
GRR **(eggs/individuas)**	17.77 ±3.27 a	11.12 ±1.54 a
R_0 **(eggs/individuas)**	4.33 ±0.85 b	8.70 ±1.34 a
r **(day^{-1})**	0.084 ±0.01 b	0.150 ±0.01 a
λ **(day^{-1})**	1.088 ±0.01 b	1.162 ±0.01 a
T **(day)**	17.38 ±1.11 a	14.39 ±0.18 b

Means (± SE) within rows followed by different letters are significantly different (100000 resamplings, paired bootstrap test, $P < 0.05$).
GRR: Gross reproductive rate, R_0: Net reproductive rate, r: Intrinsic rate of increase, λ: Finite rate of increase, T: Mean generation time.

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Table 3. Mean (±SE) predation rates of *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia tabaci*.

Parameter	Egg	Nymph (L1)
Protonymph female	0.27 ±0.07 a A	0.23 ±0.05 a A
Protonymph male	0.36 ±0.08 a A	0.26 ±0.08 a A
Deutonymph female	1.33 ±0.10 a A	1.47 ±0.07 a A
Deutonymph male	1.18 ±0.12 a A	1.11 ±0.15 a A
Pre-adult female	1.60 ±0.19 a A	1.70 ±0.18 a A
Pre-adult male	1.55 ±0.25 a A	1.37±0.22 a B
Adult female	16.30 ±5.48 b A	29.40 ±5.48 a A
Adult male	11.33 ±3.32 b B	17.67±4.36 a B
Total longevity female	17.90 ±1.55 b A	32.10 ±1.65 a A
Total longevity male	12.87 ±1.55 b B	19.04 ±1.29 a B
C_0	15.26 ±1.30 b	23.99 ±1.62 a
Q_p	3.52 ±0.54 a	2.76 ±0.34 a
ψ	0.58 ±0.03 a	0.63 ±0.03 a
ω	0.63 ±0.03 b	0.73 ±0.04 a

Mean values followed by different lowercase letters within the same row are significantly different ($P < 0.05$), based on paired bootstrap test with 100,000 samples. Mean values followed by different capital letters shows the significant difference between female and male for each parameter ($P < 0.05$), based on paired bootstrap test with 100,000 samples. C_0: Net predation rate; ω: Finite predation rate; Q_p: Transformation rate; ψ: Stable predation rate.

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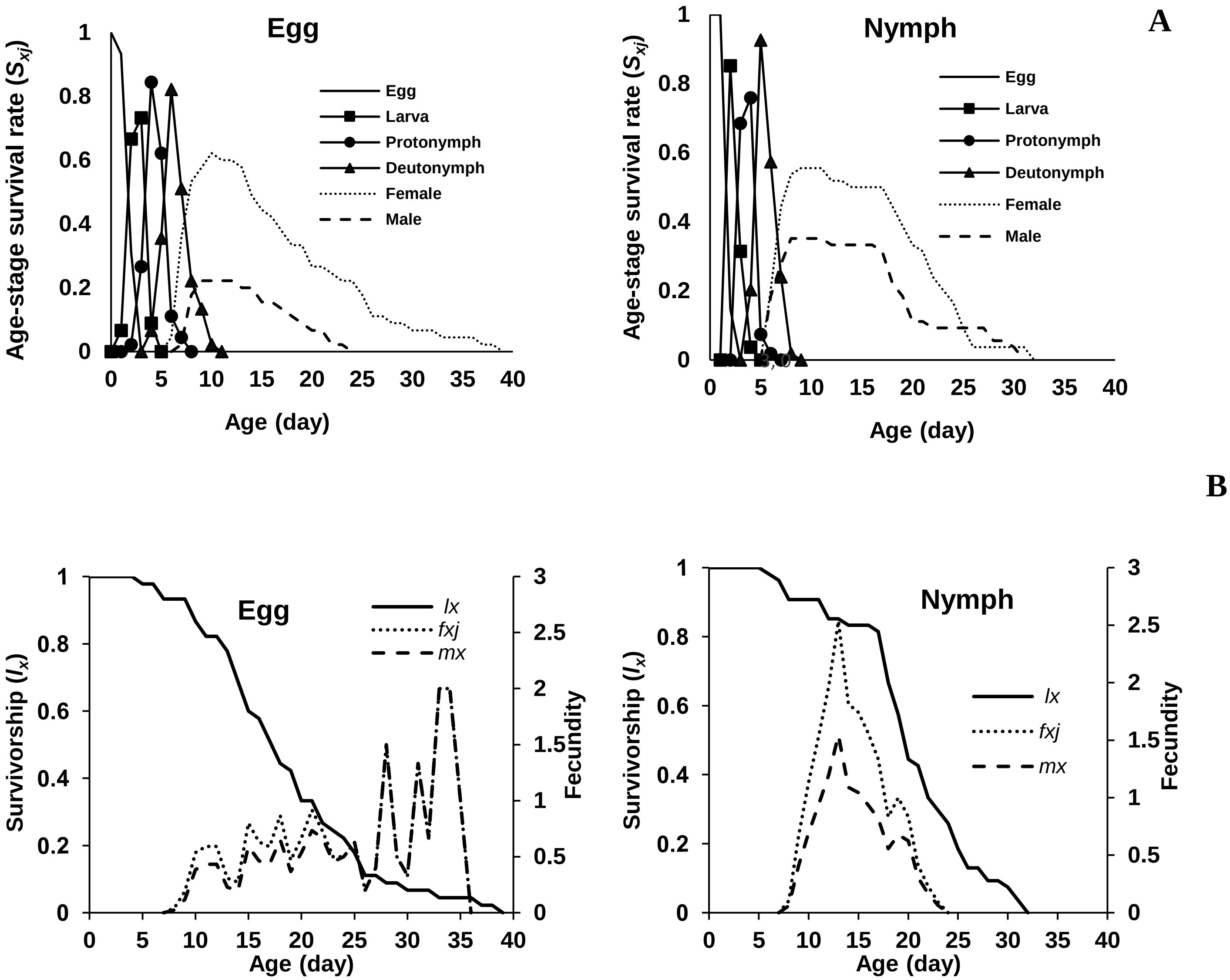

Figure 1. The age-stage survival rate (s_{xj}) (A) and the age-specific survivorship (l_x), age-stage specific fecundity of female (f_{xj}) (eggs) and age-specific fecundity (m_x) (B) of *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia tabaci*.

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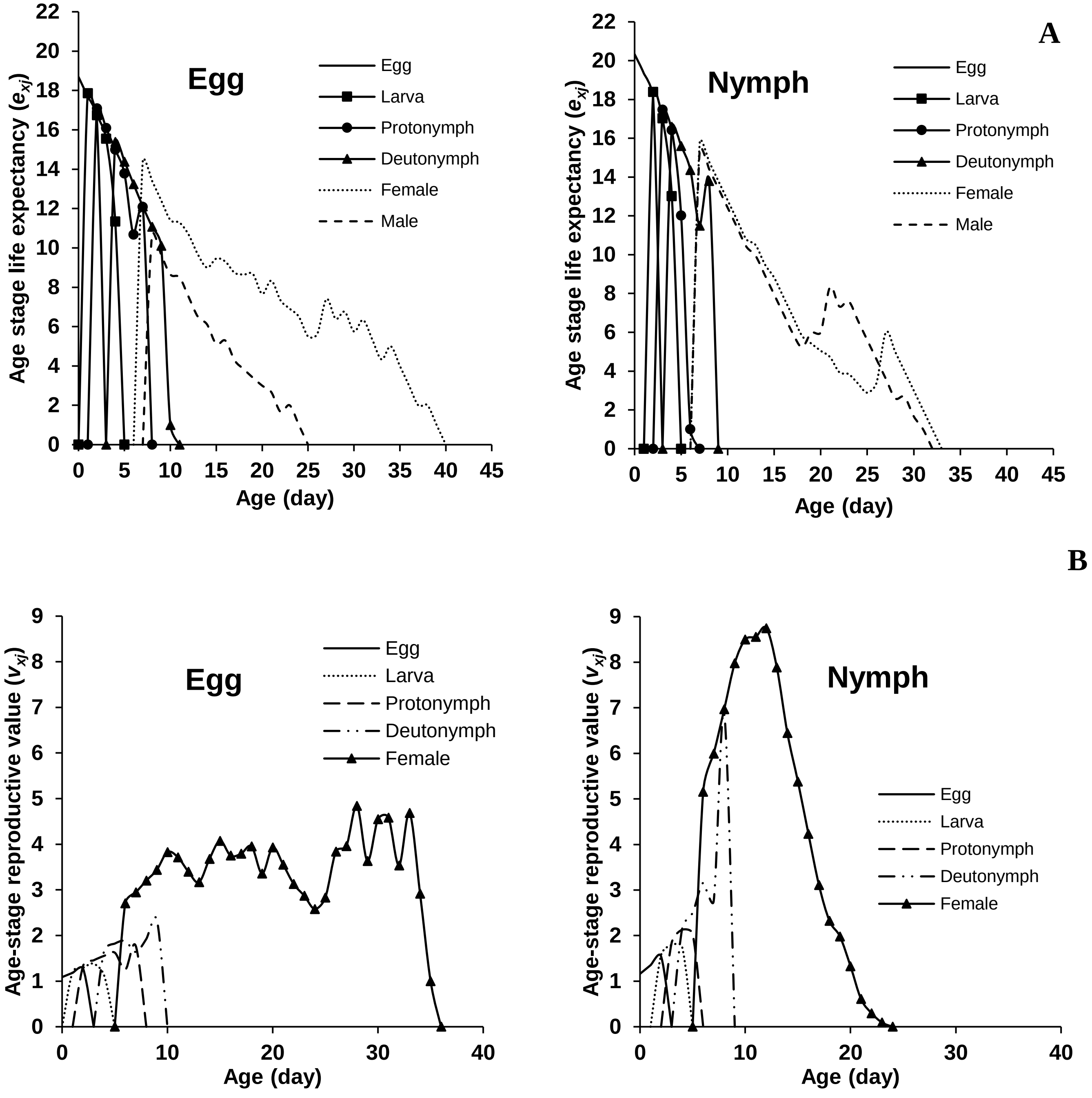

Figure 2. The age-stage specific life expectancy (e_{xj}) (A) and the age-stage reproductive value (v_{xj}) (B) of *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia tabaci*.

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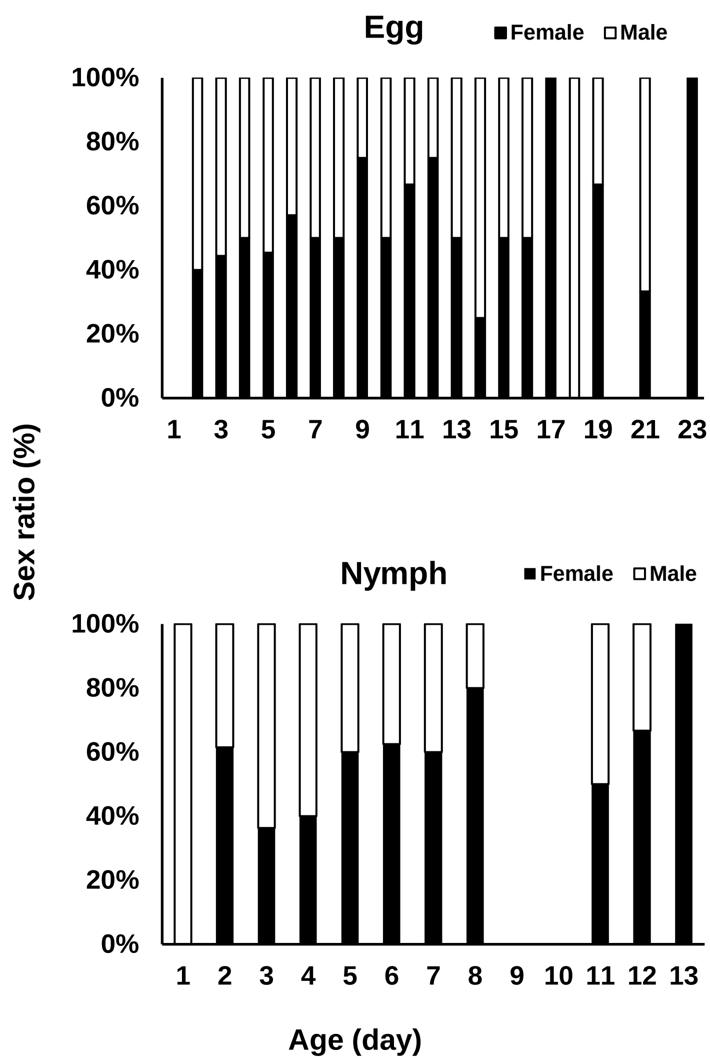

Figure 3. Offspring sex ratio of females of *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia tabaci*. White and black bars indicate the percentages of male and female offspring, respectively.

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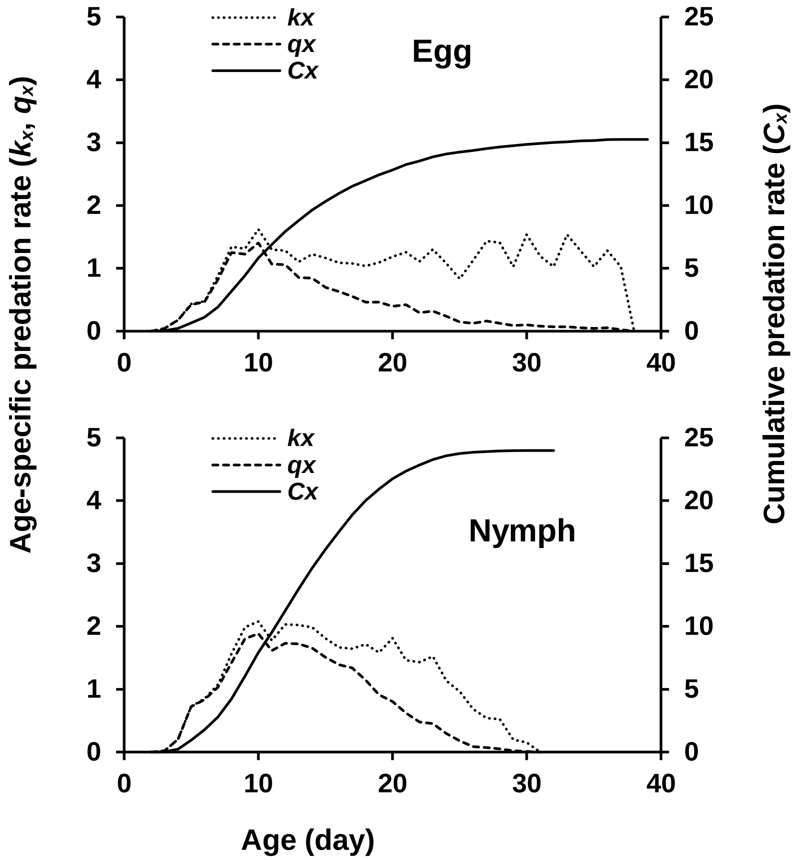

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479 **Figure 4.** Age-specific predation rate (k_x), age-specific net predation rate (q_x) and cumulative
480 predation rate (C_x) of predator mite *Euseius scutalis* fed on egg and first-instar nymph of *Bemisia*
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