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Original article (Orijinal araştırma)

Some biological parameters of *Orius niger* (Wolff, 1811) (Hemiptera: Anthocoridae) under outdoor conditions in Turkey

Orius niger (Wolff, 1811) (Hemiptera: Anthocoridae)'in dış koşullarda bazı biyolojik özellikleri

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Summary

Overwinter biology of *Orius niger* (Wolff, 1811) (Hemiptera: Anthocoridae) was studied during 2014 and 2015, in Adana Province, Turkey. Outdoor experiments were performed at the Department of Plant Protection, Faculty of Agriculture, University of Çukurova on seven different dates between October and April. The predatory bug, *O. niger,* overwinters in Adana Province as adults. Some biological parameters of the *O. niger* were investigated under outdoor conditions at monthly intervals from autumn to spring with cotton seedlings placed in vials with distilled water. Sterilized eggs of the Mediterranean flour moth, *Ephestia kuehniella* Zeller, 1879 (Lepidoptera: Pyralidae), were provided to *Orius* as food. All eggs of *O. niger* hatched even at the low temperatures in winter. Most of the experimental females laid eggs. Total mean numbers of eggs laid by the females was the highest in April (83.55±15.60 eggs/female) and the lowest in December (7.71±1.62 eggs/female). Duration of oviposition of the experimental females was nearly 30 days in October, November and April, but less than 30 days in other winter months. The proportion of non-reproductive females in December-February ranged from 25% to 40%. Longevity of females was nearly a month in winter and they did not survive until spring. While sex ratios (male/female) ranged from 1:2.5 to 1:3 in October-January, the ratio was 1:1 in April. Duration of nymph development was the highest (45 days) in January and the shortest (nearly 18 days) in April. Furthermore, most of the first instars of nymphs died in a short time due to cold winter days in December-February, and nearly 28% total nymphs matured to adults. The experimental results support that *O. niger* can severely decrease the population sizes of pest species in late spring (after April) in countries of the southern zone.

Keywords: Adana, Anthocoridae, biology, *Orius niger*, Turkey

Özet

Orius niger (Wolff, 1811) (Hemiptera: Anthocoridae)'in kışlama biyolojisi Adana'da 2014 ve 2015 yıllarında araştırılmıştır. Dış koşullardaki denemeler Ekim-Nisan periyodunda Çukurova Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü'nde 7 farklı tarihte yürütülmüştür. Avcı böcek *O. niger* Adana'da ergin olarak kışı geçirmektedir. *Orius niger*'in bazı biyolojik özellikleri Sonbahar-İlkbahar periyodunda dış koşullarda incelenmiştir. *O. niger*' e besin olarak sterilize edilmiş Akdeniz un güvesi, *Ephestia kuehniella* Zeller, 1879 (Lepidoptera: Pyralidae) yumurtaları verilmiştir. Kışın çok düşük sıcaklıklarda bile *O. niger*'in yumurtaları açılmıştır. Tüm denemelerdeki dişilerin birçoğu yumurta bırakmıştır. Dişilerin bıraktığı ortalama toplam yumurta sayıları Nisan ayında en yüksek (83 55±15.60/dişi) ve Aralık ayında ise en düşük (7.71±1.62/ dişi) olmuştur. Ekim, Kasım ve Nisan aylarında dişilerin ovipozisyon süresi 30 gün civarında olurken, diğer kış aylarında bu süre 30 günden az olmuştur. Yumurta bırakmayan dişilerin oranı ise Aralık-Şubat döneminde %25-%40 arasındadır. Dişilerin ömür süreleri kışın yaklaşık olarak bir aydır ve dişiler ilkbahar dönemine ulaşamamıştır. Ekim-Ocak ayları arasında cinsiyet oranları (dişi/erkek) 1:2.5'ten 1:3'e kadar değişirken, bu oran Nisan ayında 1:1 olmuştur. Nimf gelişme süreleri Ocak ayında en uzun (45 gün) olurken Nisan ayında en kısa (18 gün) olarak belirlenmiştir. Aralık-Şubat dönemindeki soğuk kış günlerinde birinci dönem nimflerin birçoğu kısa sürede ölürken, yaklaşık %28'i ergin döneme ulaşmıştır. Bu denemenin sonuçları *O. niger*'in güney bölgelerde nisan ayından sonra zararlı türlerin popülasyonlarını azaltabileceğini desteklemektedir.

Anahtar sözcükler: Adana, Anthocoridae, biyoloji, *Orius niger*, Türkiye

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Introduction

The Order Hemiptera is well known for containing important predators of agricultural pests including acari (Acarina) and thrips (Thripidae), as well as other soft bodies pest species (Whitcomb & Bell, 1964). Commonly they are used in integrated pest management programs (IPM) with their high consumption and searching capabilities on their host, their easy mass rearing and quick adaptability to laboratory conditions (Ramakers & van den Meiracker, 1991; Van de Veire & Degheele, 1992; Jacopson, 1993).

The western flower thrips, *Frankliniella occidentalis* Pergande, 1895 (Thysanoptera: Thripidae), is regarded as a very destructive pest of agricultural crops worldwide (Kirk & Terry, 2003). This species was recorded for the first time in Turkey in 1993 (Tunç & Göçmen, 1994). In general, insecticide treatments are not efficient on thrips, because of their cryptic behavior, such as eggs being in plant tissues, and prepupa and pupa mostly in soil. Moreover, resistant population can appear because of high number of chemicals (insecticide) used worldwide (Immaraju et al., 1992; Brødsgaard, 1994; Dağlı & Tunç, 2007). Therefore, there is special attention given to biological control agents belonging to the family Anthocoridae (Hemiptera) to use against pest thrips in agricultural habitats all over the world. *Orius* species are important as biological control agents in controlling of pest thrips species on vegetables grown in tunnels or greenhouses (Schreuder & Ramakers, 1989; Trottin-Caudal et al., 1991; Tavella et al., 1991; Villevieille & Millot, 1991; Van de Veire & Degheele, 1992; Jacopson, 1993). They also feed upon whiteflies (Hemiptera: Aleyrodidae), aphids (Aphididae) and spider mites (Acarina: Tetranychidae) (Riudavets, 1995). These predator species were previously found on different pest species on cotton in the Çukurova Region, Turkey (Ghavami & Özgür, 1992) and they have an important role in suppressing thrips species in cotton fields in Turkey (Atakan, 2006; Atakan & Gencer, 2008) as well as thrips species on vegetables (Atakan, 2007a) and fruit trees (Atakan, 2007b). Also, *Orius niger* (Wolff, 1811) has been commonly found in Turkey (Önder, 1982) and it is widely spread over the Mediterranean basin and is present under natural conditions throughout the year in the Çukurova Region (Atakan & Tunç, 2010). *Orius niger* and *Orius minutus* (L.) have effectively controlled the two-spotted red spider mite and onion thrips in potato fields in the Ardabil region of Iran (Fathi, 2009).

There are several factors that can influence efficiency of *Orius* species in IPM programs. The first factor is their behavior in winter (Ramakers & van den Meiracker, 1991; Gillespie & Quiring, 1993). Temperature and day length are important factors which affect biological control of thrips by *Orius* species, while *F. occidentalis* is well known as a very harmful greenhouse pest thrips, which does not enter reproductive diapause (Kirk & Terry, 2003). It has numerous generations under warm greenhouse conditions, while local or imported strains of some *Orius* species exhibit a diapause, which negatively effects their predation on pest thrips. However, the Antalya strain of *O. niger* (Bahşi & Tunç, 2008) and southern strain of *Orius laevigatus* (Fieber, 1860) from Sicily (Tommasini & van Lanteren, 2003) do not enter reproductive diapause under the short-day-length conditions in the laboratory. However, outdoor conditions are quite variable compared to laboratory conditions. Changeable outdoor conditions (mainly meteorological conditions) would affect winter biology of the predatory bug, i.e., diapause, and would have an impact on its potential predatory capacity in controlling pest insects including thrips in crop and wild plants in open fields and in protected areas.

The purpose of this study was to provide data on overwintering status of *O. niger* under outdoor conditions in Adana, Turkey, with emphasis on its potential usage in IPM programs including thrips pest management in agricultural crops. We investigated how different dates, i.e., months, influence biology of *O. niger*. In addition, we also evaluated whether different day lengths and temperatures at different times from winter to spring affected reproductive behavior of the predator bug. Additionally, investigation of overwintering biology of this predatory bug may help to predict predatory activity of *O. niger* on insect prey in agricultural areas in the following season.

Material and Methods

Host plant source

Cotton (*Gossypium hirsutum* L.) (Malvaceae) cv. SG125 was used in this study. Cotton plants grown in pods in the chambers at 25ºC and 60% RH. The cotton seedlings were used for the experiments when they were in two-true leaf stage.

Insect material

Colonies of *Ephestia kuehniella* Zeller, 1879 was supplied by the Biological Control Research Institute of Adana and was reared in the laboratory for two years.

Orius niger was obtained from the cotton flowers in Adana, Turkey. *Orius* individuals were reared in the climatic chamber at 25ºC, 60% RH and 16L:8D h photoperiod. Plastic cups (0.5 l capacity) with two ventilation windows covered with muslin were used as rearing units. Fresh bean pods were used as oviposition substrate. *Ephestia kuehniella* eggs were sterilized for 2 h under UV light, then glued on blue cards for *O. niger* feeding. Given of the cannibalism of *O. niger*, adults were put in other rearing cages. The rearing units were used to determine egg hatching and nymphal development. Upper side of the 500-ml plastic containers were cut and covered with fine muslin. Thirty-ml capacity glass vial was fixed onto bottom side and cotton seedling with two cotyledon leaves were immersed in water in the glass vial (7.6 x 2.5 cm).

Experimental design

Experiments were conducted on seven different dates between October and April. The plastic containers with cotton seedlings and insects were randomly placed outdoors. The plastic containers including insects were placed on a platform 3 m above ground outside a south-facing laboratory window. The platform, 90 cm in diameter, was made from concrete.

Meteorological conditions at the experiment site

The experiments were conducted in the Department of Plant Protection, Faculty of Agriculture, University of Çukurova. Experiments were performed under outdoor conditions. The mean, maximum and minimum temperatures and relative humidity were obtained from the Meteorological Station of Department of Agricultural Buildings and Irrigation (about 5 km from the experimental site).

Duration of egg development

Five pairs (10 replicates) of females (in oviposition period) and males of *O. niger* from the laboratory culture were caged in a plastic container and were kept for 24 h in the climatic chamber with the conditions 25ºC, 60% RH and 16L:8D h photoperiod. The bugs were released in the cage which contained sterilized eggs of *E. kuehniella* and *Typha* pollen (supplied by the Biological Control Research Institute of Adana, Turkey) on cotyledons of cotton plants. After 24 h, *O. niger* eggs laid into the cotyledons were counted in laboratory and 10 eggs were left in each plant cage. The plastic containers were placed outdoors at each experimental date.

Hatching of eggs inserted into the tissues of caged cotton seedlings was assessed daily under a stereo microscope in the laboratory and recorded. The experiments started on 14 October, 5 November, 4 December, 1 January, 3 February, 3 March and 20 April.

Nymphal survival rate

Newly hatched five nymphs from the egg development experiments under the outdoor conditions, were kept in a plastic container and provided with sterilized eggs of *E. kuehniella* and also *Typha* pollens. Experiment was replicated four times (20 nymphs in total). Nymph development was observed twice a week and emerged adults were sexed. The number of emerged adults in relation to the initial number of eggs was calculated from data of development duration experiments.

The experiments started on 20 October, 17 November, 12 December, 13 January, 9 February, 17 March and 25 April.

Preoviposition, oviposition, postoviposition and fecundity of females

We modified the method of Chyzik et al. (1995) for these studies. Ten pairs of one-day old bugs obtained from the laboratory stock culture were used. One unmated female and a male were taken from the *O. niger* rearing chambers and were kept in a plastic container with cotton seedlings immersed in water in a vial. *Ephestia* sterilized eggs and pollens were added. The plastic containers were placed on the same platform. Cotton seedlings and prey were changed every 2 or 3 days. The numbers of eggs laid into plant tissues by the females were counted under a stereo microscope (40x magnification).

The experiments started on 13 October, 3 November, 3 December, 5 January, 2 February, 9 March and 20 April.

Longevity

Male and female longevity were determined from the individuals used in fecundity test.

Data analysis

Biological data on eggs hatching, preoviposition, oviposition, postoviposition, eggs numbers and nymph development and adult life span according to experimental days were compared by using Tukey's honestly significant difference (HSD) test at $P < 0.05$ significant level. SPSS statistical package program was used (SPSS, 2006).

Results

Duration of egg development

Number of laid eggs ranged between 43 (14 October) and 303 (3 February) eggs/female across the different experiment dates. The duration of first hatching of eggs was similar in experiments in October and November and hatching period lasted 5.70±0.89 and 6.75±0.64 days after first hatching (Table 1). The first hatching occurred 10 days later in December and January experiments. After January, duration of the first hatching was significantly shorter than those in December and January ($F_{(6,43)} = 15.442$, $P < 0.0001$) than other sampling months. Hatching rate was determined as 62.80% in October and 76.78% in November when the eggs hatched within 10 days (Table 1). This rate was 94.01% in experiment of January. Ratio of hatching of eggs within first 5 days in April experiment was 34.31%.

Nymph development period and mortality rate

Total nymphal period was the shortest (17.50±0.18 days) in April ($F_{(6,40)} = 43.447$, $P < 0.0001$) and this was followed by nymphs of September experiment (20.07±1.10 days) (Table 2). Duration of nymph development coming from the experiments of November, December and January were 32.51±0.50, 37.71±1.74 and 45.00±0.40 days, respectively. Duration of nymph development was the highest at 45.00±0.40 days in January and the shortest at 17.50±0.18 days in April.

Mean temperature ranged from 19 to 23ºC and relative humidity was nearly 70% in April (Figure 1). Nymph development time was closely related to temperature and humidity. Mean temperature varied between 5 and 13ºC in December-February and dropped to 3ºC in the first week of January. Out of 54 nymphs, a total 189 nymphs matured to adults. Mortality rate of nymphs in November-February was over 70%. Sixty percent of nymphs in the October experiment and 44% in the March experiment matured to adults. Numbers of the emerged females were at least two-fold of numbers of the males in October-January (Table 2). After the February experiment, the sex ratio was nearly equal.

Table 1. Duration of *Orius niger* egg development under the outdoor conditions

Experiment date	No of total eggs	[a]Mean time±SEM of first hatching of eggs (day)	Hatching rates of eggs (%) according to day intervals		
			0-5 days	6-10 days	>10 days
14 October	43	5.70±0.89 bc (4-10)[b]	4.65	32.55	62.80
5 November	100	6.75±0.64 ab (5-10)	4.05	41.41	54.54
4 December	81	9.66±0.74 a (8-15)	0.00	23.22	76.78
1 January	218	9.87±0.79 a (8-14)	0.00	5.96	94.04
3 February	303	3.75±0.36 bc (2-5)	9.25	64.64	26.07
3 March	150	4.20±0.80 bc (2-7)	10.00	58.00	32.00
20 April	102	2.60±0.76 c (1-5)	34.31	65.68	0.00

[a] means with same letter in the same column are not statistically significant according to Tukey's HSD test ($P < 0.05$); [b] parenthesis indicates minimum and maximum values.

Table 2. Total development time of *Orius niger* nymphs under outdoor conditions

Experiment date	n	No of nymphs became adults	No of death nymphs	Mortality of nymphs (%)	[a]Mean duration±SEM of total nymph (day)	Sex ratio (Male/female)
15 October	25	13	12	48.00	20.07±1.13c (16-29)[b]	1:3
17 November	25	7	18	72.00	32.51±0.5b (32-33)	1:2.5
12 December	24	2	22	91.67	37.71±1.74a (31-43)	-
13 January	30	4	26	86.67	45.00±0.40a (44-46)	1:3
9 February	30	5	25	83.33	39.00±1.34a (36-42)	1:1.5
17 March	25	9	14	56.00	31.62±2.23b (23-42)	1:1.25
25 April	30	14	16	53.00	17.5±0.18c (17-18)	1:1

[a] means with same letter in the same column are not statistically significant according to Tukey's HSD test ($P < 0.05$); [b] parenthesis indicates minimum and maximum values.

Preoviposition, oviposition, postoviposition and productivity of females

Preoviposition period in the October experiment was significantly shorter at 4.33 days than those in the other experiments ($F_{(6,42)}$ = 11.660, P < 0.0001) but increased to 9.33±0.76 and 11.71±1.65 days in the November and December experiments, respectively (Table 3). Preoviposition period for the March and April experiments lasted 7.42±1.63 and 8.72±1.46 days, respectively. Oviposition time in the October, November, March and April experiments were significantly greater than those in the winter experiments ($F_{(6,42)}$ = 6.712, P < 0.0001) and nearly lasted 30 days. Oviposition was significantly less in the winter experiments (P < 0.0001). For example, female oviposited was 11.85 and 18.50 days in the December and January experiments, respectively. Females laid significantly more eggs in October and in April ($F_{(6,42)}$ = 4.669, P < 0.0001). Postoviposition in the autumn experiments was significantly longer than in the other experiments, and lasted nearly 10 days.

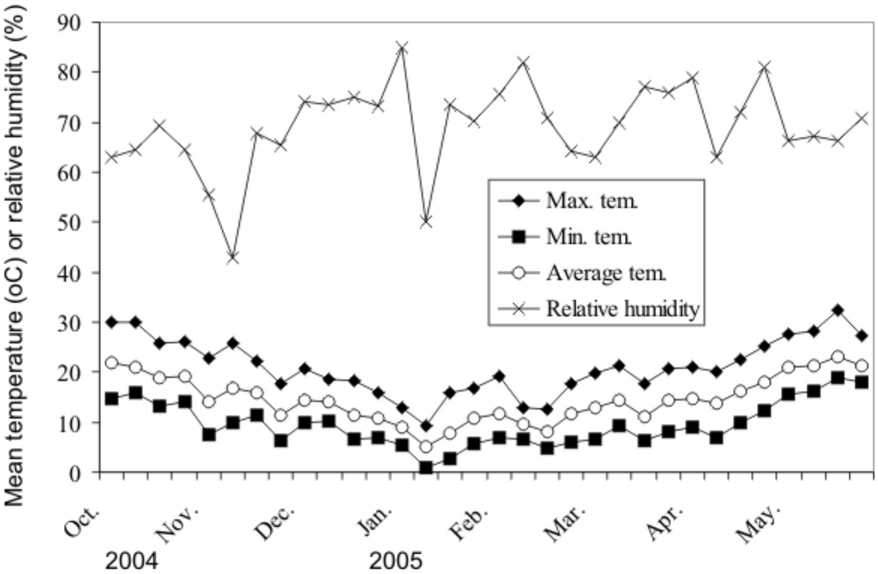

Figure 1. Average, maximum and minimum temperature and relative humidity, October 2014-May 2015 at Balcalı, Adana, Turkey.

Table 3. Duration of preoviposition, oviposition and postoviposition of *Orius niger* females and fecundity under outdoor conditions

Experiment date	*n*	[a]Preoviposition time (day)	Oviposition time (day)	Postoviposition time (day)	Eggs laid (egg/female)
13 October	9	4.33±0.33 c (4-6)[b]	30.33±4.45a (14-48)	7.44±1.66 a (2-18)	58.22±9.14 b (34-109)
3 November	9	9.33±0.76 b (5-12)	28.60±8.31a (4-87)	10.22±4.62 a (2-37)	27.55±9.11 c (8-95)
3 December	9	11.71±1.65 b (7-19)	11.85±3.26b (2-29)	5.28±1.30 b (2-12)	7.71±1.62 e (2-12)
5 January	10	19.25±3.83 a (8-21)	18.50±8.42b (3-35)	4.25±1.03 b (2-14)	18.50±7.18 d (4-36)
2 February	10	13.35±1.21 ab (5-16)	18.50±3.61b (5-32)	4.16±0.74 b (3-6)	15.16±2.41 de (9-26)
9 March	9	7.42±1.63 b (2-14)	25.75±7.56a (3-59)	4.57±0.81 b (2-7)	48.83±12.63 b (22-115)
20 April	7	8.42±1.46 b (4-16)	28.71±4.08a (13-41)	3.42±0.48 b (2-5)	83.85±15.60 a (35-135)

[a] means with same letter in the same column are not statistically significant according to Tukey's HSD test (P < 0.05); [b] parenthesis indicates minimum and maximum values.

Eggs numbers were significantly greater, with mean of 83.65±15.60 eggs/female, in the April experiment ($F_{(6,42)}$ = 6.557, P < 0.0001). Mean numbers of eggs laid by females for first 10 days in October and April were similar at 23.3 and 21.30 eggs/female, respectively, but these numbers were significant different from those in the other experiments ($F_{(6,63)}$ = 9.247, P < 0.0001). Mean numbers of eggs laid by female for first 10 days in the January experiment was 3.10 eggs/female (Table 4). In April, females laid significantly more eggs (50.20 eggs) in 11-30 day period ($F_{(6,63)}$ = 13.792, P < 0.0001). Mean numbers of eggs laid for more than 31 days were similar, excluding the December experiment, and less even in the October and April experiments. All females laid eggs in first 10 days and 11-30 days in the October and April experiments, respectively. Forty percent of females tested in January and February laid eggs in first 10 days. Only one female oviposited for 31 days (Table 4). Thirty percent of females in December, 40% in January and 25% February did not lay egg. In the other experiments, all females oviposited.

Table 4. Fecundity of *Orius niger* females under outdoor conditions

Experiment date	[a]Mean numbers of eggs laid according to day intervals (egg/female)			Rate of ovipositing females (%) according to day intervals		
	0-10	11-30	>31	0-10	11-30	>31
13 October	23.30 ±5.18 a	25.0 ±4.56 b	6.00 ±2.96 a	100	100	30
3 November	11.40 ± 2.23 b	6.00 ±2.04 c	8.6 0±5.98 a	90	60	40
3 December	3.90 ± 1.43 c	1.50 ±0.96 c	-	70	30	0
5 January	3.10 ± 1.36 c	3.20 ±2.15 c	1.10 ±1.10 b	40	20	10
2 February	4.80 ± 1.94 c	3.80 ±2.04 c	0.50 ±0.50 b	40	40	10
9 March	9.10 ± 2.16 b	14.20 ±6.34 b	8.00 ±5.17 a	90	60	30
20 April	21.30 ±2.78 a	50.20 ±9.12 a	9.10 ±5.35 a	100	100	40

[a] means with same letter in the same column are not statistically significant according to Tukey's HSD test (P < 0.005).

Longevity

Female longevity was nearly 45 days in April but was significantly longer at 55 days in November ($F_{(6,54)}$ = 4.677, P < 0.0001; Table 5). Only one female survived for nearly 100 days in the November experiment. Some females from the November experiment lived for 2 months or slightly longer. Mean longevity of females of December, January and February were less than 30 days. Female life spans in March and April lasted slightly over 30 days (March 34.50±7.38 days; April 44.74±4.21 days). Mean longevity of the males in all experimental months were shorter than those found for females (Table 5). Males assessed in the October and November experiments survived for 30.62±8.82 and 39.44±6.16 days, respectively. Mean longevity of males in December and February were similar, and these males lived for 21 days. Longevity of males approached to nearly 30 days in March and April.

Table 5. Longevity of *Orius niger* adults under outdoor conditions

Experiment date	[a]Longevity (day)					
	Female			Male		
	Mean±SEM	Max.	Min.	Mean±SEM	Max.	Min.
13 October	39.77±5.19 b	56	18	30.62±8.82 a	46	13
3 November	55.00±0.10 a	98	16	39.44±6.16 a	67	9
3 December	28.50±4.44 c	56	14	21.80±3.65 a	38	10
5 January	25.20±6.67 c	61	6	21.00±3.55 a	41	6
2 February	20.25±4.62 c	39	3	21.12±5.79 a	51	4
9 March	34.50±7.38 b	57	6	27.00±7.98 a	57	16
20 April	44.74±4.21 b	63	30	29.71±9.52 a	50	4

[a] means with same letter in the same column are not statistically significant according to Tukey’s HSD test ($P < 0.005$).

Discussion

Winter in Southeastern Mediterranean region of Turkey is mild and rainy. All eggs laid by the females easily hatched during the outdoor experiments. Low rate of nymphs (nearly 20%) survival was recorded in the winter (December-February). Durations of nymph development were nearly 20 days in autumn (October) and spring time but increased up to 30 days or slightly over 30 days in the winter. Mean temperature in October ranged from 19 to 22ºC, and 13 to 18ºC in April but varied between 5 to 13ºC in the winter (Figure 1). Duration of total nymph development of *O. niger*, when temperature increased to over 20ºC under the controlled conditions, were less than 20 days. For example, Tommasini & Nicoli (1996) reported that total duration of nymph development of *O. niger* provided with eggs of *E. kuehniella* and *F. occidentalis* as food were 12.9 and 11 days, respectively, at 26°C and 80±5% RH. Duration of total nymphal stage ranged from 16 to 18.8 days when nymphs of *O. niger* were exposed to 26ºC and to various day lengths (9-16 h) (Bahşi & Tunç, 2008). However, duration of nymphal instars of *O. niger* provided with nymphs of *Bemisia tabaci* and *Tetranychus cinnabarinus* was 21.5 and 21.8 days, respectively, under the laboratory conditions with 25±1ºC and 65±10% RH (Efe & Çakmak, 2013).

Nymphal mortality was particularly higher in the winter and only 28% nymphs of a total 189 nymphs matured to adults. Similarly, Chyzik et al. (1995) found that survival rate of nymphs of *Orius albidipennis* (Reuter, 1884) in the winter in Israel was less than 20%. Females of *O. niger* were found throughout autumn to spring in faba bean (*Vicia faba* L.) fields in the Adana Region, but no *Orius* nymph were detected on faba bean, other arable crops and wild plants until the first week of March (Atakan, 2010). This indicates that mortality rates of the early nymphs were high. Our findings are in accord with results of *O. albidipennis* in Irak (El-Serwiy et al., 1985) and *O. laevigatus* in Egypt (Tawfik & Ata, 1973). *Orius* adults survived in the winter in some regions of Israel, but no nymphs were detected until the end of March on mango blossoms (Ben-Dov et al., 1992).

High numbers of eggs were laid in the experiments conducted in October and April. Females oviposited fewer eggs through the winter months. The rate of non-reproductive females was 40% in January and February. In Israel, most adult females laid eggs in the outdoor experiments conducted in October and April, but some females did not lay eggs and died (Chyzik et al., 1995). In our study, females in the October experiment oviposited and laid fewer eggs for two months. Also, one female from the November experiment oviposited for another 2 months. We suggest that the reason why some females did not lay eggs in the winter may be due to their lack of tolerance to low temperatures, and they might have not mated.

In current study, the day length did not induce diapause in *O niger*. Chyzik et al. (1995) found that both females and males of *O. albidipennis* at the low mean temperature (below 15ºC) are active and feed on moth eggs but females do not lay eggs. Bahşi & Tunç (2008) concluded that 9-13 h day length do not induce diapause and did not affect the development of *O. niger*. They suggested that *O. niger* could survive and reproduce under the winter conditions in heated greenhouses. According to data obtained in current study, *O. niger* from Turkey might be useful for controlling *F. occidentalis* under protected conditions in southern Europe and Mediterranean regions. However, It is known that some species of *Orius* show obligatory and facultative diapause, and diapause is induced by low temperature and short day length (Iglinsky & Rainwater, 1950; Gillespie & Quiring, 1993; Ramakers & van den Meiracker, 1991).

In the current study, life spans of females in autumn and winter were less than 30 days and thus they did not survive till spring. Oviposition time of females in winter was less than 20 days. In Israel, mean longevity of *O. albidipennis* from November and December experiments were significantly longer (84.2 and 125.2 days, respectively) (Chyzik et al., 1995), and females started to oviposit again at the end March. Differences between the two studies may be related to different climatic conditions and different species of *Orius*. *Orius niger* does not build up efficient outdoor population in winter and early spring time in the region because of short-lived females and males, low reproductive rates of females and high mortality rates of nymphs. Thus, it will not be possible to control outdoor winter and spring populations of small insects, including *F. occidentalis,* in the region.

Orius niger has effectively controlled flower thrips population in cotton flowers in the region (Atakan & Gencer, 2008) and this predatory bug is more common in the Mediterranean region. Based upon some results of current study, *O. niger* could be employed as a biological control agent in IPM studies on pest thrips. Populations of *F. occidentalis* increase dramatically in spring in greenhouses and outdoors when many crops are flowering, requiring applications of pesticides. However, the present results suggest that densities of *O. niger,* even in the early spring, are still not high. *Orius niger* oviposit again in mid-March, and nymph populations appear on faba bean plants in late March (Atakan, 2010). Nymphs will become adults in mid-April. The predatory effect of the April population will be seen in May.

Finally, mortality rates of *O. niger* nymphs were high in winter to early spring. Additionally, most of the experimental females coming from the autumn and winter months were not able to survive till spring to produce nymphs. Therefore, *O. niger* might not be unable to control pest insects in the early vegetative period under open field conditions. For this reason, further studies in Turkey should focus on efforts to augment winter to early spring populations of this predator emphasizing earlier control of *F. occidentalis*. Diapause does not occur in the *O. niger* under short day length. *Orius niger* should be evaluated for control of *F. occidentalis* in greenhouses in Turkey. However, the reproductive rate of *O. niger* under laboratory conditions is lower than that of *O. laevigatus* (Tommasini et al, 2004), which is commercially used to control pest thrips in greenhouses in Turkey. Further studies are needed on rearing conditions for *O. niger* under laboratory conditions to enhance its mass production for release against pest thrips (mainly *F. occidentalis*).

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