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Development and Survival of *Chrysoperla carnea* on Two Different Preys

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Abstract

In this study, development periods and survivals of *Chrysoperla carnea* larvae fed on *Aphis fabae* and *Aspidiotus nerii* were investigated in climate cabinets with 26±0.0 °C temperature, 60±1 % humidity and 16: 8 hours light-dark period conditions. Results were statistically evaluated by SPSS 21.0, JMP 8.0 and Curve Expert Pro 1.6.8 package programs. As a result of the study, average periods of egg, 1st instar, 2nd instar, 3rd instar, pupa and total development of *C. carnea* fed on *A. fabae* and *A. nerii* were 3.00-3.00, 2.95-4.77, 2.80-3.77, 4.47-5.36, 6.53-7.10 and 19.62-23.40 days, respectively. Results of the statistical analysis showed that there were significant differences among all biological periods except egg period of *C. carnea*. Weibull distribution was fitted to survival rate of development periods of both *C. carnea* populations which was developed on two preys. Survival curves was fitted to Holling's type III life curves for both populations because of the high mortality at the development periods. Parameters of Weibull distribution equation were calculated as c = 0.55, 0.55; b = 64.18, 29.91 for both populations which were used as prey of *A. fabae* and *A. nerii,* respectively.

Keywords: Green lacewing, *Aspidiotus nerii, Aphis fabae,* development time, survival, Weibull distribution

İki Farklı Av Üzerinde *Chrysoperla carnea*'nın Gelişme ve Yaşam Oranı

Özet

Bu çalışmada, *Aphis fabae* ve *Aspidiotus nerii* üzerinde beslenen *Chrysoperla carnea*'nın ergin öncesi dönemlerinin gelişme süreleri, yaşam ve ölüm oranları, sıcaklığı 26±0.0 °C'ye, nemi % 60±1'e ve fotoperiyodu 16:8 aydınlık-karanlığa ayarlanmış iklim kabinlerinde belirlenmiştir. Sonuçlar istatistik olarak SPSS 21.0, JMP 8.0 ve CurveExpertPro 1.6.8 programları kullanılarak değerlendirilmiştir. Sonuçta, *A. fabae* ve *A. nerii ile* beslenen *C. carnea* 'nın yumurta, 1. larva, 2. larva, 3. larva, pupa ve toplam gelişme süreleri sırasıyla 3.00-3.00, 2.95-4.77, 2.80-3.77, 4.47-5.36, 6.53-7.10 ve 19.62-23.40 gün olarak hesaplanmıştır. Yumurta açılma süresi dışında tüm biyolojik dönemlerin gelişme sürelerinin istatistik olarak birbirinden farklı olduğu saptanmıştır. Her iki av üzerinde beslenen avcının biyolojik gelişme dönemlerinin zamana bağlı yaşam eğrileri Weibull dağılımı ile ortaya çıkarılmıştır. Her iki populasyonun Weibull dağılım parametreleri sırasıyla c için 0.55 ve 0.55, b için 64.18 ve 29.91 olarak hesaplanmıştır.

Anahtar Kelimeler: Altın gözlü yeşilkelebek, *Aspidiotus nerii, Aphis fabae,* gelişme süresi, yaşam oranı, Weibull dağılımı

Introductıon

Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae) is a polyphagous natural enemy widely distributed in the world (McMurtry et al., 1970; Jeppson et al., 1975; Stark and Whitford, 1987; Jokar and Zarabi, 2012). Although it prefers soft bodied insects (aphid, whitefly, mealybug) (Syed et al., 2005; Sattar et al., 2007; Jokar and Zarabi, 2012), it can feed on scale insects, thrips, leafhoppers and larvae of butterfly (Lingren et al., 1968; Ridgway and Jones, 1968; Lingren and Green, 1984; Sattar, 2010; Batool et al., 2014), that it has a wide host spectrum. *C. carnea* is a benefit predator because compatibility with a variety of environmental conditions, food diversity and ability to hunt 80 species of pest (Jokar and Zarabi, 2012). Besides, because of its high searching, finding and consumption capacities, *C. carnea* is also produced commercially (Daane et al., 1998; Tauber et al., 2000; Hodle and Robinson, 2004).

The aim of the present study was to determine biological properties of *C. carnea* on

polyphagous pests; *Aphis fabae* (Hemiptera: Aphidae) reported in almost all farmland, and *Aspidiotus nerii* (Hemiptera: Diaspididae) a harmful pest for parks and ornamental plants.

Materıals and Methods

In order to determine the biological features of *C. carnea* fed on *A. fabae* and *A. nerii,* plants and preys were produced.

Vicia faba culture

Selvi variety was used for *Vicia faba* culture. Seeds were placed in plastic pots filled with perlite, soil and peat. Plants were grown in a climatic chamber and irrigated every two days. Plants were transferred to aphid production room when they were 15-20 cm hight. Production was carried out in a glasshouse during the study at Plant Protection Department, Faculty of Agriculture, Süleyman Demirel University.

A. fabae culture

A. fabae was obtained from a culture maintained at growth chambers in Biological Control Laboratory in the same department. To ensure the continuity of colonies, weekly produced clean plants were replaced with the infested ones.

A. nerii culture

Biparantel *A. nerii* population grown on potato tubers in the insectarium of Biological Control Laboratory, were used in the study. Clean potato tubers in plastic trays were deliberately infested with crawlers of *A. nerii* to build up the population. This procedure was continued during the study.

A. fabae and *A. nerii* were reared in rooms adjusted to 25±1°C, 65±5% RH and L:D 16:8 h photoperiod.

C. *carnea* culture

The predatory insect C. *carnea* was originally collected by sweeping net from the clover field in Farmer Education Center, Süleyman Demirel University. Adult individuals were transferred to culture bottles with *V. faba* infested with various stages of *A. fabae*. When the eggs of the predator were observed on *V. faba*, adults were transferred to new bottles. Climatic conditions were the same as the rooms used for rearing the prey.

Experimental procedure

Adult individuals of *C. carnea* collected from predator rearing room were placed in plastic jars with cotton pieces impregnated with honey water mixture. The newly laid eggs were separately transferred to plastic petri dishes of 10 cm diameter with *V. faba* leaves infested by *A. fabae* and potato tubers infested by *A. nerii.* A piece of filter paper was placed at the bottom of the petri dishes, and a few drops of water were added to maintain humidity. The experiments were controlled every day to observe the development periods of eggs, first larvae, second larvae, third larvae and pupae.

The experiment was designed in a completely randomized design. Treatments were replicated twenty four times. The climatic cabin conditions adjusted to 26±0 °C, 60 ± 1 % relative humidity and 16 hours light in 4000 lux and 8 hours dark period.

Data analysis

Statistical analyses for difference of development periods were done by using SPSS (ver. 21) software. The Weibull frequency distribution was chosen as a statistical model to summarize the *C. carnea* survivorship data of all individuals on different preys (Deevey, 1947; Pinder et al., 1978):

$$S_p(t) = e^{\left[-\left(\frac{t}{b}\right)^c\right]}$$

t, b, c > 0

where $S_p(t)$ represents the probability of surviving to a given age, b is the parameter that describes the scale, c is shape of the curve and t is time. The shape of parameters c>1, c=1 and c<1 correspond to type I, II and III survivorship curves, respectively (Deevey, 1947; Pinder et al., 1978). Statistical analyses were done by using following softwares, CurveExpert pro (ver. 1.6.8), JMP (ver. 8), SPSS (ver. 21), MS Excel (ver. 2003).

Results and Discussion

Development periods of *C. carnea* fed on different preys were given in Table 1. Results of the statistical analysis showed that there were significant differences among all biological periods except egg period of *C. carnea* fed on *A. fabae* and *A. nerii*. Biological stages of *C. carnea* were longer on *A. nerii* than those on *A. fabae*.

Table 1. Development times of *C. carnea* fed on *Aphis fabae* and *Aspidiotus nerii* (Day, Mean±SE)

Stages	n	*Aphis fabae*	*n*	*Aspidiotus nerii*
Eggs	24	3.00±0.00 a*	23	3.00±0.00 a
L1	20	2.95±0.05 b	13	4.77±0.12 a
L2	15	2.80±0.14 b	13	3.77±0.12 a
L3	15	4.47±0.16 b	11	5.36±0.15 a
Pupae	13	6.53±0.14 b	10	7.10±0.23 a
Total development time	13	19.62±0.24 b	10	23.40±0.22 a

*Means in the same row followed by different letters are significantly different (Tukey-Kramer HSD test, $P < 0.05$).

Pupal period of *C. carnea* was longer than other development stages for both preys.
Egg period of *C. carnea* lasted 3.5 days on *Aphis pomi* and three larval stages, pupal period and total development time were 3.08, 3.54, 4.72, 10.82 and 25.68, respectively (Kasap et al., 2002). In the same study, the authors reported that *C. carnea* fed on *Tetranychus urticae* could not reach the adult stage. The duration of egg, 1st, 2nd, 3rd larva, pupa and total development periods of *C. carnea* fed on *A. hedericola* were 3.26, 4.75, 4.78, 5.57, 8.54 and 26.9 days, respectively, at 25±10 °C, 65±10% relative humidity and 16 hours light conditions (Özbesnili and Özsisli, 2011).

The total developmental time of *C. carnea* on *A. fabae* was 19.62 days, approximately 4 days shorter than on *A. nerii* (23.40 days). Total development time of *C. carnea* fed on *Macrosiphum euphorbiae* and *Trialeurodes vaporariorum* lasted 23.12, 24.68 and 21.00, 22.00 days in F1 and F2 generations under the laboratory conditions, respectively (Yoldaş, 1994). Atlıhan et al. (2001) reported that total development time of *C. carnea* fed on *Hyalopterus pruni* was 18.81 days.

Mortality rates of *C. carnea* fed on *Aphis fabae* and *Aspidiotus nerii* were 45.83 % and 56.52 %, respectively. Özbesnili and Özsisli (2011) reported that mortality rate of *C. carnea* fed on *A. hedericola* was 63.63 %. *C. carnea* fed on *Tetranychus urticae* could not reach the adult stage (Kasap et al., 2002). Gautam et al., (2009) given as 48 % total immature mortality of *Chrysoperla* sp. (*carnea*-group).

Weibull frequency distribution was used to determine the curve that best describes survival ratio of *C. carnea* fed on *Aphis fabae* and *Aspidiotus nerii (*Figure 2).

The curve shape parameters are given in Table 3. Survivorship data can be effectively summarized using the shape and scale parameters of the Weibull frequency distribution (Pinder et al., 1978).

Table 3. Weibull parameters for survival curves of *C. carnea* fed on *Aphis fabae* and *Aspidiotus nerii.*

Parameters	*Aphis fabae*	*Aspidiotus nerii*
b	64.17±11.34	29.91±3.66
c	0.55±0.06	0.55±0.07
Type	3	3
R^2	0.86	0.83

Parameters of Weibull distribution equation were calculated as c = 0.55 and 0.55; b = 64.18 and 29.91 for both populations which were used as prey of *A. fabae* and *A. nerii,* respectively. Population tends to decrease because of the c parameters less than one.

Survival curves were fitted to Holling's type III life curves for both populations because of the high mortality at the development periods.

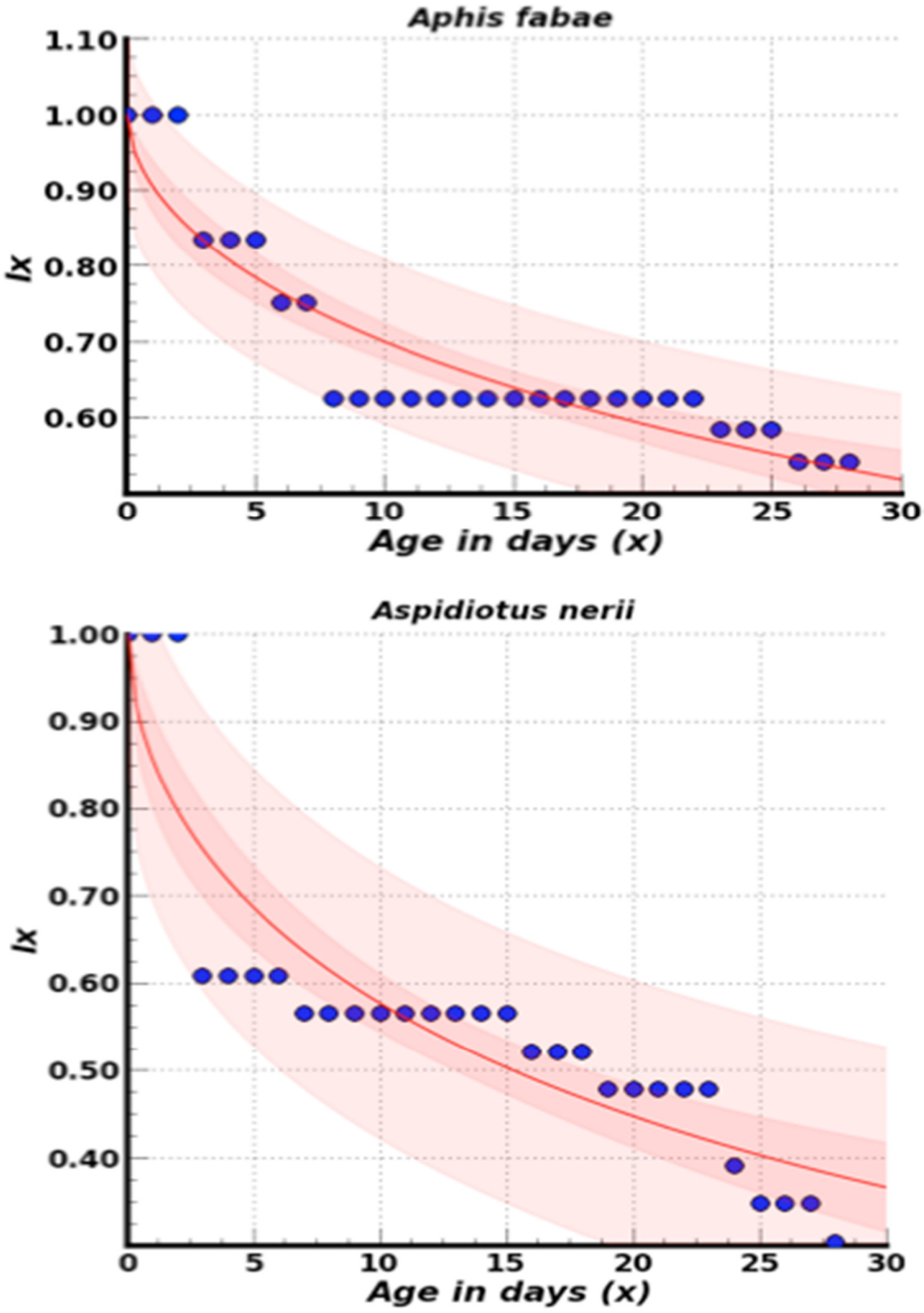

Figure 2. Weibull distribution fitted to survivorship data of *C. carnea* fed on *Aphis fabae* and *Aspidiotus nerii*.

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