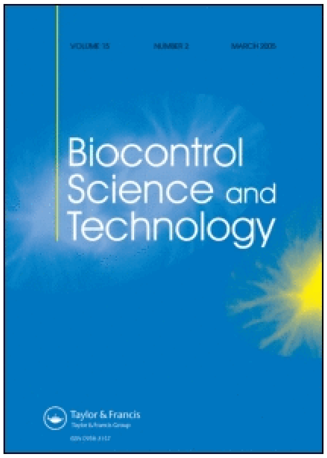

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Nihal Özder; Özgür Sağlam

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SHORT COMMUNICATION

Effects of Aphid Prey on Larval Development and Mortality of *Adalia bipunctata* and *Coccinella septempunctata* (Coleoptera: Coccinellidae)

NIHAL ÖZDER AND ÖZGÜR SAĞLAM

Department of Plant Protection, Faculty of Agriculture, Trakya University, Tekirdağ, Turkey

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Developmental time and mortality rate of Adalia bipunctata *(L.) and* Coccinella septempunctata *L. (Coleoptera: Coccinellidae) were determined when feeding on five aphid species.* Metopolophium dirhodum *(Walker),* Sitobion avenae *(F.),* Rhopalosiphum padi *(L.),* Hyalopterus pruni *(Geoffr.) and* Myzus cerasi *F. (Homoptera: Aphididae) are widespread in Tekirdağ, Turkey. Tests were carried out in a controlled environmental chamber (25 ± 1°C temperature, 65 ± 5% relative humidity and 16 h light:8 h dark period). Developmental times for* A. bipunctata *and* C. septempunctata *larvae varied significantly depending on species of aphid prey ($P < 0.05$). Development time (± S.E.) varied from 17.50 ± 0.84 to 20.83 ± 1.60 days for* C. septempunctata *and 16.7 ± 0.76 to 20.7 ± 1.03 days for* A. bipunctata. *Mortality of* A. bipunctata *(50%) and* C. septempunctata *(63%) were highest on* H. pruni.

Keywords: Adalia bipunctata, Coccinella septempunctata, Metopolophium dirhodum, Sitobion avenae, Rhopalosiphum padi, Myzus cerasi, Hyalopterus pruni *prey, development, mortality rate*

Generally, coccinellids (Coleoptera) are the most important predators of aphids and are spread in Turkey and Europe (Hodek, 1970, 1973; Uygun, 1981; Düzgüneş *et al*., 1982; Kring & Gilstrap, 1984; Öncüer, 1991; Hodek & Honek, 1996). Coccinellids represent about 80% of predators found in wheat fields and *Coccinella septempunctata* L. comprise 60% of 13 extant coccinellid species (Özder & Toros, 1999). *Adalia bipunctata* (L.) (Coccinellidae) is commonly found throughout Turkey in fruit trees (Uygun, 1981; Düzgüneş *et al*., 1982; Öncüer, 1991). Aphids (Homoptera) infesting wheat and their natural enemies have been surveyed in previous studies in Tekirdağ, Turkey. *Sitobion avenae* (F.), *Metopolophium dirhodum* (Walker) and *Rhopalosiphum padi* (L.) (Homoptera: Aphididae) are the most

Correspondence to: N. Özder. E-mail: nozder@hotmail.com/nozder@tu.tzf.edu.tr

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common aphid species on wheat in the region (Özder & Toros, 1999). *Myzus cerasi* F. and *Hyalopterus pruni* (Geoffr.) are the most common pest aphid species on fruit trees in Tekirdağ region (Özder, 1999).

Developmental time, mortality, fecundity and prey preference vary considerably depending on the species of aphid that *C. septempunctata* feeds (Blackman, 1967a; Ghanim *et al*., 1984; Malcolm, 1992; El Hag & Zaitoon, 1996; Shefali *et al*., 1997; Hauge *et al*., 1998; Lakhanpal *et al*., 1998). Some species of aphids are more suitable than others among essential prey. The lower suitability may be caused by their lower nutrient quality or lower palatability (Hodek, 1993). We conducted laboratory studies to determine the developmental rate and survivorship of *Adalia bipunctata* and *Coccinella septempunctata* when feeding on these five aphid species.

The study was carried out at the Faculty of Agriculture in Tekirdağ, Turkey. A*dalia bipunctata* adults were obtained from a cherry orchard grown at the experiment station in July 2001. *Coccinella septempunctata* adults were obtained from wheat plants grown at the experimental station in May 2001 and their offspring were used for this experiment. These insects were kept as a stock culture and one new generation of coccinellids was reared separately on each aphid species. *Adalia bipunctata* and *Coccinella septempunctata* were fed with the cereal aphid species *M. dirhodum*, *S. avenae* and *R. padi* on wheat, *M. cerasi* on cherry leaves and *H. pruni* on peach leaves. Tests were carried out in environmental growth chambers ($25 \pm 1°C$ temperature, $65 \pm 5\%$ relative humidity and 16 h light:8 h dark photoperiod).

The newly hatched coccinellid larvae were placed individually into plastic petri dishes (6 cm diameter) with screen top lids, supplied daily with fresh leaf sections moistened using a cotton ball containing an overabundance of aphids (from 50 up to 100), on which parents also fed earlier, and then placed in an incubator. All coccinellid larvae were obtained from a single female for each aphid species. The larvae were checked twice a day for deaths and moults. The prepupal stage was considered initiated after larvae attached their abdomens to the petri dish wall. The pupae were observed twice a day to determine the exact date of emergence of the adult coccinellids. This study was conducted in the laboratory under constant conditions of $25 \pm 1°C$ temperature, $65 \pm 5\%$ relative humidity and 16h light: 8 h dark photoperiod. The experiments on development and survival were conducted using 30 individual larvae from a single mother for each aphid species. All data were analyzed separately by one-way analysis of variance (ANOVA) and comparisons were made using Duncan's multiple range tests.

The developmental time of *Adalia bipunctata* varied significantly depending on species of prey aphid ($P < 0.05$). Significant differences in developmental times were measured for second ($F = 4.82$), third ($F = 2.58$) and fourth ($F = 3.78$) larval instars, as well as total larval development time ($F = 17.47$) ($P < 0.05$) (Table 1).

While larval developmental time on *R. padi* (10.29 ± 0.76 days) was the shortest of all tested aphid species, it was the longest on *H. pruni* (13.40 ± 1.17 days) ($P < 0.05$).There was no significant difference with regards to prepupal duration among the aphid species, however pupal duration was longest on *S. avenae* (6.17 ± 0.98 days) ($F = 6.35$). Total developmental time for *Adalia bipunctata* was significantly longer on *S. avenae* (20.67 ± 1.03 days) and *H. pruni* (19.80 ± 1.14 days) ($F = 27.68$) ($P < 0.05$).

Mortality rates of *A. bipunctata* during the post-embryonal development were 33, 22, 18 and 50%, respectively, for *S. avenae*, *R. padi*, *M. cerasi* and *H. pruni*. Among the aphids studied, the mortality rate for *A. bipunctata* was lowest on *M. cerasi* and highest on *H. pruni*.

The developmental time of *C. septempunctata* varied significantly, depending on species of prey aphid ($P < 0.05$).

Significant differences in developmental times were measured for first ($F = 26.66$), second ($F = 13.30$), third ($F = 1.87$) and fourth ($F = 8.49$) larval instars, as well as total larval development time ($F = 10.39$) ($P < 0.05$) (Table 2). While larval developmental time on *M.*

TABLE 1. Development times in days (means ±SE) and percent mortality of *A. bipunctata* on different aphid species

Predator developmental stage	Aphid species			
	S. avenae	*R. padi*	*M. cerasi*	*H. pruni*
First	4.00±0.71 (3–5)a	4.22±0.83 (3–5)a	3.47±0.61 (3–4)a	3.50±01.84 (2–7)a
Second	1.88±0.64 (1–3)a	1.56±0.53 (1–2)a	2.90±1.52 (1–5)b	3.10±1.73 (1–6)b
Third	2.50±1.05 (1–4)ab	1.57±1.53 (1–2)a	2.41±1.062 (2–3)ab	2.90±1.52 (1–5)b
Fourth	4.83±1.94 (3–8)b	3.00±1.15 (1–4)a	3.47±0.92 (3–6)a	3.90±0.57 (3–5)ab
Total larval	13.17±1.47 (11–15)b	10.29±0.76 (9–11)a	11.13±0.92 (10–13)a	13.40±1.17 (12–15)b
Prepupal	1.33±0.52 (1–2)a	1.43±0.53 (1–2)a	1.06±0.24 (1–2)a	1.40±0.70 (1–3)a
Pupal	6.17±0.98 (5–8)b	5.00±0 (5–5)a	5.73±0.46 (5–6)b	5.00±0.82 (3–6)a
Total develop	20.67±1.03 (19–22)c	16.71±0.76 (16–18) a	17.93±0.80 (17–20) b	19.80±1.14 (18–21)c
Mortality	33ab	22ab	18a	50b

Within rows, means followed by a common letter do not differ significantly ($P < 0.05$).
Figures are values±S.E.; the range of minimum and maximum values is given in parentheses ($n = 30$).

cerasi (10.86±0.38 days) was the shortest of all tested aphid species, it was the longest on *H. pruni* (15.00±1.26 days) ($P < 0.05$). There was no significant difference with regards to prepupal duration among the aphid species; however, pupal duration was shortest on *R. padi* (4.00±0.82 days) ($F = 4.23$). There were no significant differences in total *C. septempunctata*

TABLE 2. Development times in days (means±SE) and percent mortality of *C. septempunctata* on different aphid species

Predator developmental stage	Aphid species				
	M. dirhodum	*S. avenae*	*R. padi*	*M. cerasi*	*H. pruni*
First	2.13±0.35 (2–3)a[1]	2.06±0.68 (1–4)a	3.50±0.85 (3–5)b	3.80±0.42 (3–4)b	4.83±0.98 (1–6)c
Second	1.43±0.53 (1–2)ab	1.88±0.34 (1–2)b	1.50±0.53 (1–2)ab	1.20±0.42 (1–2)a	3.00±0.89 (2–4)c
Third	2.43±0.53 (2–3)ab	2.40±0.51 (2–3)ab	2.00±0.67 (1–3)a	2.00±0.53 (1–3)a	2.66±0.82 (2–4)b
Fourth	7.17±1.72 (5–10)c	5.93±1.14 (4–8)b	5.00±1.41 (4–7)ab	3.86±0.38 (3–4)a	4.50±0.55 (4–5)a
Total larval	12.60±1.14 (11–14)b	12.14±1.02 (10–14)b	12.25±1.75 (10–15)b	10.86±0.38 (10–11)a	15.00±1.26 (13–16)c
Prepupal	1.00±0.0 (1–1)	1.29±0.47 (1–2)	1.00±0.0 (1–1)	1.33±0.52 (1–2)	1.00±0.0 (1–1)
Pupal	5.20±0.45 (5–6)b	5.29±0.73 (4–6)b	4.00±0.82 (3–5)a	5.33±0.82 (4–6)b	4.83±0.75 (4–6)b
Total develop	18.60±0.89 (18–20)a	18.86±1.07 (16–21)a	19.00±1.15 (18–21)a	17.50±0.84 (16–18)a	20.83±1.60 (19–23)b
Mortality	37ab	16a	30ab	40ab	63b

Within rows, means followed by a common letter do not differ significantly ($P < 0.05$).
Figures are values±S.E.; the range of minimum and maximum values is given in parentheses ($n = 30$).

development time (larvae + pupae) when feeding on *M. dirhodum*, *S. avenae*, *R. padi* and *M. cerasi.* Total developmental time for *C. septempunctata* was significantly ($F = 4.12$) longer on *H. pruni* (20.83 ± 1.60 days). Mortality rates of *C. septempunctata* during the post-embryonal development duration were 37, 16, 30, 40 and 63% for *M. dirhodum*, *S. avenae*, *R. padi, M. cerasi* and *H. pruni*, respectively. The mortality rate for *C. septempunctata* was lowest on *S. avenae* and highest on *H. pruni* among the aphids studied.

Adalia bipunctata and *Coccinella septempunctata* fed on all tested prey aphid species but total developmental time and mortality rates varied depending on prey species. As with other species of coccinellids, larval development, oviposition and fecundity and total development time can be directly influenced by prey quality (Hodek, 1956; Blackman, 1967b; Semyanov, 1970; Mills, 1981; Vet & Dick, 1992; Formusoh & Wild, 1993; Hodek & Honek, 1996).

Sitobion avenae was the most suitable prey for *C. septempunctata* in this study because of the predator's faster development and lower mortality rate on this prey. Our results corroborated those of Blackman (1965) and Elhag and Zaitoon (1996), but differed from Hauge *et al*. (1998). Differences may be caused from different experimental conditions. We consider *M. dirhodum*, *R. padi* and *M. cerasi* of intermediate food value for *C. septempunctata* among the five tested prey species. Among these, *R. padi* was the least suitable prey because of its longer development time when feeding on this aphid. Others have found that oviposition by *C. septempunctata* when feeding on *R. padi* is poor (Kuznetsov, 1975). *Hyalopterus pruni,* relative to other tested prey, was least suitable for *C. septempunctata* due to the longer total development time and high mortality rate recorded in our research. This may be due to the aphid's waxy covering, and perhaps lower nutrient value (Hodek, 1993).

Rhopalosiphum padi and *M. cerasi* were the most suitable prey for *A. bipunctata* because of its faster development and lower mortality rate in this study. We consider *S. avenae* of intermediate food value among the four tested prey species. *Hyalopterus purini*, relative to other tested prey, was least suitable for *A. bipunctata* due to the longer total developmental time and high mortality rate recorded in our research. Our results differed from Özgen and Yasar (1999) which may have been caused by different humidity levels used in our studies or different strains of the same prey species (Hodek & Honek, 1996).

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