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The effect of different temperatures and food densities on development of *Blattisocius tarsalis* (Berlese) (Acari: Ascidae) reared on Mediterranean flour moth *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae)*

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Summary

Blattisocius tarsalis (Berlese) (Acari: Ascidae) is an effective predatory mite species on eggs of Mediterranean flour moth ***Ephestia kuehniella*** Zeller (Lepidoptera: Pyralidae). Mediterranean flour moth is an important pest of flour storages and mills in Turkey. The aim of this paper is to investigate the possibilities for the use of ***B. tarsalis*** as a biological control agent to control moth. The effect of different temperatures (15±1 °C and 25±1 °C) on development time of ***B. tarsalis*** at different food density levels (5, 10, 15 and 20 eggs densities) has been investigated. For 15 °C; the development times of immature stages were 5,53 (1-6); 4,86 (3-5); 4,53 (0-5) and 4,86 (1-6) days while adults life span were determined 52,00 (3-67); 42,77 (5-67); 29,85 (1-66) and 27,36 (7-39) days for 5, 10, 15 and 20 moth egg densities. For 25 °C the development times of immature stages were 5,00 (5-5) days at 10 prey eggs and 6,00 (6-6) days at the rest of prey densities, beside this life span of adults were determined 32,00 (20-39); 30,67 (15-40); 42,20 (10-64) and 38,67 (4-69) days at each food densities consequently.

Fecundity and the consumption capacity of predatory mites have been carried out for each temperatures at different food densities. The duration of preovipositon, oviposition and postoviposition periods of ***B. tarsalis*** were also determined.

The highest consumption of immature stages were determined (13,27 individuals/for development time) for 20 moth egg densities at 15 °C, this value was observed at 10 moth

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egg densities for adults (172,8 individuals/duration of adult life span). The highest consumption of immature stages were determined (34,20 individuals /for development time) for 20 moth egg densities while this value was observed at 20 moth egg densities for adults (555,1 individuals /duration of adult life span) at 25 °C.

Key words: ***Blattisocius tarsalis***, ***Ephestia kuehniella***, Biological control**,** Predatory mite

Anahtar sözcükler: ***Blattisocius tarsalis***, ***Ephestia kuehniella***, Biyolojik kontrol, Avcı akar

Introduction

Ephestia kuehniella (Zeller) (Lepidoptera: Pyralidae) (Mediterranean flour moth) is the most abundant and primary pest species of cereals, flour, mills and other stored products. This moth causes 10 % of crop losses in Turkey (Esin, 1990; Çobanoğlu, 2002; Coşkuncu & Kovancı, 2005).

The protection of storage pests is mainly based on the use of traditional pesticides and residual insecticides. Among these the most preferred chemicals are phosphine and methyl bromide. Due to Montreal protocol, the using of methyl bromide will be banned completely in Turkey at 2007. The possibilities of methyl bromide alternatives have been investigated and biological control is considered as good alternatives for Mediterranean flour moth. The predatory mite ***Blattisocius tarsalis*** (Berlese) (Acari: Ascidae) is a common predatory mite of moth eggs in storages (Hughes, 1976; Haines, 1981; Hansen & Nielsen, 2001). However, many studies are known related to the biology of this predatory mite in the world (Haines, 1981; Hansen, 1998; Nielsen, 1998, 1999, 2001; Hansen & Nielsen, 2001). There was no information on the biology of this mite in Turkey.

We choose ***B. tarsalis*** because this predatory mite is very common in storages of Turkey (Özer et al., 1989; Çobanoğlu, 1996). The potential of ***B. tarsalis*** against Mediterranean flour moth has not been tested previously in Turkey. The goal of this study was to determine the reproductive potential, consumption capacity, developmental time of immatures and adult longevity of ***B. tarsalis*** on different prey egg densities.

Material and Methods

The predators were reared on the 1–3 day-old eggs of ***E. kuehniella***. ***B. tarsalis*** and ***E. kuehniella*** were reared at laboratory condition (15–25 °C, 65 % Rh and 16 h photoperiod) at University of Ankara during the years of 2003–2005 (Özkan, 1999).

The development time of the immature and adult longevity, consumption capasity, daily and total egg laying capacity, the duration of preoviposition, oviposition and postoviposition periods of the predatory mite were carried out on different prey egg densities (5, 10, 15, 20) at 15 °C and 25 °C temperatures and 65 % relative humidity. All the experiments were started with 15 individuals (one day-old eggs) and examined daily interval. Eggs hatching values were derived from 100 eggs. Ten replicates were used for each experiment. All the treatments related to development time of immatures, adult longevity, consumption capacity (prey eggs/individual), daily and total egg laying capacity, were initiated with 15 replicates but the ones which die or got escaped are deducted from this number. These values were obtained from average 11-15 members and indicated in each related result as (n) on the Table 1.

The obtained data were evaluated with Kruskal-Wallis tests (for the detection of different groups).

Results and Discussion

The data obtained from different temperatures (15-25 °C; 65 % Rh) were shown on Table 1.

At 15 °C; the longest average development time of immature stages was 5,53 while the the shortest was 4,53 days depending on the food densities (Figure 1). The highest consumption capacity of immature was 13,27 while the lowest was 7,14 number of prey eggs (Figure 2). Average life spans of adults were determined as 52,00; 42,77; 29,85 and 27,36 days for increasing food densities (Figure 3). The highest average consumption capacity of adult was 172,8 at 10 prey eggs while the lowest was 75,7 at 20 prey eggs (Figure 4). Daily consumption capacity for the adults ranges 1 to 10 prey eggs depending on the food densities. The shortest average duration of preoviposition period was 1,53 days at 5 food density, while the longest was 3,15 at 10 prey density (Figure 5). The longest average duration of oviposition period was 7,00 days at 5 prey eggs while the shortest was 1,38 at 10 and 15 food densities (Figure 6). The longest postoviposition period was 10,64 days at 20 food densities while the shortest was 5,69 at 15 prey egg density (Figure 7). Total egg laying capacity of female during the life span was significantly decreased depending on the prey densities as 8,77; 2,38; 2,46 and 7,09 for each prey density (5, 10, 15 and 20 prey eggs) (Figure 8).

At 15 °C development time of the immatures from egg to adult varied (4 to 5 days) for different prey density level (5, 10, 15, 20) ($p>0,01$). ***B. tarsalis*** had the shortest development time at 15 food density. Adult longevity was important for the different food density ($p>0,05$). The shortest life span was observed at 20 food density (27,36 days) while the longest life span was observed at 5 food density (52,00 days). Egg laying capacity was negatively correlated with the food density ($p>0,05$).The highest egg laying capacity was observed at 5 food density (8,77), while the lowest egg laying capacity was occurred 10 eggs served as food (2,38). Predation capacity of immatures was important for food densities ($p>0,01$). The lowest predation capacity of immatures was observed at 15 food density (7,14 eggs/individual), while the highest one observed at 20 prey eggs (13,27 eggs/individual). For adults, the lowest daily predation capacity was observed at 20 prey density (75,7 eggs/ adult), while the highest one observed at 10 prey eggs (172,8 eggs/ adult) ($p>0,05$) (Figure 4, Table 1).

Table 1. The development time, egg laying and consumption capasity of ***Blattisocius tarsalis*** (Berlese) at different temperature (15 ºC, 25 ºC, 65 %) and different egg density levels of ***Ephestia kuehiella*** Zeller (5, 10, 15, 20)

Temperature	Prey density			
15ºC	5	10	15	20
Development time of immature stages (days)	5,53± 1,35 (1-6) (n=15)	4,86 ± 0,51 (3-5) (n=15)	4,53 ± 1,35 (0-5) (n=15)	4,86 ± 2,06 (1-6) (n=15)
Consumption capacity of immatures (prey eggs/individual)	9,53±2,90 (1-13) (n=15)	8,20± 1,42 (4-10) (n=15)	7,14± 1,51 (4-10) (n=14)	13,27±6,32 (1-18) (n=15)
Adult longevity (days)	52,00± 24,51 (3-67)(n=14)	42,77± 26,24 (5-67)(n=13)	29,85± 24,69 (1-66)(n=13)	27,36±13,96 (7-39)(n=11)
Consumption capacity of adults (prey eggs/individual)	131,4±72,9 (2-197)(n=14)	172,8±102,9 (17-288) (n=13)	147,4± 113,2 (2-308)(n=13)	75,7±39,3 (13-133)(n=11)
Daily consumption capacity of adults	min.1-max.5	min.2-max.8	min.2-max.10	min.1-max.7
Duration preoviposition period (days)	1,53± 2,40 (0-5)(n=13)	3,15± 7,21 (0-25)(n=13)	2,17±5,13 (0-15)(n=12)	1,81± 2,52 (0-5)(n=11)
Duration oviposition period (days)	7,00± 12,99 (0-40)(n=13)	1,38± 4,13 (0-15)(n=13)	1,38± 3,47 (0-11)(n=13)	2,91± 4,35 (0-11)(n=11)
Duration postoviposition period (days)	9,92± 17,01 (0-49)(n= 13)	7,62±15,88 (0-49)(n=13)	5,69±13,89 (0-37)(n=13)	10,64±14,87 (0-33)(n=11)
Egg laying capacity of adult	8,77±15,52 (0-46)(n=13)	2,38±7,44 (0-27)(n=13)	2,46±6,02 (0-17)(n= 13)	7,09±10,14 (0-26)(n=11)
25 ºC				
Development time of immature stages (days)	6,00±0,00 (6-6)(n:15)	5,00± 0,00 (5-5)(n:15)	6,00±0,00 (6-6)(n:15)	6,00± 0,00 (6-6)(n:15)
Consumption capacity of immatures (prey eggs/individual)	16,73± 1,43 (14-19)(n=15)	14,26± 1,03 (3-15)(n=15)	30,20±2,70 (26-37) (n=15)	34,20± 2,27 (32-38) (n=15)
Adult longevity (days)	32,00± 5,90 (20-39)(n=15)	30,67± 7,58 (15-40)(n=15)	42,20± 18,82 (10-64)(n=15)	38,67± 23,10 (4-69)(n=15)
Consumption capacity of the adults (prey eggs/individual)	148,07± 29,17 (93-179)(n=15)	244,7± 67,6 (108-330) (n=15)	491,9± 234,4 (134-762) (n=15)	555,1±327,6 (49-976)(n=15)
Daily consumption capacity of the adults	min.3-max.5	min.3-max10	min.5-max.14	min.7-max.19
Duration of preoviposition period (days)	6,13± 1,99 (5-12)(n=15)	6,73±2,57 (0-11) (n=15)	8,27± 8,40 (0-30) (n=15)	3,67±5,37 (0-11) (n=15)
Duration of oviposition period (days)	10,53± 7,83 (1-18)(n=15)	7,80± 5,95 (0-22) (n=15)	4,33± 6,02 (0-17) (n=15)	2,20± 3,70 (0-10) (n=15)
Duration of postoviposition period (days)	22,13± 6,95 (10-30) (n=15)	23,20 ± 7,73 (0-32) (n=15)	28,27±24,46 (0-55) (n=15)	16,73± 24,57 (0-56) (n=15)
Egg laying capacity of female	26,60±21,19 (5-70) (n=15)	25,53± 19,94 (0-81) (n=15)	11,93± 7,71 (0-52) (n=15)	7,07±11,87 (0-37) (n=15)

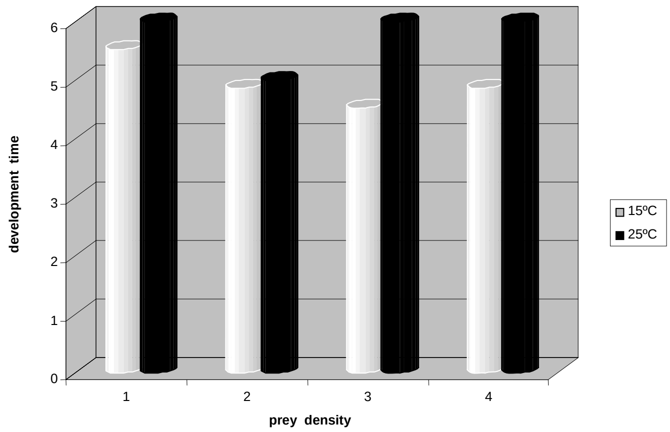

Figure 1. Development time of immature stages of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food levels of 5, 10, 15 and 20, respectively).

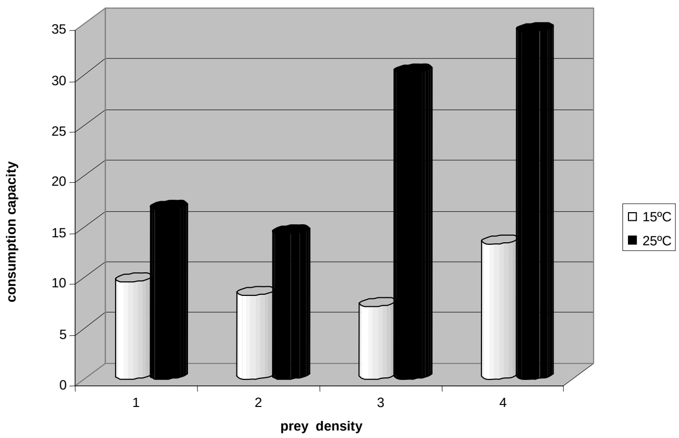

Figure 2. Consumption capasity of immature stages of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20, respectively).

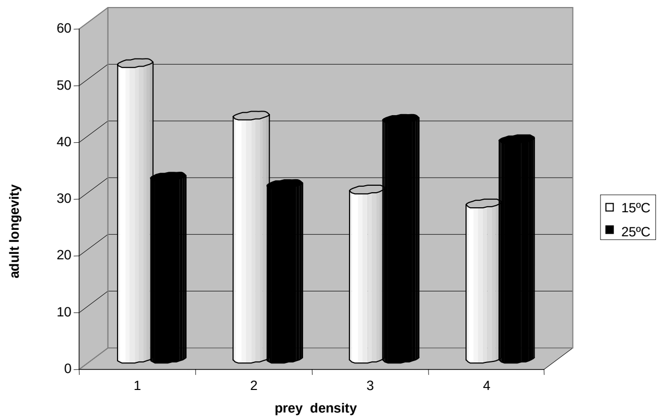

Figure 3. Adult longevity of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuenhiella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20, respectively).

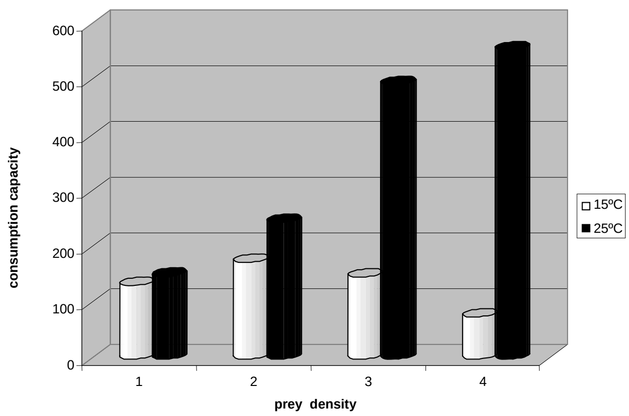

Figure 4. Consumption capacity of the adults of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20, respectively).

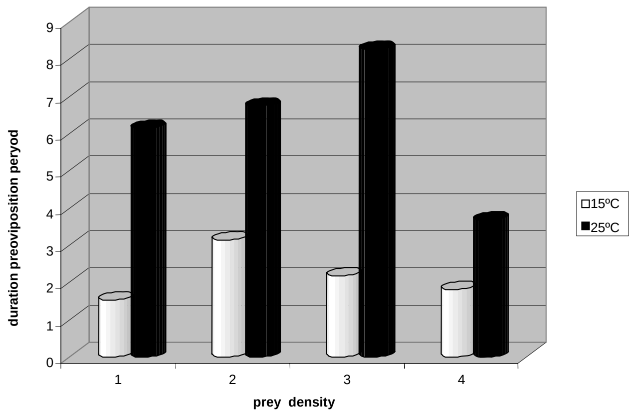

Figure 5. Duration preoviposition period of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20, respectively).

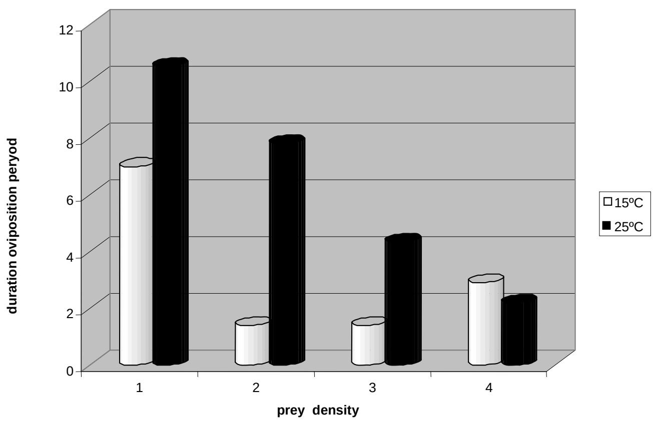

Figure 6. Duration of oviposition period of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different prey density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20, respectively).

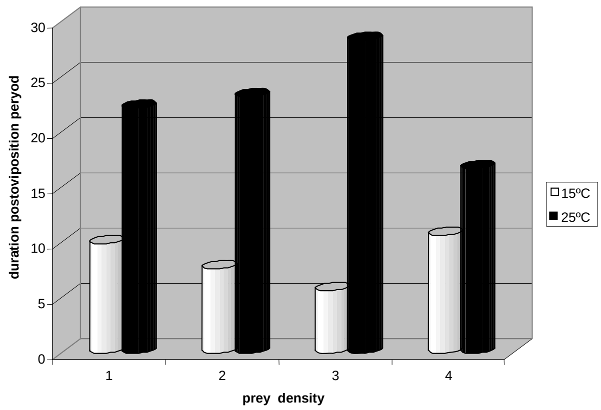

Figure 7. Duration of postoviposition period of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different prey density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20 respectively).

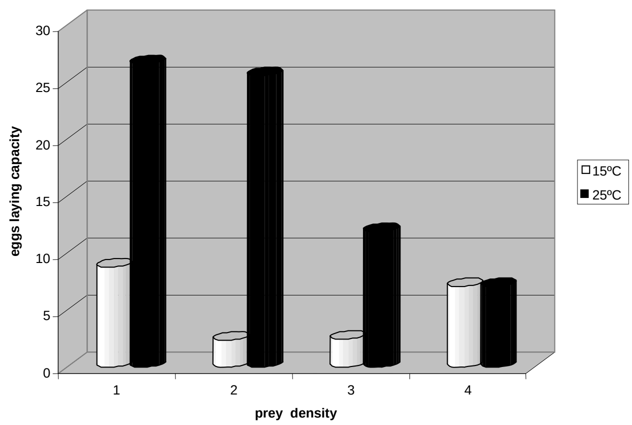

Figure 8. Egg laying capacity of female of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15 and 20, respectively).

At 25 °C, the average development time of immature stages were examined 6,00; 5,00; 6,00 and 6,00 days respectively for 5, 10, 15 and 20 food density (Figure 1). Predation capacity of immatures were 16,73; 14,26; 30,20 and 34,20 number of eggs for each prey density ($p<0,01$) (Figure 2). Average life span of adults were examined as 32,00; 30,67; 42,20 and 38,67 days at different food densities (Figure 3). Average predation capacity of the adults was 148,07; 244,7; 491,9 and 555,1 number of eggs for each food density level (Figure 4). Daily predation capacity for the adults ranges 3 to 5 for 5 prey eggs while this values were ranged 3 to 10; 5 to 14 and 7 to 19 for different prey densities, respectively (10,15 and 20 prey densities). Average preoviposition periods were 6,13; 6,73; 8,27 and 3,67 days for each food density, respectively (Figure 5). Average oviposition periods were 10,53; 7,80; 4,33 and 2,20 days, respectively (Figure 6). Duration of postoviposition periods were 22,13; 23,20; 28,27 and 16,73 days for each food density, (Figure 7). Average egg laying capacity of female during the life span were determined as 26,6; 25,53; 11,93 and 7,07 number of eggs for each prey density (Figure 8).

At 25 °C, the development time of the immatures from egg to adult is about 5 to 6 days for most combinations of predatory mite and different prey egg densities (5, 10, 15, 20) ($p<0,01$). ***B. tarsalis*** had the shortest development time at 10 prey density level (5 days). For adult longevity the shortest life span was observed at 10 food density (30,67 days). There was no significant difference for adult longevity depending on the prey densities ($p>0,05$). The highest egg laying capacity was 26,60 (egg/female) for 5 food density level while the lowest was 7,07 (egg/female) for 20 prey density ($p<0,01$). Food consumption capacity of immatures was important for prey densities ($p<0,01$). The lowest food predation capacity of immatures was observed at 10 food density level (14,26 number of eggs), while the highest one observed at 20 prey eggs (34,2 prey eggs).The consumption capacity of the adult was important for the food densities ($p<0,01$).The observed lowest consumption capasity was 148,06 (prey eggs) at 5 food density while the highest one observed at 20 prey density (555,1 prey eggs). The duration of oviposition period was important for the food levels ($p<0,01$). The longest oviposition period was 10,53 days (5 prey density) while the shortest one 2,20 days (20 food density) (Table 1).

The development time of the immatures were not significantly changed depending on the temperatures ($p>0,05$). The longest development time of the immatures was 6,00 days at 25 °C (Figure 1). The adult longevities were significantly changed by temperatures and prey densities ($p<0,01$). The longest life span was observed at 15 °C and 5 food density (52,00 days). The shortest longevity was observed at 15 °C and 20 food density (27,36 days) (Figure 3). Consumption capacity of immatures were important for temperatures ($p<0,01$). The highest consumption capacity of immatures were observed at 25 °C and 20 food density (34,2 individual) while the lowest predation capacity was observed at 15 °C and 15 food density (7,143) (Figure 2). Consumption capacity of adults changed significantly depending on temperatures ($p<0,01$). The highest consumption capacity of adults were observed at 25 °C and 20 food density (555,1 individual). The lowest one observed at 15 °C and 20 food density (75,70 eggs) (Figure 4). Egg laying capacity was significantly changed depending on the prey densities and temperatures ($p<0,01$). The highest egg laying capacity was observed at 25 °C and 5 food density (26,60 eggs) while the lowest egg laying capacity was observed at 15 °C and 10 food density (2,38 eggs) (Figure 8). Preoviposition periods were also changed in relation to temperatures ($p<0,01$). The longest preoviposition periods were observed at 25 °C and 15 food density (8,27days) while the shortest one was observed at 15 °C and 5 prey density (1,53 days) (Figure 5). Temperature and prey density affected oviposition periods ($p<0,05$). The longest value was obtained at 25 °C and 5 food density (10,53 days) while the shortest values were at 15 °C, 10 and 15 food densities (1,38 days) (Figure 6). Postoviposition period is important for temperatures ($p<0,05$) and the longest value was obtained at 25 °C and 15 food density (28,27 days) while the shortest values were at 15 °C and 15 food density (5,69 days) (Figure 7). The highest egg laying capacity was observed at 25 °C and 5 food density level (26, 60 eggs) while the lowest was observed at 15 °C and 10 food density (2,38 eggs) (Figure 8). The maximum egg laying was at 25 °C and 10 food density (81 eggs/per female).

The overall sex ratio of the progeny was female biased at 25 °C (70 % female) and male biased at 15 °C (10,9 % female) (Figure 9, 10).

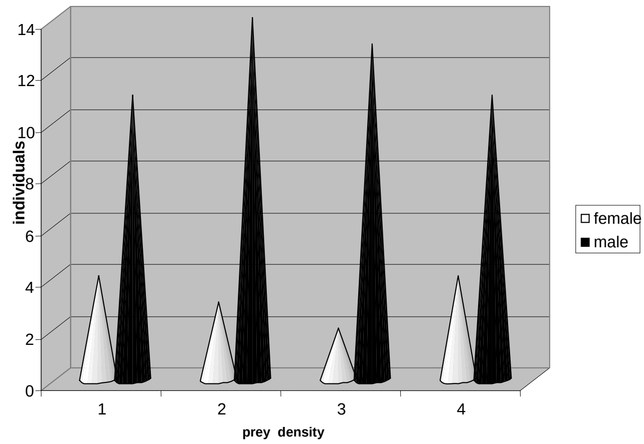

Figure 9. The overall sex ratio of ***Blattisocius tarsalis*** (Berlese) at 15 °C and different prey density of ***Ephestia kuehniella*** Zeller (5, 10, 15, 20).

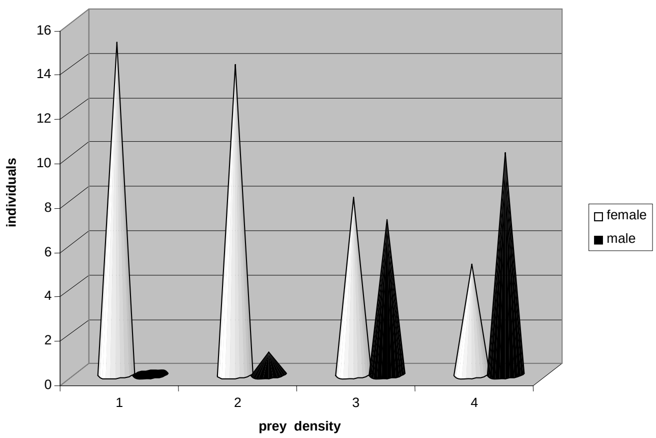

Figure 10. The overall sex ratio of ***Blattisocius tarsalis*** (Berlese) at 25 °C and different food density of ***Ephestia kuehniella*** Zeller (5, 10, 15, 20).

B. tarsalis is commonly occurs in stored products of Turkey. It was effective predatory species in cereal and dried apricot storages on small insects and their eggs in Izmir and Edirne region of Turkey (Özer et al.,1989; Çobanoğlu, 1996; 2002; Kılıç & Toros, 2000). Their adults have phoretic life cycles. We easily collected the adults of mites from Mediterranean flour moth ***E. kuehniella***.

B. tarsalis is very common predatory mite species and found on the larvae and pupae of the Greater wax moth ***Galleria mellonella*** (L.) (Lepidoptera: Pyralidae) in beehive; it was also reported from honey bee hives in Canada and effective predator on various moths and beetles of stored products in North America. ***B. tarsalis*** could control the Mediterranean flour moth populations in specific conditions (depth of grain); the mites consumed the insect eggs and were phoretic upon the adult moths. The longest mite life span was from egg to egg was 57,53 days at 15 °C and 5 food density while this value was 48,20 at 25 °C and 15 food density. The shortest longevity was (from egg to egg) 32, 22 days at 15 °C and 20 food densities while this value was 35,67 at 25 °C and 10 food density (Figure 11). The consumption rate of ***B. tarsalis*** was changed depending on the food density. The highest consumption ratio was obtained for the highest prey density (20 food density) at 25 °C (Figure 12). The fully number of ingested eggs changed between 0.5 and 1.0 egg in 24 h at 13–19 °C while the mean was above 1.0 egg in 24 h at temperatures of 21–27 °C The mean number of destroyed eggs ranged from three to five eggs per day per female at temperatures above 13 °C (Nielsen, 1999).

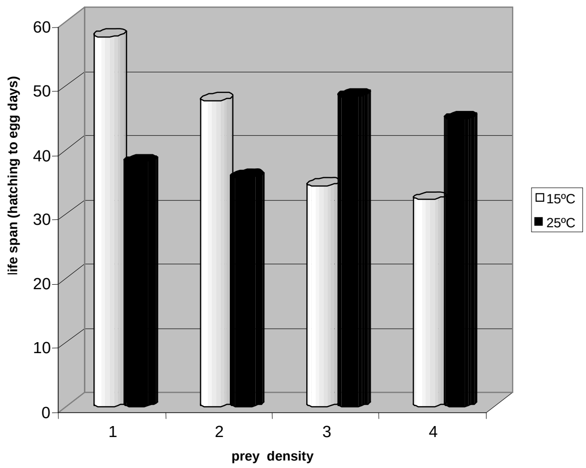

Figure 11. Duration of life span (hatching to egg) of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different prey density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food density of 5, 10, 15, 20).

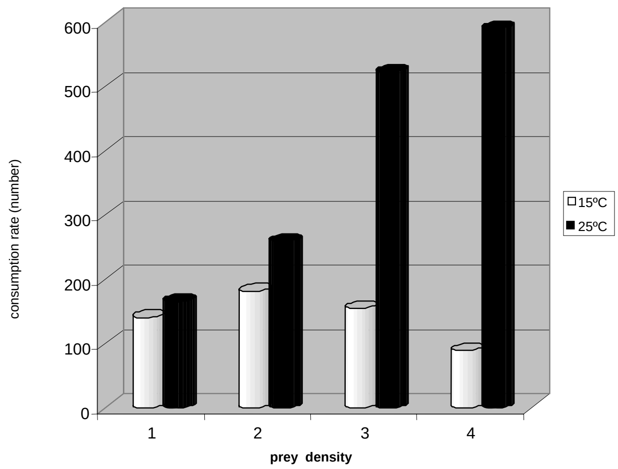

Figure 12. Consumption rate of ***Blattisocius tarsalis*** (Berlese) at different temperatures and different food density of ***Ephestia kuehniella*** Zeller (1, 2, 3 and 4 indicates the food levels of 5, 10, 15, 20).

E. kuehniella is very common pest in storages and mills of Turkey. There are very limited numbers of studies available on the relationship between predatory mite and pest species in storages of Turkey. The only available data is about on the predatory mite ***Cheyletus eruditus*** (Schrank) (Acari: Cheyletidae) and harmful mite species ***Acarus siro*** (Acarina: Acaridae) (Emekçi & Toros, 1994). Biological paraemeters of ***B. tarsalis*** on Mediterranean flour moth ***E. kuehniella*** is not studied previously; there was no information on the biology and the biological control potential of this agent on Mediterranean flour moth in Turkey (Özer et al., 1989; Çobanoğlu, 1996).

B. tarsalis is a common predatory mite on moth eggs (***Ephestia*** spp., ***Sitotroga*** spp. and ***Plodia*** spp.) and cosmopolit species in storages of Europe and all over the world (Hughes, 1976; Haines, 1981). ***B. tarsalis*** is predator on the eggs and larvae of insects of stored grains and reported feeding on the eggs and capable of regulating size of Mediterranean flour moth population in Germany, the life cycle of the mite from egg to egg was ten days and life span of the adult has also the same duration at 27 °C (Flanders & Badgley, 1963; Treat, 1975). Darst & King (1969), mentioned that ***B. tarsalis*** predator on the eggs and larvae of Indian meal moth ***Plodia interpunctella*** (Hübner) (Lep.: Pyralidae) and they found that the life cycle from egg to egg was between eight and nine days. Many studies is known related to the biology of this predatory mite in the world (Haines, 1981; Hansen, 1998; Hansen & Nielsen, 2001; Nielsen, 1998, 1999, 2001). ***B. tarsalis*** could control successfully to Mediterranean flour moth and considered good alternatives of methyl bromide in Denmark (Nielsen, 2001; Hansen & Nielsen, 2001). These data confirm that our data.

As a conclusion, ***B. tarsalis*** is very common predatory mite species in storages and an effective is predatory mite on the eggs of Mediterranean flour moth ***E. kuehniella*** in Turkey. ***B. tarsalis*** consumed the Mediterranean flour moth eggs and was phoretic on the adult moths; their offspring emerged for each temperature (15-25 °C). The highest egg laying capacity was obtained at 25 °C, 5 and 10 food densities while the highest predation rate was obtained at the same temperature at 20 food densities. The optimum condition for the development of ***B. tarsalis*** was 25 °C and 15 and 20 food densities. 25 °C is more suitable temperature for the development, egg laying and consumption capacity of this predatory mite.

Özet

Avcı akar *Blattisocius tarsalis* **(Berlese) (Acari: Ascidae)'in farklı sıcaklık ve av yoğunluğunda depo zararlısı** *Ephestia kuehniella* **Zeller (Lepidoptera: Pyrallidae) üzerinde avlanma kapasitesi ve biyolojik özelliklerinin saptanması üzerine araştırmalar**

Ephestia kuehniella Zeller (Lepidoptera: Pyralidae) ülkemizde depo ve değirmenlerde bulunan tahılların, unların ve diğer depolanmış ürünlerin önemli bir zararlısıdır. ***Blattisocius tarsalis*** (Berlese) (Acari: Ascidae) ise bu zararlı güvenin yumurtaları ile beslenen etkili bir predatör akardır. Bu çalışma sonucunda ***B. Tarsalis***'in un güvesi ile biyolojik mücadele programı içerisinde kullanılabileceği ortaya konmuştur. Farklı sıcaklık ve besin yoğunluklarında ***B. tarsalis*** gelişim dönemleri bulunmuştur. 15 °C için ergin öncesi dönem gelişim süresi 5, 10, 15 ve 20 besin yoğunluklarında 5.53 (1-6), 4.86 (3-5), 4.53 (0-5) ve 4.86 (1-6) gün, ergin yaşam süresi ise 52,00 (3-67), 42,77 (5-67), 29,85 (1-66) ve 27,36 (7-39) gün olarak tespit edilmiştir. 25 °C için ergin öncesi dönem gelişimi 6.00 (6-6), 5.00 (5-5), 6.00 (6- 6) ve 6,00 (6-6) gün, ergin yaşam süresi ise 32,00 (20-39), 30,67 (15-40), 42,20 (10-64) ve 38,67 (4-69) gün olarak aynı besin yoğunluklarında tespit edilmiştir.

Üreme ve tüketim kapasiteleri her sıcaklık ve besin yoğunlukları için ortaya konmuştur. 15 °C'de üreme kapasitesi (5, 10, 15 ve 20 besin yoğunluklarında) 8,77; 2.38; 2,46 ve 7,09'dur. Söz konusu değerler 25 °C'de ise 26,60; 25,53; 11,93 ve 7,07 olarak saptanmıştır. Ayrıca ***B.tarsalis***'in preovipozisyon, ovipozisyon ve postovipozisyon süreleri belirlenmiştir. Yapılan bu çalışmada 15 °C'de ergin öncesi dönemde en yüksek tüketim 20 besin yoğunluğunda (13,27 birey/gelişim süresi), ergin dönem için 10 besin yoğunluğunda (172,8 birey/gelişim süresi) olarak bulunmuştur. 25 °C de ergin öncesi dönemde en yüksek tüketim 20 besin yoğunluğunda (34,20 birey/gelişim süresi), ergin dönem için 20 besin yoğunluğunda (555,1 birey/gelişim süresi) olarak bulunmuştur.

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