Türk. biyo. müc. derg., 2013, 4 (1): 3-9
ISSN 2146-0035 ***Orijinal araştırma* (*Original article*)**

Biological features and stage specific life-table of *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) on *Aspidiotus hedericola* Leonardi (Hemiptera: Diaspididae)[1]

Erkan ÖZBESNİLİ[2], Tülin ÖZSİSLİ[2]

Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae)'nın *Aspidiotus hedericola* Leonardi (Hemiptera: Diaspididae) üzerinde biyolojik özellikleri ve döneme bağlı yaşam çizelgesi

Özet: Bu çalışmadaki avcı böcek, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae)'nın erginleri Kahramanmaraş Tarımsal Araştırma Enstitüsü'nden toplanmıştır. Kültüre alınan *C. carnea* dişilerinin bıraktıkları yumurtalar Petri kutularına aktarılmıştır. Çalışma 25±1 °C sıcaklık, % 65±10 orantılı nem ve 16 saat aydınlatmalı iklim odasında yürütülmüştür. Yumurtadan çıkan *C. carnea* larvalarına ergin oluncaya kadar besin olarak *Aspidiotus hedericola* Leonardi (Hemiptera: Diaspididae)'nın değişik dönemleri verilmiştir. *A. hedericola* Kahramanmaraş Sütçü İmam Üniversitesi, Merkez Kampüs bahçesindeki *Hedera helix* L. (Araliaceae) yapraklarından elde edilmiştir. *C. carnea*'nın yumurta, birinci, ikinci, üçüncü larva, pupa ve toplam gelişme dönemlerinin süreleri sırasıyla 3.26±0.09, 4.75±0.13, 4.78±0.17, 5.57±0.21, 8.54±0.30 ve 26.90±0.61 gün olarak tespit edilmiştir. *C. carnea*'nın yumurta, birinci, ikinci, üçüncü larva ve pupa dönemlerinin ölüm oranları sırasıyla % 11.69, 29.87, 11.69, 3.90 ve 6.49 olmuştur. *C. carnea*'nın yumurta, birinci, ikinci, üçüncü larva ve pupa dönemlerinin yaşam çizelgesindeki k-değerleri sırasıyla 0.1243, 0.4127, 0.2231, 0.0869 ve 0.1642 olarak saptanmıştır. En hassas ergin öncesi dönem en yüksek ölüm oranı ve k-değeri ile birinci larva dönemi olmuştur.

Anahtar sözcükler: *Chrysoperla carnea*, *Aspidiotus hedericola*, *Hedera helix*, biyoloji, döneme bağlı yaşam çizelgesi

Abstract: The predator insect, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) in this study were obtained from Kahramanmaras Agricultural Research Institute. The eggs laid by females of cultured *C. carnea* were transferred in Petri dishes. The study were conducted in a climate controlled room in at 25±1 °C, 65%±10 relative humidity, 16-h L:8-h D photo period. The larvae hatched from eggs to adult stage were given the different stages of *Aspidiotus hedericola* Leonardi (Hemiptera: Diaspididae) as food. *A. hedericola* was obtained from the leaves of *Hedera helix* L. (Araliaceae) from

---

[1]Bu çalışma; mezuniyet tezi olup, 28-30 Haziran 2011 tarihinde Kahramanmaraş'ta düzenlenen "Türkiye IV. Bitki Koruma Kongresi"nde poster olarak sunulmuştur.

[2]Sütçü İmam Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü, Kahramanmaraş
Sorumlu yazar (Corresponding author) e-mail: tulin@ksu.edu.tr
Alınış (Recieved): 13.09.2012 Kabul ediliş (Accepted): 05.06.2013

Kahramanmaraş Sütçü İmam Central Campus. The duration of egg, first, second, third larva, pupa and total development periods of *C. carnea* fed on *A. hedericola* was determined were 3.26±0.09, 4.75±0.13, 4.78±0.17, 5.57±0.21, 8.54±0.30 and 26.90±0.61 days, respectively. The mortality rates (%) of eggs, first, second, third larval and pupal stages of *C. carnea* were 11.69, 29.87, 11.69, 3.90 and 6.49 respectively. The k-values for eggs, first, second, third larval, pupal stages of *C. carnea* were 0.1243, 0.4127, 0.2231, 0.0869 and 0.1642, respectively. The most sensitive of immature stage was the first larva stage with the highest mortality rate and k-value.

Key words: *Chrysoperla carnea*, *Aspidiotus hedericola*, *Hedera helix*, biology, stage specific life table

Introduction

The green lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysophidae) is one of the most common generalist predators in Turkey (Şengonca 1980). *C. carnea* had been reported for culture plants such as field and orchard crops (Atlıhan et al. 2001; Karut et al. 2003; Işıkber & Karcı 2006; Bilgin et al. 2008; Yarpuzlu et al. 2008).

In our study, *C. carnea* was determined with together the scale insect *Aspidiotus hedericola* Leonardi (Hemiptera: Diaspididae) on *Hedera helix* L. (Araliaceae). The scale insects (Coccoidea) are serious pest group that attack ornamental plants (Ülgentürk & Çanakçıoğlu 2004). *A. hedericola* was reported on the perennial ornamental plants such as *H. helix* L. and *Laurus nobilis* L. (Lauraceae) (Kaydan et al. 2007).

C. carnea is a natural enemy of *A. hedericola* on ornamental plants. On the other hand, *A. hedericola* is also an alternate prey for *C. carnea* out of the areas is grown field and orchards crops. The presence of an alternative food source is important for the sustainability of populations of biological control agents. The development of biological control in integrated pest management requires an evaluation the population dynamics of biological control agents on different alternative preys. Life-table is one of the most important approaches used to define the population dynamics of insects and also gives a comprehensive description of the survivorship, development, feeding and expectation life (Önder & Zümreoğlu 1981; Ali & Rizvi 2009). Therefore, development time, mortality rates and stage specific life table of *C. carnea* were evaluated on *A. hedericola* in the present study.

Material and methods

The adults of the predator insect, *C. carnea* were collected from Kahramanmaraş Agricultural Research Institute in the month of July, 2008. The scale insect, *A. hedericola* (prey) was obtained from the leaves of *H. helix* in the garden of KSU Central Campus.

The pairs of *C. carnea* were collected from the field and brought to the laboratory. Each pair was placed in a glass jars closed with tulle cover in the laboratory. The mixture specified by Kişmir & Şengonca (1981) was prepared as food to the pairs of *C. carnea*. The food mixture was spread on the tulle daily. The each one of the zero day old eggs laid the inner surface of the jars by females of *C. carnea* were collected with the help of a fine paint brush daily. Eggs were placed separately in Petri dishes (55 x 15 mm). The experiment commenced with a total of 77 eggs.

The different stages of *A. hedericola* on *H. helix* were supplied as food to the newly hatched larvae of *C. carnea*. Likewise, fresh *A. hedericola* infested cut leaves of *H. helix* were also provided as food to the second and third stage larvae of *C. carnea* in Petri dishes daily. The leaves of *H. helix* were examined under binocular stereomicroscope to provide healthy *A. hedericola* to larval stages of *C. carnea*. For example, parasitized *A. hedericola* on *H. helix* were removed with a sable brush or with the aid of a needle. The exuviae found in Petri dishes was removed soon after the larvae entered into next instars. *C. carnea* in each Petri dish were observed twice daily from egg to adult stage. The immature development time and mortality rate was evaluated for each stage of *C. carnea*. The experiments were conducted in a climate controlled room at 25±1 °C, 65%±10 RH and 16-h L:8-h D photo period.

Following standard parameters were used to complete stage specific life-table: x = biological stage of the insect, lx = the number surviving at the beginning of the stage x and dx = mortality during the stage indicated in the column x. dx = the number of deaths in (x) stage. dx1=lx1-lx2.

The data calculated through above assumptions were used for computing various life parameters as given below:

Apparent mortality (100qx): It gives the information on number dying as percentage of number entering that stage. 100qx1= (dx/lx) x 100.

Survival fraction (Sx): Data obtained on apparent mortality was used for the calculation of the stage specific survival fraction (Sx) of each stage by using the equation: Sx = particular stage = [lx of subsequent stage] / [lx of particular stage] (Brower & Zar (1977) referring to Önder 2004).

Mortality survivor ratio (MSR): It is the increase in population that would have occurred if the mortality in the stage, in question had not occurred and was calculated as follows: MSR of particular stage = [Mortality in particular stage] / [lx of subsequent stage].

Indispensible mortality (IM): This type of mortality would not be there in case the factor (s) causing it is not allowed to operate. However, the subsequent mortality factors operate. IM = [Number of adults emerged] x [MSR of particular stage]. k-values: It is the key factor, which is primarily responsible for increase or decrease in number from one generation to another. k = to measure mortality in k-value which is the negative logarithms of survival: k = [-ln(Sx)]. k-value also obtainable as the difference between the successive values for “log l_x”. The total generation mortality, ‘K’ was calculated by adding the k-values of different development stages of the insect (Varley & Gradwell (1960) referring to Önder (2004) and Ali & Rizvi (2009).

$K = k_E + k_{L1} + k_{L2} + k_{L3} + k_P$, where k_E, k_{L1}, k_{L2}, k_{L3}, and k_P are the k-values at egg, first instar, second instar, third instar and pupal stage of *C. carnea*.

Results and discussion

The duration of development stages of *Chrysoperla carnea* on *Aspidiotus hedericola*

The development times of various stages of *C. carnea* on *A. hedericola* are given in Table 1. Total development time from egg to adult of *C. carnea* on *A. hedericola* was 26.90 days. Development times of *C. carnea* at 25±2 °C were reported by Yoldaş (1994), and the mean development times were 23.12 and 24.68 on *Macrosiphum euphorbiae* (Thomas) (Homoptera: Aphididae) and *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) respectively. In similar climate chamber, Atlıhan et al. (2001) and Kasap et al. (2003) studied the total development stages of *C. carnea* on different aphid species, *Hyalopterus pruni* (Geoffer) and *Aphis pomi* (De Geer) and the mean development times were 18.81 and 25.68 days respectively. Kasap et al. (2003) also reported that *C. carnea* fed on *Tetranycus urticae* (Acarina: Tetranychidae) could not reach the adult stage. In our study, the total development time of *C. carnea* was longer than the studies reported. This difference may be resulted from the feeding of *C. carnea* on different preys. *C. carnea* was able to reach adulthood on *A. hedericola*.

Table 1. Duration (in days) of various stages of *Chrysoperla carnea* on *Aspidiotus hedericola* at 25±1 °C (mean±SEM)

Stages	Egg	Larvae 1	Larvae 2	Larvae 3	Pupae	Total
n	77	68	45	36	33	28
Min.-max	2.0-5.0	3.0-7.0	2.0-7.0	3.0-8.0	6.0-12.0	21.0-32.0
Days	3.26±0.09	4.75±0.13	4.78±0.17	5.57±0.21	8.54±0.30	26.90±0.61

Min.-max.: Minimum- maximum n: replicates

The mortality rates (%) of pre-adult stages of *Chrysoperla carnea* on *Aspidiotus hedericola*

The mortality rate (%) of eggs, first, second, third larval and pupal stages of *C. carnea* on *A. hedericola* were 11.69, 29.87, 11.69, 3.90 and 6.49 respectively. While considering larval instars of *C. carnea*, the highest mortality (29.87%) was recorded at first instar stage (Figure 1). In previous studies mentioned below, the high mortality rates were often reported for eggs and larvae stages of *C. carnea*. The mortality was only observed at egg (20%) and first larval (7.14%) stages of *C. carnea* on *H. pruni* and was not seen for the other immature stages of *C. carnea* by Atlıhan et al. (2001). Kasap et al. (2003) reported that the highest mortality rates were determined at egg (11%) and first larval (13.3%) stages of *C. carnea* on *A. pomi*. Similar findings are available in the present study.

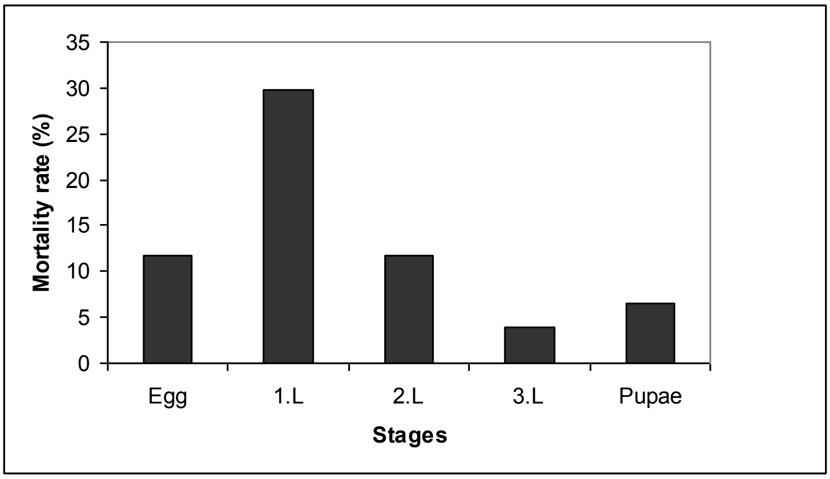

Figure 1. The mortality rates (%) of pre-adult stages of *Chrysoperla carnea* feeding on *Aspidiotus hedericola* at 25±1 °C (L: larvae stage).

The stage specific life-table of *Chrysoperla carnea* on *Aspidiotus hedericola*

The stage specific life-table of *C. carnea* on *A. hedericola* was given in Table 2. The initial number of individuals of *C. carnea* dramatically reduced at different rates in each stage and only 28 individuals of *C. carnea* were able to reach adulthood. Among larval instars, the lowest apparent mortality (8.33%) was recorded at third instar stage. The survival fraction was obtained minimum 0.66 at first larval stage. The mortality survivor ratio and indispensible mortality were noted maximum 0.51 and 14.31 at first larval stages. Also, the highest k-value (0.4127) and the lowest k-value 0.0869) were obtained at the first and third larval stages, respectively. The total generation mortality (K) was found to be 1.0114 (Table 2).

Table 2. Stage specific life-table of *Chrysoperla carnea* (predator) on *Aspidiotus hedericola* (prey) at 25±1 °C

Stage (x)	**Initial no (lx)**	**No dying in each stage (dx)**	**Apparent mortality (100qx)**	**Survival fraction (Sx)**	**Mortality /survivor ratio MSR**	**Indispen-sible mortality IM**	**k-value [-ln(Sx)]**
Egg	77.00	9.00	11.69	0.88	0.13	3.71	0.1243
Larvae 1	68.00	23.00	33.82	0.66	0.51	14.31	0.4127
Larvae 2	45.00	9.00	20.00	0.80	0.25	7.00	0.2231
Larvae 3	36.00	3.00	8.33	0.92	0.09	2.55	0.0869
Pupae	33.00	5.00	15.15	0.85	0.18	5.00	0.1642
Adults	28.00	-	-	-	-	-	-
							K=1.0114

Likewise, early larval instars were much sensitive than the later instars in previous studies (Atlıhan et al. 2001; Kasap et al. 2003). Similar trend was reported for the first instar stage of different predator, *Coccinella transversalis* Fabricius (Coleoptera: Coccinellidae) at 28±1 °C (Ali & Rizvi (2009). The use of second and third larval stages of *C. carnea* will be more efficient result for biological control programs. On the other hand, *C. carnea* was able to reach adulthood on *A. hedericola* and hence, the present study indicates that *A. hedericola* are suitable prey for developing stages of *C. carnea*. *A. hedericola* can be regarded as potential prey for *C. carnea* outside the agricultural areas.

Acknowledgements

We would like to express our sincere to Prof. Dr. Selma Ülgentürk (Ankara University, Agricultural Faculty, Plant Protection Department, Ankara) for his help in identification of the scale insect *Aspidiotus hedericola* which is one of the main materials.

References

Ali A. & P.Q. Rizvi 2009. Age and stage specific life-table of *Coccinella transversalis* with regards to various temperatures. *Tunisian Journal of Plant Protection*, 4: 211-219.

Atlıhan R., M.S. Özgökçe & M.B. Kaydan 2001. Some biological characteristics of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) on *Hyalopterus pruni* (Geoffer) (Homoptera: Aphididae). *Turkish Journal of Entomology*, 25 (3): 223-230.

Bilgin M.G., T. Çölkesen Özsisli & A.A. Işıkber 2008. Population densities and natural enemies of Aphids in the wheat fields in Kahramanmaraş Province (Turkey). *KSU Journal of Science and Engineering*, 11 (2): 97-110.

Brower J.E. & J.H. Zar 1977. Field and Laboratory Methods for General Ecology. William C. Brown Company Publishers, Lowa, 122: 34-44.

Işıkber A.A. & Karcı A. 2006. Determination of predatory insect species, their density and prevalence on some field crops in Kahramanmaraş Provinces. *KSU Journal of Science and Engineering*, 9 (1): 111-116.

Karut K., C. Kazak, A. Arslan & E. Sekeroğlu 2003. Natural Parasitism of *Chrysoperla carnea* by Hymenopterous Parasitoids in Cotton-Growing Areas of Cukurova, Turkey. *Phytoparasitica*, 3 (1): 90-93.

Kasap İ., Y. Aktuğ & R. Atlıhan 2003. Studies on the some biological features of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae). *YYU Journal of Agricultural Science*, 13 (1): 49-53.

Kaydan M.B., S. Ülgentürk & L. Erkılıç 2007. Checlist of Turkish Coccoidea species (Hemiptera). *YYU Journal of Agricultural Science*, 17 (2): 89-106.

Kişmir A. & Ç. Şengonca 1980. Çukurova Bölgesinde pamuk zararlılarına karşı kullanılan bazı kimyasal preparatların, avcı böcek *Anisochrysa carnea*'ya etkileri üzerinde bir araştırma. *Türkiye Bitki Koruma Dergisi*, 4 (4) : 243-250.

Önder F. 2004. Hayvansal Zararlıların Populasyon Ekolojisi. E.Ü. Ziraat Fakültesi, Bitki Koruma Bölümü, Bornova- İzmir, 94 p.

Önder F. & A. Zümreoğlu 1981. The use of life tables in entomological researches. *Turkish Journal of Plant Protection*, 5 (3):185-194.

Şengonca Ç. 1980. Türkiye Chrysopidae (Neuroptera) Faunası Üzerinde Sistematik ve Taksonomik Araştırmalar. T.C. Gıda Tarım ve Hayvancılık Bak. Zir. Müc. ve Zir. Kar. Gn. Md. Yayınları, Ankara, 138 p.

Ülgentürk S. & H. Çanakçıoğlu 2004. Scale insect pest on ornamental plants in urban habitats in Turkey. *Journal of Pest Science*, 77: 79-84.

Varley G.C. & G.R. Gradwell 1960. Key factors in population studies. *Journal of Animal Ecology*, 29: 399-401.

Yarpuzlu F., S. Öztemiz & M. Karacaoğlu 2008. Natural enemies and population *Aonidiella aurantii* Maskell (Homoptera: Diaspididae) with efficiency of parasitoid, *Aphytis melinus* (How.) (Hymenoptera: Aphelinidae) in lemon orchards. *Journal of Entomological Research Society*, 10 (1): 43-58.

Yoldaş Z. 1994. Studies on the biology of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) feeding on two different preys. Proceedings of the Third Turkish National Congress of Biological Control, Izmir, 25-28 January, 1994, 375-380.