Türk. entomol. derg., 2013, 37 (2): 161-167
ISSN 1010-6960

Orijinal araştırma (Original article)

Life table parameters and predation of *Orius niger* Wolff (Hemiptera: Anthocoridae) feeding on two different preys

İki farklı av üzerinde beslenen *Orius niger* Wolff (Hemiptera: Anthocoridae)' in yaşam çizelgeleri ve av tüketim kapasitesi

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Summary

The development period, longevity, fecundity, and prey consumption of *Orius niger* Wolff (Hemiptera: Anthocoridae) feeding on *Tetranychus cinnabarinus* Boisduval (Acari: Tetranychidae) and *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) were studied in a climate room under 25±1 ºC, 65±10% RH and 16 h of artificial light conditions. Feeding with different food sources did not change duration of egg, nymphal stages and total immature period for both males and females of *O. niger* except the third nymphal stage of males and the fifth nymphal stage of females. Oviposition period and female longevity of *O. niger* fed on *B. tabaci* were significantly longer than those of *O. niger* fed on *T. cinnabarinus*. Average total and daily fecundity of *O. niger* fed on *B. tabaci* was significantly higher than those of *O. niger* fed on *T. cinnabarinus*. The higher net reproductive rate (R_0 = 87.2 ♀/♀), intrinsic rate of increase (r_m = 0.120 ♀/♀/day) and the longer mean generation time (T_0 = 37.2 days) of *O. niger* were obtained for individuals fed on *B. tabaci* than those of *O. niger* fed on *T. cinnabarinus. O. niger* showed increasing consumption withincreasing prey densities and, the number of *T. cinnabarinus* eggs consumed by *O. niger* significantly changed depending on prey densities. The highest number of eggs consumed by *O. niger* per day was 89.85 when confined to 150 eggs.

Key words: *Bemisia tabaci,* development, longevity, reproduction, *Tetranychus cinnabarinus*

Özet

Tetranychus cinnabarinus Boisduval (Acari: Tetranychidae) ve *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) üzerinde beslenen *Orius niger* (Hemiptera: Anthocoridae)' in gelişme süresi, ömrü, üreme gücü ve av tüketim kapasitesi, 25±1 ºC sıcaklık, %65±10 orantılı nem ve 16 saat aydınlık koşulları içeren iklim odasında araştırılmıştır. Erkeklerin üçüncü nimf dönemi ve dişilerin beşinci nimf dönemleri hariç, *T. cinnabarinus* ve *B. tabaci* ile beslenen *O. niger'* in erkek ve dişi bireylerin yumurta, nimf ve toplam gelişme süreleri, besin kaynakları arasında önemli farklılık göstermemiştir. *B. tabaci* ile beslenen *O. niger'* in dişi ömür uzunluğu ve yumurtlama periyodu, *T. cinnabarinus* ile beslenmesine göre önemli derece uzun olmuştur. *B. tabaci* ile beslenen *O. niger'* in günlük ve toplam bıraktığı yumurta sayısı, *T. cinnabarinus* ile beslenmesine göre önemli derece yüksek bulunmuştur. *B. tabaci* ile beslenen *O. niger'* in net üreme gücü (R_0 = 87.2 ♀/♀) ve kalıtsal üreme yeteneği (r_m = 0.120 ♀/♀/gün) daha yüksek, ortalama döl süresi (T_0 = 37.2 gün) de daha uzun olarak saptanmıştır. *O. niger,* artan av yoğunluğuna bağlı olarak tüketimini arttırmış ve tüketilen *T. cinnabarinus* yumurtalarının sayısı av yoğunlukları arasında önemli farklılık göstermiştir. Avcıya günde 150 *T. cinnabarinus* yumurtası verildiğinde, bunun ortalama 89,95 adedini tükettiği görülmüştür.

Anahtar sözcükler: *Bemisia tabaci,* gelişme, ömür uzunluğu, üreme gücü, *Tetranychus cinnabarinus*

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Alınış (Received): 21.09.2012 Kabul ediliş (Accepted): 21.01.2013

Introduction

Çukurova region of Turkey has a wide range of crop diversity and cotton is among the most important ones. There are a lot of pests causing economical yield losses on cotton. *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) and *Tetranychus cinnabarinus* Boisduval (Acari: Tetranychidae) gain economic importance almost every year and are in general controlled by broad spectrum pesticide application (Ghavami & Özgür, 1992; Atakan & Özgür, 2001). However, the extensive use of pesticides results in the development of pest strains that are highly resistant to pesticides, and it has negative side-effects on the environment and human health. Recent studies on integrated pest management in cotton in east Mediterranean region of Turkey enlightened the importance of biological control agents in particularly predators in controlling cotton pests (Atakan & Gençer, 2008). *Orius niger* Wolff (Hemiptera: Anthocoridae) was determined as a common predatory insect at cotton fields in the Çukurova region of Turkey (Ghavami, 1994; 1997; Atakan & Özgür, 2001; Atakan & Gençer, 2008). It is polyphagous species and feeds on soft bodied insects and mites, also it is found to be an important factor suppressing pest build up (Whitcomb & Bell, 1964; Chinajariyawong & Harris, 1987).

In spite of the wide distribution of *O. niger* and its apparent importance as natural enemy of pest species in the field, very little is known about biology, prey consumption, and efficacy on different prey. The present experiment was designed to elucidate development period, longevity, fecundity, and functional response of *O. niger* feeding on *T. cinnabarinus* and *B. tabaci*. Results obtained in this study may provide useful information to improve IPM programs in cotton.

Materials and Methods

Insect and mite rearing

Orius niger (Hemiptera: Anthocoridae) was collected from cotton fields near Adana in the east Mediterranean region of Turkey and cultured on 4-6 week-old cotton plants (*Gossypium hirsutum* cv. Çukurova 1518) infested with *B. tabaci* or *T. cinnabarinus* as prey at 25±1 ºC, 65±10% RH and 16 h of artificial light. *Bemisia tabaci* and *T. cinnabarinus* were obtained from laboratory stock cultures, and reared on cotton under the same conditions. Clean cotton plants were grown in a climate room (same regime), and they were subsequently added biweekly to *B. tabaci* and *T. cinnabarinus* cultures.

Life table of *Orius niger*

The development period of *O. niger* from egg to adult was examined at 25±1 ºC, 65±10% RH and 16 h of artificial light in a climate room. Experiments were conducted on cotton leaf discs (6 cm diameter) in plastic boxes (12 x 8 x 7 cm). Each leaf disc was placed abaxial side up on a layer of water-saturated foam and filter paper in a plastic box. Second instar nymphs of *B. tabaci* and different developmental stages of *T. cinnabarinus* obtained from stock cultures were used as prey. One *O. niger* gravid female obtained from the stock cultures was transferred onto each leaf disc and allowed to lay eggs for 12 h. The number of *O. niger* eggs was reduced to 1 egg by carefully removing excess eggs with a needle; the female was also removed. The developmental periods of the *O. niger* immature stages were observed at 12-h intervals until the immature stages reached the adult stage. The presence of an exuvium was used as the criterion for successful molting to the next developmental stage.

To determine longevity and fecundity, one newly emerged *O. niger* female and 1 male from the above experiment were subsequently placed on a leaf disc containing second instar nymphs of *B. tabaci* or the different developmental stages of *T. cinnabarinus*. After mating and *O. niger* female began laying eggs, the male was removed. The female was transferred to a new leaf disc every day with the new food source. When the female died, the replicate was terminated. The oviposition period and pre- and post-oviposition periods were calculated. The number of eggs laid was recorded daily until all female parents died. Life tables were constructed from the data obtained for developmental period of immature stages, and for adult oviposition and development. The number of replicates for each prey varied from 10-12 (see Table 1-2).

Predation ability of *Orius niger*

The predation rate of *O. niger* was conducted on excised cotton leaf disc placed upside down on wetted foam rubber and filter paper in Petri dishes (9 cm diameter) at 25±1 ºC, 65±10% RH and 16 h of artificial light in a climate room. 1-day-old eggs of *T. cinnabarinus* were used as prey. To obtain this stage, gravid females of *T. cinnabarinus* were transferred onto clean leaf discs for oviposition. After 24 h, the females were removed. The number of eggs was reduced with a fine brush or needle to the exact number needed. Adult *O. niger* females obtained from the stock cultures were individually starved in small petri dishes (3.5 cm diameter) for 5 h prior to the experiments. Subsequently, the female predators were confined on the leaf disc in a petri dish by a small leaf cage (4 cm diameter), the upper side closed with fine mesh, and provided *T. cinnabarinus* eggs at various densities, i.e. 1, 2, 4, 8, 16, 32, 64, 100, 128 and 150. After 24 h, the number of prey consumed and eggs laid by the predator were recorded. The experiment was replicated 20 times.

Statistical Analysis

Data on development period, longevity, fecundity were analyzed separately with Student's *t*-test. Data on functional response were analyzed using one-way ANOVA, followed by Tukey's test at $P = 0.05$. Population growth rates on different prey were calculated by constructing life tables using the following equation (Birch, 1948):

$$1 = \Sigma e^{-r*x} l_x.* m_x.$$

Age-specific survival rates (l_x) and the number of female offspring (m_x) for each age interval (x) day were used for life table data. From these data, net reproductive rate (R_0), intrinsic rate of natural increase (r_m), and mean generation time ($T_0 = \ln R_0/r_\mathrm{m}$), in days were calculated (Laing, 1968). Differences in r_m values were tested for significance by estimating variance using the jack-knife method, which facilitated calculation of the standard errors of r_m estimates. The jack-knife pseudo-value (r_j) was calculated for n samples using the following equation (Krebs, 1998): $r_\mathrm{j} = n * r_\mathrm{all} - (n - 1) * r_\mathrm{i}$

The mean values of ($n - 1$) jack-knife pseudo-values for mean growth rate in each treatment were analyzed with Student's *t*-test. Analysis of developmental period, longevity, fecundity and prey consumption of *O. niger* was conducted using SPSS statistical software (SPSS, 2004).

Results

The duration of egg, nymphal stages and total developmental period for males and females of *O. niger* fed on *B. tabaci* and *T. cinnabarinus* was not significantly different between the food sources except for the third nymphal stage of males and the fifth nymphal stage of females (Table 1). The duration of egg, nymphal stages, and total development period of *O. niger* did not differ significantly between males and females ($P>0.05$).

The pre-oviposition and post-oviposition periods of *O. niger* population which fed on *B. tabaci* and *T. cinnabarinus* were not different statistically between food sources (Table 2). Oviposition period and female longevity of *O. niger* fed on *B. tabaci* were significantly longer than those of *O. niger* fed on *T. cinnabarinus* (Table 2). Mean total and daily fecundity of *O. niger* fed on *B. tabaci* were significantly higher than those of *O. niger* fed on *T. cinnabarinus* (Table 2). Daily egg production of *O. niger* peaked on days 50 (3.60 eggs/♀/day) and 35 (1.90 eggs/♀/day) on *B. tabaci* and *T. cinnabarinus*, respectively (Figure 1).

Table 1. Duration in days of egg and immature stages of *Orius niger* feeding on different prey (mean ± S.E.)

		Prey		
		Bemisia tabaci	*Tetranychus cinnabarinus*	
n^z	♀	12	11	*P*
	♂	12	12	
Egg	♀	6.0±0.2 [y]	5.6±0.2	0.22
	♂	6.0±0.2	5.5±0.2	0.09
1. instar	♀	3.1±0.1	2.9±0.1	0.38
	♂	2.9±0.1	2.9±0.1	0.69
2. instar	♀	2.3±0.1	2.7±0.3	0.21
	♂	2.3±0.1	2.6±0.1	0.06
3. instar	♀	3.1±0.3	2.8±0.2	0.34
	♂	3.1±0.2 a	2.3±0.3 b	0.02
4. instar	♀	2.7±0.2	2.6±0.3	0.75
	♂	2.6±0.1	2.5±0.2	0.45
5. instar	♀	4.3±0.2 b	5.2±0.3 a	0.01
	♂	4.5±0.2	4.9±0.2	0.12
Total development period	♀	21.5±0.6	21.8±0.5	0.77
	♂	21.4±0.2	20.7±0.4	0.13

[z] Numbers of replicates.

[y] Within rows, means followed by a different lower-case letter differ significantly (*t*-test).
Within columns, for both sexes, means do not differ significantly (*t* test).

Table 2. Longevity and fecundity of *Orius niger* feeding on two different prey (mean ± S.E.)

	Preys		
	Bemisia tabaci	*Tetranychus cinnabarinus*	
n^z	10	10	*P*
Pre-oviposition[1]	3.3±0.1 [y]	3.1±0.1	0.21
Oviposition	39.3±2.1 a	23.2±0.6 b	0.00
Post-oviposition	26.1±4.4	26.4±2.9	0.96
Longevity ♀	68.7±4.2 a	52.7±2.8 b	0.01
Total fecundity[2]	209.3±19.7 a	62.8±2.5 b	0.00
Daily fecundity	5.2±0.3 a	2.7±0.1 b	0.00

[z] Numbers of replicates. [1] Duration (days). [2] Number of eggs per female.

[y] Within rows, means followed by a different lower-case letter differ significantly (*t*- test).

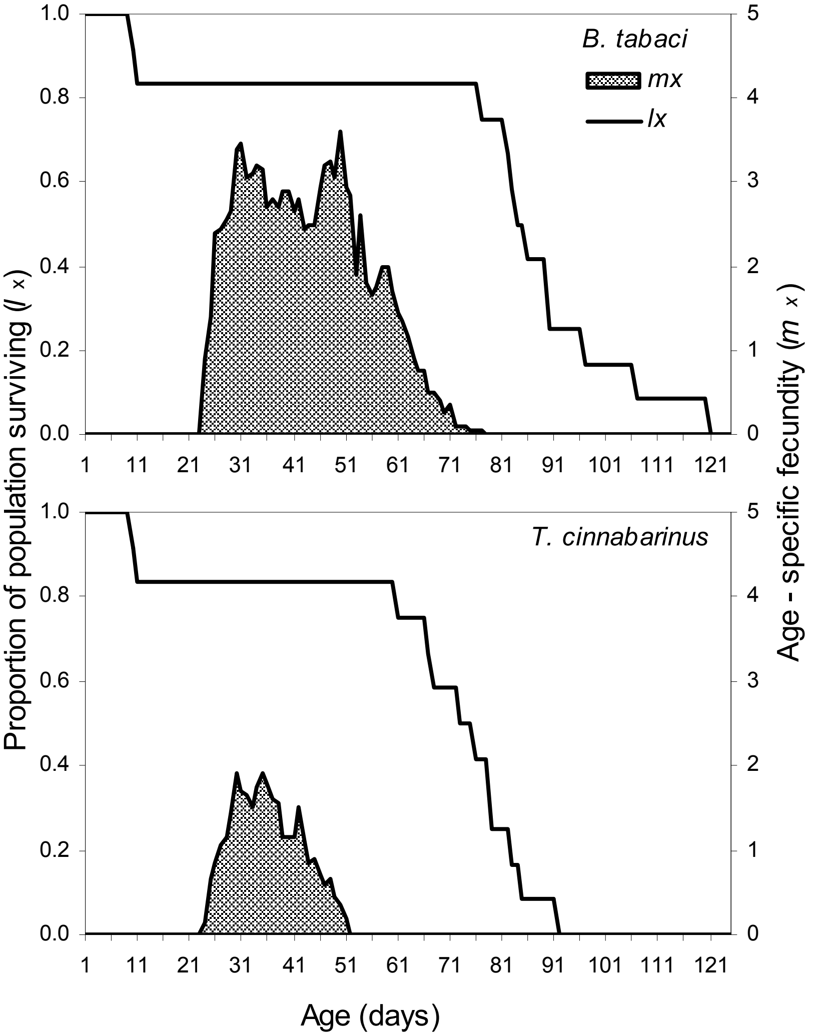

Figure 1. Survivorship curve (l_x) and age-specific fecundity rate (m_x) of *Orius niger* feeding on *Bemisia tabaci* and *Tetranychus cinnabarinus.*

A higher net reproductive rate (R_0 = 87.2 ♀/♀), intrinsic rate of increase (r_m = 0.120 ♀/♀/day) and the longer mean generation time (T_0 = 37.2 days) of *O. niger* were obtained for individuals fed on *B. tabaci* than those of *O. niger* fed on *T. cinnabarinus.* The r_m value of *O. niger* was significantly different between the food sources (Table 3).

Table 3. Net reproductive rate (R_0), intrinsic rate of increase (r_m) and generation time (T_0) of *Orius niger* fed on two different prey

Preys	Net reproductive rate (R_0) (♀ / ♀)	Intrinsic rate of increase (r_m)^z (♀ / ♀ / day)	Generation time (T_0) (days)
Bemisia tabaci	87.2	0.120 a	37.2
Tetranychus cinnabarinus	26.2	0.095 b	34.3

[z] Within the column, means followed by a different lower-case letter differ significantly (*t*-test, P<0.001).

Orius niger showed an increasing consumption with increasing prey densities and, the number of *T. cinnabarinus* eggs consumed by *O. niger* was significantly different among the prey densities (Table 4).

The highest number of eggs consumed by *O. niger* per day was 89.85 when confined to 150 eggs. The oviposition rates of *O. niger* were significantly different at various prey densities (Table 4). The maximum number of eggs laid by a female predator was 4.72, 4.80 and 4.72 at a prey density of 100, 128 and 150 individuals, respectively (Table 4).

Table 4. Mean daily number of prey consumed and egg deposited by gravid female *Orius niger* on increasing prey densities of *Tetranychus cinnabarinus* eggs (Mean ± S.E.)

Number of prey provided	Mean number of prey consumed	Mean number of egg deposited
1	0.29 ± 0.1 f	0.00 ± 0.0 e
2	0.47 ± 0.1 f	1.08 ± 0.2 d
4	3.24 ± 0.2 f	1.72 ± 0.3 cd
8	6.03 ± 0.3 ef	2.24 ± 0.4 c
16	12.24 ± 0.6 e	2.40 ± 0.4 bc
32	23.75 ± 1.1 d	2.68 ± 0.2 bc
64	42.17 ± 2.0 c	3.28 ± 0.4 b
100	64.16 ± 2.9 b	4.72 ± 0.5 a
128	68.18 ± 3.6 b	4.80 ± 0.4 a
150	89.85 ± 4.7 a	4.72 ± 0.2 a
F ratio	187.957	24.213

Within columns, means followed by the same letter do not differ significantly (Tukey test).

Discussion

This study showed that the duration of nymphal stages of *O. niger* fed on nymphs of *B. tabaci* and different developmental stages of *T. cinnabarinus* was 15.5± 0.5 and 16.2±0.5 days, respectively. These findings are in agreement with the results obtained by Keçeci (2005) who reported that the total nymphal periods of *O. niger* fed on nymphs of *T. cinnabarinus* were 16.6±0.14 days. Tommasini & Nicoli (1994) found that the total nymphal periods of *O. niger* fed on eggs of *E. kuehniella* and *F. occidentalis* were 12.9 and 11.9 days, respectively at 26 ºC and 80±5 % relative humidity. Başhi & Tunç (2008) found that the duration of the total nymphal stages of *O. niger* was 11.6±0.1 days when fed on eggs of *E. kuehniella*. Fathi (2009) showed that total nymphal periods of *O. niger* fed on *T. urticae* females and 2nd instar larvae of *Thrips tabaci* were 14.06±2.03 and 13.7±1.97 days, respectively. These different findings might be due to different responses of *O. niger* to different prey sources, as well as different stages of prey.

The longevity and fecundity of *Orius* species varies according to the consumed prey species (Deligeorgidis, 2002; Fathi, 2009). This study showed that *O. niger* had greater longevity and higher fecundity when fed on *B. tabaci* instead of *T. cinnabarinus*. Similar results were obtained by Fathi (2009) who found that *O. niger* fed on *T. tabaci,* compared to *T. urticae,* had longer longevity and higher fecundity. Başhi & Tunç (2008) found that longevity and total fecundity of *O. niger* fed on the eggs of *E. kuehniella* were 38.8± 2.5 days and 110.6±7.6 eggs, respectively.

The intrinsic rate of increase (r_m) is an important parameter, describing the growth potential of a population, because it reflects the overall effects of temperature and food on development, reproduction and survival characteristics of the population (Southwood, 1978). In this study, *O. niger* had higher r_m and net reproductive rate (R_0) when fed on *B. tabaci* compared to *T. cinnabarinus*. Similarly, Fathi (2009) found that *O. niger* feeding on *T. tabaci*, when compared to *T. urticae,* had a higher r_m value and higher R_0 rates. Furthermore, Fathi (2009) reported that *O. minutus* fed on mites compared to thrips had a higher r_m value and higher R_0 rates. Baniameri et al. (2005) estimated a high r_m (0.113 female/female/day) for *O.*

niger on a diet of *E. kuehniella* eggs. The r_m value of *O. niger* varies according to the different species of the prey offered and greater difficulty for *Orius* species to catch adult and nymphal stages of prey than the egg stage (Teerling, 1993; Fathi, 2009).

In conclusion, our study indicated that *O. niger* exhibited a high capacity for population increase when fed *B. tabaci* compared to *T. cinnabarinus*, and thus may be able to provide effective control of *B. tabaci* in the field. For test this hypothesis, field experiments are needed to investigate the effect of *O. niger* on *B. tabaci* populations.

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