Development, survival, feeding consumption and reproduction of the convergent lady beetle, *Hippodamia convergens* (Coleoptera: Coccinellidae) feeding on three aphid species

Mandour, N. S.
Department of Plant Protection, Faculty of Agriculture, Suez Canal University, 41522 Ismailia, Egypt

Received: *25/1/2009*

Abstract: The preimaginal development, survival, feeding consumption and reproduction of the convergent lady beetle, *Hippodamia convergens* Guérin-Méneville (Coleoptera: Coccinellidae) were studied in relation to three aphid species, *Aphis craccivora* Koch, *Brevicoryne brassicae* L. and *Hyalopterus pruni* (Geoffroy) (Homptera: Aphididae) under laboratory conditions. Data indicated that the total developmental time (egg-adult) of *H. convergens* was significantly influenced by the aphid species; being longest (19.44 days) when larvae were fed on *B. brassicae* and shortest (16.90 days) on *A. craccivora*. Number of consumed preys increased as larvae of *H. convergens* aged. The total number of consumed preys during larval stage differed significantly among the tested preys species; being greatest (295.55 nymphs) on *A. craccivora* and lowest (235.80 nymphs) on *B. brassicae*. No significant differences were existed among the three aphid species in terms of percentages of egg hatching, larval survival, adult emergence and the overall generation survival. Also, the three aphid species had no effect on the length of pre- and post-ovispoitional period as well as male longevity. However, the length of ovipositional period, female longevity and total lifetime fecundity differed significantly among the three aphid species. Moreover, *H. convergens* females consumed significantly higher numbers of *A. craccivora* (5496 nymphs) as compared to *B. brassicae* (3123.80) and *H. pruni* (4936.60 nymphs). On contrary, the total numbers of consumed preys by *H. convergens* males were comparable and did not differ significantly among the three aphid species.

Keywords: *Hippodamia convergens*, coccinellids, aphids species, biology, reproduction, feeding consumption, survival

INTRODUCTION

Predatory ladybirds (Coccinellidae: Coleoptera) are widely recognized as important bioagents for aphids, mealy bugs, scale insects, whiteflies and mites (Hodek and Honek, 1996; Obrycki and Kring, 1998; Omkar and Srivastava, 2003). They are linked to all biological control strategies, *i.e.* classical, inundative, inoculative and conservative biological control more than any other predatory group (Obrycki and Kring, 1998). Despite the importance of coccinellids in biological control programs, not all attempts using predatory coccinellids had ended with success. For example, the estimated establishment rate of these coccinellids into North America (0.10) was lower than the worldwide estimate (0.34) for all biological control programs (Greathead and Greathead, 1992). The failure in biological control programs with predatory coccinellids may be attributable to the unmatched environmental factors, unavailability of the suitable preys or food as well as intraguild competition with other coccinellids (Kring *et al.*, 1985; Hodek and Honek, 1996).

Aphid species vary considerably in supporting the predatory coccinellids with their nutritional demands (Obrycki and Kring, 1998; Omkar and Srivastava, 2003; Kalushkov and Hodek, 2004). The same aphid species may vary in its nutritional value from one host plant to another indeed. Furthermore, one aphid species may be toxic to specific ladybird beetle in one season but innocuous in another season (Omkar and Srivastava, 2003). Subsequently the biological parameters, *i.e.* developmental period, survival, fecundity, feeding consumption and longevity are likely affected by aphid species that may contribute to the failure or the success of the establishment of a given predatory species (Hodek & Honek, 1996; Kalushkov and Hodek, 2004; Katsarou *et al.*, 2005).

The convergent lady beetle, *Hippodamia convergens* Guérin-Méneville, is a very important predator of several aphid species in many agroecosystems throughout the Neatrctic region (Mohammed *et al.*, 2000). *H. convergens* has become one of the most abundant coccinellid species in Egypt (Bahy-Eldin, 2006). It contributes by 28.3 and 17.98% of the total lady beetles in 2003 and 2004, respectively in cotton fields in Qalubyia Governorate (Bahy-Eldin, 2006). There are relatively few studies (Abdel-Sallam *et al.*, 1997; Bahy-Eldin, 2006) on the biology of *H. convergens* on the aphid species that are common in Egypt. Such information of prey specificity, feeding consumption, reproductive biology as well as minimum density of aphid/prey species, are very crucial in evaluating the importance of this predator.

Taken all these views in consideration, the present study therefore aimed to shed the light on the reproductive biology and feeding consumption of the convergent lady beetle, *Hippodamia convergens* Guérin-Méneville on three aphid species, *viz. Aphis craccivora* Koch on faba bean, *Brevicoryne brassicae* (Linn.) on cabbage and *Hyalopterus pruni* (Geoffroy) on apricot under laboratory conditions.

MATERIALS AND METHODS

Rearing of *H. convergens*:

Adults of *H. convergens* were first collected from alfalfa fields infested with mixed aphid species at The Experimental Farm, Faculty of Agriculture, Suez Canal University. Adults were paired for mating in glass jars and then mated adults were separated and kept in plastic box (30 cm in diameter × 20 cm in height). To increase ventilation, the core of the cover of the plastic box was removed and replaced with fine muslin cloth. To initiate a separate culture of this lady beetle on different aphid species, *viz Aphis craccivora* Koch, *Brevicoryne brassicae* and *Hyalopterus pruni* (Geoffroy), twigs or leaves of the host plants bearing aphids were provided to the beetles in the rearing boxes. Dried twigs/leaves were replaced daily with fresh ones. The newly deposited eggs of *H. convergens* were removed every 24 hours and kept in clean plastic cages till hatching, then hatched larvae were fed with the intended aphid species. All adults and immature stages of *H. convergens* were maintained at laboratory conditions of 25±2 °C; 60±10% R.H. and 12:12 L/D photoperiod.

Maintenance of aphid colonies:

Aphis craccivora and *Brevicoryne brassicae* were maintained in a glasshouse at temperature of 25±2 °C; 70±10% R.H on faba bean and cabbage plants, respectively. Host plants were potted in small plastic pots (18 cm diameter) and were placed beside aphid-infested plants to maintain the culture throughout the experimental period. As for *Hyalopterus pruni*, insects were taken directly from infested apricot trees in the Experimental Farm, Faculty of Agriculture, Suez Canal University.

Preimaginal development, feeding consumption and survival:

To avoid reproduction by aphid adults that may cause experimental error, only fourth instar nymphs of *A. craccivora*, *B. brassicae* and *H. pruni* were used in the experiments. A specific number of fourth instar nymphs of each studied aphid species on their host plant were placed separately in clean glass jars (15 cm in height × 10 cm in diameter). A fine muslin cloth was used to close the open end of the glass jar and secured with a rubber band. The number of aphids provided to each larva was increased as the ladybird larva molted to the next instar; being 40, 75, 120 and 200 nymphs for *H. convergens* first, seconds, third and fourth instar, respectively. Jars were checked daily and the number of remained aphids was completed to the desired number of nymphs on fresh twigs/leaves. This experiment was conducted at laboratory conditions of 25±2 °C; 60±10% RH and 12:12 L/D photoperiod.

To study the effect of the tested aphid species on *H. convergens* immature development, feeding consumption and survival, 100 eggs were collected from the laboratory colonies and divided into five replicates with 20 eggs each. Eggs were then placed on moistened filter paper in Petri dish (12 cm diameter) till hatching. Each *H. convergens* first instar larva (< 4 hour-old) was gently transferred into the glass jar and paced over the aphid-infested twigs/leaves by the aid of a fine camel hairbrush. Glass jars were checked every day and data were recorded in forms of daily number of consumed aphids and survival until the formation of the pupal stage. Cast exuviae were used to record the development of the larval stage.

Adult fecundity, longevity and feeding consumption:

After emergence, emerging adults of *H. convergens* were first kept in cohort in plastic box for mating. Mated adults were then separated in glass jars (15 cm in height × 10 cm in diameter), covered with muslin cloth and fastened with a rubber band. Adults were provided with 200 nymphs of each tested species on its host plants. Jars were checked daily and the number of consumed, deposited eggs and surviving adults were recorded. Also eggs were observed and percentages of egg hatching were recorded. The experiment was continued until the death of all females.

Statistical analysis:

Data of duration for immature stages, longevity, fecundity, feeding consumption, survival as well as egg hatching for *H. convergens* fed on each aphid species were compared using ANOVA analysis of variance. When F values were significant, means were separated using Turkey' HSD (SAS Institute 2003).

RESULTS

As shown in Table 1, the developmental times of the immature stages of *H. convergens* that fed on *B. brassicae* were longer than those fed on *A. craccivora* or *H. pruni*. Significant differences were existed in terms of the developmental time of first instar (F= 10.35; P= 0.0001), second instar (F= 6.16; P= 0.0038), fourth instar (F= 10.57; P= 0.0001), pupal period (F= 5.91; P= 0.0047) and total developmental time (egg-adult) (F= 13.18; P= 0.0001). However, there was no significant difference in incubation period (F= 0.93; P= 0.3987), duration of third instar (F= 0.16; P= 0.8555) and pre-pupal period (F= 0.78; P= 0.4629, Table 1).

All the three aphid species were consumed by *H. convergens* larval instars, and fourth instar larvae were the most voracious one (Table 2). The number of prey consumed increased as *H. convergens* larvae proceeded to the next instar and significant differences were existed in the number of preys consumed by first instar larvae (F= 7.17; P= 0.0017), fourth instar larvae (F= 4.65; P= 0.0134) as well as the total number of consumed preys during the larval stage (F= 2.93; P= 0.0617). However, the number of consumed preys by *H. convergens* second (F= 0.61; P= 0.5443) and third instar larvae (F= 1.99; P= 0.1463) did not differ among the three aphid species (Table 2).

Data in Table 3 revealed that the tested aphid species had slight effect on the survivorship of *H. convergens* immature stages. There was no significant difference in the percentages of egg hatching (F= 0.25; P= 0.7794), larval survival (F=0.75; P=0.4947), adult emergence (F= 2.05; P= 0.1715) and generation survival (F= 1.18; P= 0.3419; Table 3).

As shown in Table 4, the three tested aphid species had no effect on the length of pre- (F= 0.51; P= 0.6069) and post- ovipoistional period (F= 1.35; P= 0.2772) of *H. convergens* females. However, significant differences were existed in terms of the length of ovipositional period (F= 4.33; P= 0.2334). As for adult longevity, *H. convergens* females lived longer than males on all tested aphid species. The longevity of *H.*

convergens females was significantly affected by the aphid species provided as preys (F= 4.67; P= 0.0181; Table 4) being longest (52.70 days) on *A. craccivora* and shortest (35.80 days) on *B. brassicae*. However, male longevity was comparable with no significant difference among tested preys (F= 1.03; P= 0.3723; Table 4).

H. convergens females fed on *A. craccivora* laid twice (976.40 eggs/female) as many eggs as those females fed on *B. brassicae* (479.60 eggs/female). Fecundity of *H. convergens* females fed on *H. pruni* was in-between (802.60 eggs/female). Significant differences were existed among the three aphid species in the total life time fecundity (F= 6.52; P= 0.0049), but significant difference was not observed in case of the mean daily number of laid eggs per female (F= 0.31; P= 0.7384; Table 5). As for number of consumed preys throughout the adult life time, females of *H. convergens* consumed on average 5496.00, 3123.80 and 4936.60 preys when fed on *A. craccivora*, *B. brassicae* and *H. pruni*, respectively and significant differences were found among the three aphid species (F= 4.93; F= 0.0150). The total numbers of consumed preys by *H. convergens* males when fed on the respective preys were 3020.30, 2231.30 and 2720.30 nymphs with no significant differences among the three aphid species (F= 0.66; P= 0.5259; Table 5).

Table (1): Preimaginal developmental time (days ±SE) of *H. convergens* fed on *A. craccivora*, *B. brassicae* and *H. pruni* under laboratory conditions.

Preys	Incubation period	Larval stage				Prepupal Period	Pupal period	TDP*
		First instar	Second instar	Third instar	Fourth instar			
A. craccivora	2.85±0.05 a	2.20±0.012 a	2.20±0.15 b	2.08±0.17 a	3.10±0.17 a	0.70±0.06 a	3.73±0.09 b	16.90±0.41 a
B. brassicae	2.90±0.05 a	2.83±0.11 b	2.60±0.10 a	2.03±0.17 a	3.85±0.12 b	0.80±0.06 a	4.43±0.19 a	19.44±0.39 b
H. pruni	2.80±0.06 a	2.15±0.08 a	2.35±0.09 b	1.95±0.13 a	2.98±0.18 a	0.85±0.06 a	4.10±0.14 ab	17.23±0.34 a
F values	0..93	10.35	6.16	0.16	10.57	0.78	5.91	13.18
P values	0.3987	0.0001	0.0038	0.8555	0.0001	0.4629	0.0047	0.0001

Means followed with different letters in the same column are significantly different (Tukey'HSD; P < 0.05).
* indicates total developmental period from egg to adult.

Table (2): Mean (±SE) feeding consumption of *H. convergens* larval instars fed on *A. craccivora*, *B. brassicae* and *H. pruni* under laboratory conditions

Prey species	First instar	Second instar	Third instar	Fourth instar	Total
A. craccivora	29.85±1.60 a	41.90±2.48 a	68.90±5.56 a	154.85±8.00 a	295.55±12.63 a
B. brassicae	21.50±1.03 b	35.95±2.40 a	47.75±2.87 a	130.80±7.35 ab	235.80±9.01 ab
H. pruni	27.10±1.19 a	39.50±1.88 a	65.80±3.30 a	132.05±5.51 b	264.15±7.91 b
F values	F= 7.17	F= 0.61	F= 1.99	F= 4.65	F= 2.93
P values	0.0017	0.5443	0.1463	0.0134	0.0617

Means followed with different letters in the same column are significantly different (Tukey' HSD; P < 0.05).

Table (3): Percentages (±SE) of egg hatching, larval survival, adult emergence and generation survival of *H. convergens* fed on *A. craccivora*, *B. brassicae* and *H. pruni* under laboratory conditions

Prey species	Egg hatching (%)	Larval survival (%)	Adult emergence (%)	Generation survival (%)
A. craccivora	90.00±3.54 a	90.99±1.50 a	95.10±1.96 a	78.00±4.06 a
B. brassicae	89.00±1.87 a	88.76±3.05 a	89.87±2.47 a	71.00±3.67 a
H. pruni	92.00±3.39 a	92.37±1.32 a	92.75±1.53 a	77.00±4.30 a
F value	0.25	0.75	2.05	1.18
P value	0.7794	0.4947	0.1715	0.3419

Means followed with different letters in the same column are significantly different (Tukey' HSD; P < 0.05).

Table (4): Ovipositional periods and longevity of *H. convergens* reared on *A. craccivora*, *B. brassicae* and *H. pruni* under laboratory conditions.

Prey species	Oviposition period			Longevity	
	Pre-ovipositional period	Ovipositional period	Post-ovipositional period	Female	Male
A. craccivora	5.10±0.23 a	41.20±4.45 a	6.40±0.68 a	52.70±3.81 a	34.80±4.64 a
B. brassicae	6.50±0.34 a	23.70±4.73 b	5.60±0.70 a	35.80±5.07 b	27.80±2.52 a
H. pruni	5.20±0.29 a	37.50±4.09 ab	4.80±0.69 a	47.50±4.40 ab	33.40±3.50 a
F value	0.51	4.33	1.35	4.67	1.03
P value	0.6069	0.0234	0.2772	0.0181	0.3723

Means followed with different letters in the same column are significantly different (Tukey' HSD; P < 0.05).

Table (5): Mean (±SE) longevity and feeding consumption of *H. convergens* adults fed on *A. craccivora*, *B. brassicae* and *H. pruni* under laboratory conditions

Prey species	Fecundity		Total number of consumed preys	
	Total	Daily	Female	Male
A. craccivora	976.40±117.76 [a]	23.49±2.43 [a]	5496.00±436.34 [a]	3020.30±591.29 [a]
B. brassicae	479.60±69.79 [b]	23.23±2.65 [a]	3123.80±686.57 [b]	2231.30±301.25 [a]
H. pruni	802.60±102.41 [ab]	21.23±1.41 [a]	4936.60±516.50 [ab]	2720.30±531.48 [a]
F value	6.52	0.31	4.93	0.66
P value	0.0049	0.7384	0.0150	0.5259

Means followed with different letters in the same column are significantly different (Tukey' HSD; $P < 0.05$).

DISCUSSION

It is widely recognized that not all eaten or consumed aphid preys are suitable for aphidophagous coccinellids. Aphid preys are classified into 1) essential preys, which enable developemnet and reproduction, 2) alternate preys, which enable only survival (Hodek and Honek, 1996; Kalushkov and Honek, 2004) and 3) toxic preys, such as *Aphis nerii,* which had ben reported to be toxic to *Hippodamia convergens* (Bristow, 1991). In the present study, *H. convergens* developed successfully and reproduced on the three tested aphid species with low reproduction on *B. brassicae.*

In this study, the developmental time of *H. convergens* was influenced by aphid species particularly in second, fourth, pupal stage and total developmental period, being 2 and 2.5 days shorter when fed on *A. craccivora* and *H. pruni,* respectively as compared when larvae were fed on *B. brassicae.* The differences may be attributed to the higher consumption and palatability of *A. craccivora* (295 nymphs) and *H. pruni* (264 nymphs) as compared to *B. brassicae* (236 nymphs). These findings were in conformity with those reported for *H. convergens* fed on *A. criaccivora* (Bahy-Eldin, 2006) and on *Myzys persicae nicotinae* (Katsarou *et al.,* 2005). The same finding was also found in *Coccinella septumpunctata* (Omkar and Srvistava, 2003). Apparently, the developmental rates of coccinellids seem to be proportional to the amount of prey consumed by their larvae (Omkar and Srvistava, 2003).

The suitability of *A. craccivora* for coccinellids is controversial. This species was reported to be suitable for *C. septumpunctata* (Hodek, 1966) and *H. convergens* (Bahy-Eldin, 2006). However, it was reported to be unsuitable for other coccinellids such as *C. septumpunctata* (Azzam and Ali, 1970), *Harmonia axyridis* (Hukusima and Kamei, 1970). Since the prey species was the same, therefore the differences might be attributed to the different host plant used in these studies.

H. pruni was suitable for the development and reproduction of *H. convergens.* These results are in agreement with those reported by Altihan and Kaydan (2002) who found that *H. pruni* was suitable prey for three coccinellid species, *Exochomus nigromaculatus, Scymnus apetzi* and *Scymnus subivillosus.* The developmental periods of the three respective coccinellid species fed on *H. pruni* were 20.4, 17.1 and 16.7 days. However, data on the survival of *H. convergens* fed on *H. pruni* in the current study are higher than those reported for the three coccinellid species fed on *H. pruni* in the study of Altihan and Kaydan (2002).

In the current study, the second and third instar larvae showed similar feeding consumption on the three aphid species. However, last instar and adult stages responded differently to the tested three aphid species. These results are in consistent with the conclusion of Omkar and Srvistava (2003) who argued that the early instars of coccinellids predate without discriminating toward aphid species, while the older instar and adult stage discriminate between preys and consume large numbers of preys to achieve fast development, biggest size and body weight. Moreover, the prey consumption by *H. convergens* had been reported to be highly affected by temperature (Katsarou *et al.,* 2005). They found that the total consumption of *M. persicae nicotinae* adults by larval stage of *H. convergens* was only 85 adults, which is lower than those reported in this study for the same predator.

Based on the preimaginal survival, results indicated that *H. pruni* and *A. craccivora* were similar in their food quality and nutritional value. However, *B. brassicae* seems to be less important with the lowest rates of survival across all immature stages. Similarly, Phoofolo *et al.* (2007) found that preimaginal survival, body size and weight of *H. convergens* fed the two cereal aphids, *Schizaphis graminum* and *Rhopalosiphum padi,* were prey-dependent.

The length of the pre-ovipositional period was one day longer when fed on *B. brassicae* than on *H. pruni* and *A. craccivora.* This may be due to the fact that low consumption of low quality prey (*B. brassicae*) slowed down the immature development and resulting in slower sex maturation and extended the duration of this non-reproductive phase (Hukusima and Kamei, 1970; Omkar and Srivastava, 2003).

Data of reproduction for *H. convergens* indicated that the three aphid species varied considerably in their values as food for larvae and adults of this predator. *A. craccivora* was the most suitable aphid species in this study with the longest reproduction period (41.20 days) and egg laying capacity (976.40 eggs/female). The causes of the differences between the three tested aphid species are uncertain, but it might be attributable to the differences in their nutritional content that may act as chemical defense against insect predators (Hauge *et al.,* 1998). These findings are in agreement with those reported by Bahy-Eldin (2006) who found that the total lifetime fecundity of *H. convergens* fed on *A. craccivora* was 880 eggs/female. Also data of daily number of deposited eggs/female in this study are in the same trend with those reported for *H. convergens* by Hagen and Sluss (1966) who reported a daily fecundity of 20 eggs/female.

Data in this study also proved that *B. brassicae* was the least suitable prey. This prey was found to be unsuitable and poor quality prey for *Cydonia vicina isis* and *Cydonia vicina nilotica* (Mandour, unpublished).

It could be concluded that *H. convergens* developed successfully on the three tested aphid species. *A. craccivora* and *H. pruni* were equally suitable but *B. brassicae* was poor quality preys. As far as the present author is aware, *B. brassicae* and *H. pruni* have not been investigated as potential preys for *H. convergens*. Therefore, the results of this study broaden the knowledge regarding the prey range of this lady beetle species. Moreover, these results can be utilized in mass rearing by choosing the best prey and in predicting the abundance of this predator population in response to different aphid infestation under field conditions (Omkar and Srvistava, 2003).

ACKNOWLEDGEMENTS

The author would like to thank Dr Sarhan A. A. (Suez Canal University) and Awadallah, K. T. (Cairo University) for their critical comments on the early version of the manuscript and Dr Omkar (University of Lucknow, India) for the identification of *Hippodamia convergens*. Thanks are also extended to all staff of the Biological Control Center, Suez canal University for their help during the course of this study.

REFERENCES

Abdel-Salam, A. H., J. J. Ellington, M. A. El-Adl, A. M. Abou-El-Naga and A. A. Ghanim. (1997). Rearing *Olla-v-nigrum* and *Hippodamia convergens* larvae on an artificial diet and yellow pecan aphids, *Monelliopsis pecanis*. Proceding of First National Conference of Applied Using of Natural Enemies for Controlling Insect and Mite Pests, Mansoura, 4-5 March, 1997.

Altihan, R. and M. B. Kaydan (2002). Developemnt, survival and reproduction of three coccinellids feeding on *Hyalopterus pruni* (Geoffer) (Homoptera: Aphididae). Turkish Journal of Agriculture and Forestry, 26: 119-124.

Azzam, K.M. and M.H. Ali (1970). A study of factor affecting the discrimination of the predatory beetle, *Coccinella septumpunctata* L. Final technical Report (F6-IN-249, A7-ENT-40). Department of Entomology, Andhra Pradesh Agricultural University, Rajendra Nagar, Hyderabad, India.

Bahy-Eldin, I. A. (2006). Studies on the biology and feeding capacity of some coccinellid species. M.Sc. thesis, Faculty of Agriculture, Moshtohor, Banha University.

Bristow, C. M. (1991). Are ant aphid association a tritrophic interaction? Oleander aphids and Argentine ants. Oecologia, 87: 514-521.

Greathead, D. J. and A. H. Greathead (1992). Biological control of insect pests by insect parasitoids and predators: The BIOCAT database. Biocontrol News and Information, 12: 1N-68N.

Hagen, K. and R. R. Sluss (1966). Quality of aphid required for reproduction by *Hippodamia* spp. in the laboratory. *In*: Ecology of aphidophagous Insects. Academia, Prague. Pp 47-59.

Hauge, M. S., F. H. Nielsen and S. Toft (1998). The influence of three cereal aphis species and mixed diet on larval survival, development and adult weight of *Coccinella septumpunctata*. Entomologia Experimentalis et Applicata, 89: 319-322.

Hodek, I. (1966). Bionomics and Ecology of Predaceous Coccinellidae. Annual Review of Entomology, 12: 79-104.

Hodek, I. and A. Honek (1996). Ecology of Coccinellidae. Kluwer Academic Publishers, Dordrecht, 364 pp.

Hukusima, S. and M. Kamei (1970). Effect of various species of aphid as food on development, fecundity and longevity of *Harmonia* aixyridis Pallas (Coleoptera: Coccinellidae). Research Bulletin, Faculty of Agriculture, Gifu University, 29: 53-66.

Kalushkov, P. and I. Hodek (2004). The effect of thirteen aphids on some life history parameters of the ladybird *Coccinella septumpunctata*. BioControl, 49: 21-32.

Katsarou, I., J. T. Margaritopoulos, J. A. Tsitsipis, D. C. Perdikis and K. D. Zarpas (2005). Effect of temperature on development, growth and feeding of *Coccinella septumpunctata* and *Hippodamia convergens* reared on the tobacco aphid, *Myzus persicae nicotianae*. BioControl, 50: 565-588.

Kring, T. J., F. E. Gilstrap and G. J. Michels (1985). Role of indigenous coccinellids on regulating greenbugs (Homoptera: Aphididae) on Texas grain sorghum. Journal of Economic Entomology, 78: 269-273.

Mohammed, A. H., J. Lester and T. O. Holtzer (2000). Abundance and effects of predators and parasitoids on the Russian wheat aphid (Homoptera: Aphididae) under organic farming in Colorado. Environmental Entomology, 29: 360-368.

Obrycki, J. J. and T. J. Kring (1998). Predaceous Coccinellidae in biological control. Annual Review of Entomology, 43: 295-321.

Omkar and S. Srivastava (2003). Influence of six aphid species on the development and reproduction of the ladybird beetle, *Coccinella septumpunctata*. BioControl, 48: 379-393.

Phoofolo, M., K. L. Giles and N. C. Elliott (2007). Quantative evaluation of suitability of the greenbug, *Schizaphis graminum*, and the bird cherry-oat aphid, *Rhopalosiphum padi*, as preys for *Hippodamia convergens* (Coleoptera: Coccinellidae). Biological Control, 41: 25-32.

SAS Institute (2003). SAS/STAT Version 8.2. SAS Institute, Cary, NC.

نمو، وبقائية ، والإستهلاك الغذائى ، وإنتاجية أبو العيد هيبوديميا كونفرجنس المتغذى على ثلاثة أنواع من حشرات المن

ناصر سعيد مندور
قسم وقاية النبات – كلية الزراعة – جامعة قناة السويس- ٤١٥٢٢ الإسماعيلية – مصر

تم دراسة نمو الأطوار غير الكاملة، ومعدل البقاء، والإستهلاك الغذائى ، والإنتاجية لأبى العيد هيبوديميا كونفرجنس على ثلاثة أنواع من حشرات المن هى من اللوبيا، ومن الكرنب ، ومن البرقوق الدقيقى تحت الظروف المعملية. أظهرت النتائج أن فترة النمو لهذا المفترس قد تأثرت معنوياً بنوع الفريسه المتغذى عليها ، حيث كانت أطول فترة نمو(من البيضة – الحشرة الكاملة) هى (١٩,٤٤ يوم) عند التغذية على من الكرنب وأقصرها (١٦,٩ يوم) عند التغذية على من اللوبيا. إزداد عدد الأفراد المستهلكة بواسطة يرقات أبو العيد هيبوديميا كونفرجنس بتقدم اليرقة فى العمر وكان هناك فروق معنوية فى العدد الكلى للفرائس المتغذى عليها خلال الطور اليرقى لهذا المفترس، حيث بلغت أعلاها (٢٩٥,٥٥ حورية) من حشرات من اللوبيا، وأقلها (٢٣٥,٨ حورية) عند التغذية على من الكرنب. لم يكن لأنواع الفرائس الثلاثة أى تأثير معنوى على نسبة الفقس، ونسبة بقاء اليرقات، و نسبة خروج الحشرات الكاملة، ونسبة بقاء الجيل (البيضة – الحشرة الكاملة). أيضاً لم يكن لأنواع المن الثلاثة أى تأثير معنوى على طول فترة ما قبل وضع البيض، وفترة ما بعد وضع البيض، وطول حياة الذكور لهذا المفترس. على العكس من ذلك، كان هناك تأثيرمعنوى لأنواع المن الثلاثة على طول فترة وضع البيض، وطول حياة الإناث، وعدد البيض الكلى للأنثى. إستهلكت الإناث عدداً أكبر من حشرات من اللوبيا (٥٤٩٦ حورية) مقارنة بالفرائس المستهلكة من حشرات من الكرنب (٣١٢٣,٨٠ حورية) ومن البرقوق الدقيقى (٤٩٣٦,٦٠ حورية). على العكس من ذلك، لم يكن هناك فروق معنوية فى عدد الفرائس المستهلكة بواسطة الذكور من أنواع المن الثلاثة.