Jurnal Perlindungan Tanaman Indonesia, Vol. 22, No. 2, 2018: 210–216
DOI: 10.22146/jpti.26191

Research Article

Comparison of Feeding Ability between *Ischiodon scutellaris* (Diptera: Syrphidae) and *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) on *Aphis craccivora* (Hemiptera: Aphididae)

Perbandingan Kemampuan Makan antara Ischiodon scutellaris *(Diptera: Syrphidae) dan* Menochilus sexmaculatus *(Coleoptera: Coccinellidae) terhadap* Aphis craccivora *(Hemiptera: Aphididae)*

Adhyatma Noor Rizal[1)]*, Nugroho Susetya Putra[1)], & Suputa[1)]

[1)]*Department of Plant Protection, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta*
Jln. Flora No. 1, Bulaksumur, Sleman, Yogyakarta 55281

**Corresponding author. E-mail:adhyatma.noor.r@mail.ugm.ac.id*

Received June 22, 2017; accepted September 19, 2017

ABSTRACT

Study on the feeding ability of two predators of *Aphis craccivora* (Koch), i.e. larvae of syrphid fly, *Ischiodon scutellaris* and coccinellid beetle, *Menochilus sexmaculatus* has been done in the laboratory. The study was conducted to determine the impacts of prey densities on larval development time, and the survival rate of larval stage. The results showed that *M. sexmaculatus* larvae required more prey than *I. scutellaris* in the 1st instar, but *I. scutellaris* ate more prey than *M. sexmaculatus* in the 3rd instar. Furthermore, addition of prey number shortened significanly the development time of the larvae stage, almost all of 1st and 3rd instars *M. sexmaculatus* and *I. scutellaris* were able to develop into pupae, whereas, only 45% out of total 1st instar provided with 20 prey individuals succeed to pupate. The impact of the number of prey on the biology of aphidophaga in relation to their role as controlling aphid in nature is discussed in this paper.

Keywords: *Aphis craccivora*, feeding ability, *Ischiodon scutellaris*, *Menochilus sexmaculatus*

INTISARI

Kajian tentang kemampuan makan dua predator Aphis craccivora *(Koch), yaitu larva lalat syrphid,* Ischiodon scutellaris *dan kumbang koksi,* Menochilus sexmaculatus *telah dilakukan di laboratorium. Kajian juga dilakukan untuk memahami dampak jumlah mangsa pada lama perkembangan larva menjadi pupa dan keloloshidupan larva menjadi pupa. Hasil kajian menunjukkan bahwa larva* M. sexmaculatus *membutuhkan lebih banyak mangsa daripada* I. scutellaris *pada instar 1, namun* I. scutellaris *makan lebih banyak mangsa daripada* M. sexmaculatus *pada instar 3. Hasil penelitian juga menunjukkan bahwa penambahan mangsa mempercepat waktu perkembangan larva secara signifikan. Semua larva instar 1 dan 3* M. sexmaculatus *dan* I. scutellaris *mampu lolos menjadi pupa, kecuali larva instar 1* M. sexmaculatus *yang hanya mampu lolos menjadi pupa sebanyak 45% jika diberi mangsa 20 ekor. Dampak jumlah mangsa pada biologi afidofaga dalam kaitannya dengan peran mereka sebagai pengendali populasi kutu afid di alam dibahas dalam tulisan ini.*

Kata kunci: Aphis craccivora*,* Ischiodon scutellaris*, kemampuan makan,* Menochilus sexmaculatus

INTRODUCTION

Aphis craccivora (Koch) is noted as an important pest on legume and ornamental crops in the world (Kalshoven, 1981). Feeding activity directlies damage the plant directly due mecanical injury and loss of phloem sap. In addition, it has long history for transmitting viruse diseases on many cropspecies, for example on *Vicia fabae* (Allam & El-Kady, 1966; Nuessly *et al*., 2004), *Vigna unguiculata* (Atiri & Thottappilly, 1985; Damiri *et al.*, 2013), and citrus (Satar & Onelge, 2009). The use of natural enemies is one of the best alternative for controlling this aphids, since many species of predator and parasitoid often naturally present in fields. Among the huge number of aphidophagous insects, ladybeetle (Coleoptera: Coccinellidae) and hover fly (Diptera: Syrphidae) are noted as important predators due to their ability to consume a high number of aphids.

Menochilus sexmaculatus (Coleoptera: Coccinellidae) is a common aphidophagous beetle which has a wide range of preys (Rajamohan & Jayaraj, 1973; Mari *et al*., 2004; Rana, 2006). This species also has a wide distribution area, so its ability to prey upon different species of prey has been received much attention. In general, *M. sexmaculatus* showed a good response to prey densities, although apparently it more likely to forage on a smaller number of prey density, as showed in a study by Agarwala *et al*. (2001). In addition, the female of coccinellid shows resource partitioning in terms of body size and density of prey. Chaudary *et al*. (2015) revealed that small and big female of *M. sexmaculatus* tended to prey on small and big instars of aphids, respectively.

Meanwhile, *Ischiodon scutellaris* (Diptera: Syrphidae) is also well known as aphid predator. However, it has received only a few attention by ecologist. In general, several studies have been showing the importance of predatory syrphids to suppress the populations of aphids. For example, Gilbert (2005) noted that predatory syrphids having many types prey species and each species might has prey specifity. Thus, in terms of shaping community structure, the occurence of predatory syrphids is very important. In addition, Tenhumberg and Poehling (1995) showed that population of syrphid reached maximum number at prey density of 100 aphids per day at temperature above 22°C, indicating that it is a potential prodator that has positive response to aphid population.

Furthermore, although studies on the feeding ability of *I. scutellaris* and *M. sexmaculatus* on *Aphis craccivora* and other aphids are numerous, study to compare their feeding ability on the same prey is rare. This experiment was done to determine the feeding ability of the two predator species, and its ecological consequence to suppress the population of aphid in field based on their response to prey density.

MATERIALS AND METHODS

Insect Culture

Cultures of *Ischiodon scutellaris*, *Menochilus sexmaculatus,* and *Aphis craccivora* were maintained at the Laboratory of Basic Entomology, Faculty of Agriculture, University of Gadjah Mada at room condition (temperature 24−26.5°C and relative humidity 67%−85%).

Aphid as prey for both predators were fed with yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis*), seedlings were grown on soil prepared in small plastic tray (28.5 cm × 21 cm). Larvae of *I. scutellaris* were collected from yardlong bean in Magelang and Sleman Regency, then were placed in petri dishs (5.5 cm in diameter and 1cm in height) and were provided with *A. craccivora* as prey until pupal stage. Pupae were placed in *mushlin* cages (30 × 30 × 30 cm) under 16 light :8 dark hours of photoperiod until emerged into adult. Cuttings of yardlong bean seedling with a colony of *A. craccivora* were placed into the cage to collect the eggs of syrphids. A bamboo stick was smeared with the mixture of bee pollen and honey (ratio 1g/10 mL) was placed as feed for flies. Whereas, *M. sexmaculatus* was reared by collecting larvae and placed in the petri dishes (5.5 cm in diameter and 1 cm in height) with paper tissue and provided with *Aphis craccivora* as prey until pupation. Pupae were placed in another petridishes under 16L:8D of photoperiod until emerged into adult. The seedling with a colony of *A. craccivora* and a pair of *M. sexmaculatus* was placed into petridishes until females lay eggs.

Feeding Performance of Predators

The experiment was done at the Basic Entomology Laboratory at temperature 24°−25°C and relative humidity of 66−85% (similar to methods by Saleem *et al*., 2014 and Jalilian, 2015). Four densities of aphid, i.e. 20, 40, 60, and 80 individu as treatment were each arranged in small plastic petridish (5.5 cm in diameter and 1cm in height) prior to placement of a single individu of 1st and 3rd instars of *I. scutellaris* or *M. sexmaculatus.* The number of *A. craccivora* consumed by either predator was recorded 24 hours after trial starts, and feeding rate of each predator was calculated by using formula proposed by Jalilian (2015):

Each treatment was replicated 20 times, and observed daily until entered the pupal stage. The feeding rate of predators was determined by counting the number of prey eaten on each prey density by the 1st and 3rd instar of predators, and the pattern of functional response of these two predators was determined by using Holling equation (Holling, 1965; Spring, 2001). *T*-test analysis was done to compare the feeding rate of both predators at the same instar (Ist instar of *I. scutellaris* vs Ist instar of *M. sexmaculatus,* and at the 3rd instars as well).

Correlation test was also performed to calculate the equation and to determine the type of functional response of each predator. All of statistical analysis were done by using SAS 9.1.3 software (SAS Institute Inc., 2013).

RESULTS AND DISCUSSION

Prey Consumption of the Two Predators

The results showed that the two predators responded positively on prey. Either predator increased prey consumtion with the increase of the prey densities (Figure 1). However, this experiment also revealed that the larvae of *I. scutellaris* and *M. sexmaculatus* have different responses to prey densities, coccinellid larvae were more voracious then were syrphid larvae at 1st instar, but it was less voracious when they were at the 3rd instar.

The number of prey consumed by the 1st instar larva of *I. scutellaris* never exceed 21 individuals (Table 1) on all prey densities, while 1st instar larva of *M. sexmaculatus* seemed to follow the density of preys offered. The 3rd instar of both predators increased with the increase of prey densities. But, the 3rd instar larva of *I. scutellaris* consumed little higher number of prey individuals than *M. sexmaculatus* at all prey densities.

The 1st instar of *M. sexmaculatus* had linear response to the increase of prey densities, while *I. scutellaris* seemed to consume lower number of prey at 60 and 80 prey densities (Figure 1). In contrast, the number of prey consumed by the 3rd instar larva of *I. scutellaris* followed the increse of prey number, while the 3rd instar larva of *M. sexmaculatus* tended to follow the type II of Holling's functional response. Figure 1 also showed the superiority of *M. sexmaculatus* preyed on aphid as compared to *I. scutellaris* at 1st instar larvae. However, the predation ability of 3rd instar of *M. sexmaculatus* larvae was inferior when compared to *I. scutellaris*.

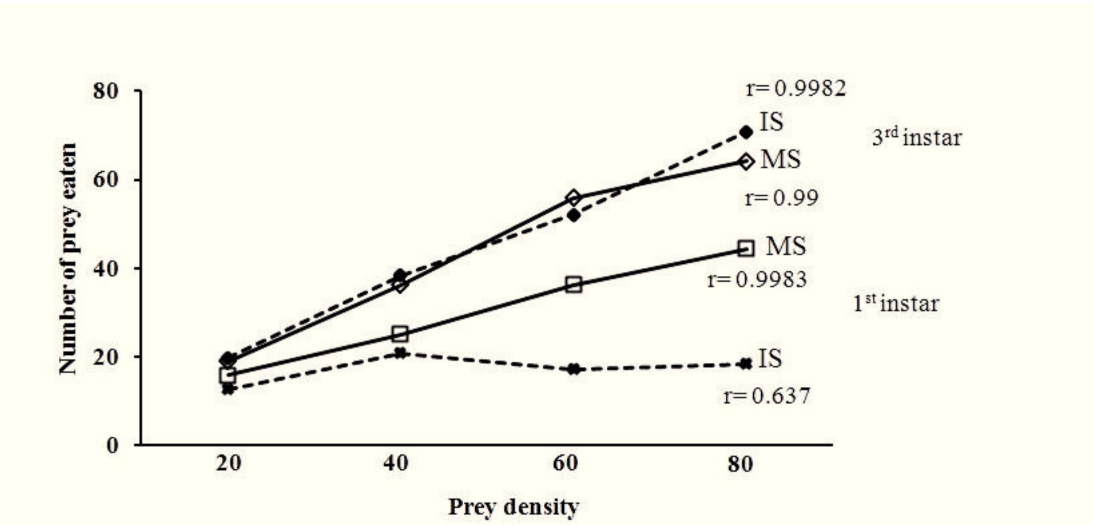

Figure 1. Relationship between prey density and number of prey eaten per day per single larva of *Ischiodon scutellaris* (IS) and *Menochilus sexmaculatus* (MS)

Table 1. Comparison of voraciousness of *Ischiodon scutellaris* and *Menochilus sexmaculatus* when fed on different densities of *Aphis craccivora*

Prey density	Average of prey consumed (n=20)			
	Ischiodon scutellaris		*Menochilus sexmaculatus*	
	1st instar larval	3rd instar larval*	1st instar larval*	3rd instar larval
20 individual	12.55 ± 0.68	19.72 ± 0.72	15.80 ± 1.31	18.92 ± 2.35
40 individual	20.85 ± 1.85	38.35 ± 1.14	24.98 ± 3.38	36.19 ± 2.34
60 individual	17.12 ± 0.72	52.08 ± 1.26	36.22 ± 4.16	55.88 ± 5.38
80 individual	18.38 ± 0.78	70.89 ± 4.16	44.40 ± 4.76	64.20 ± 4.30

Remark: *show the significant difference on feeding capacity between *Ischiodon scutellaris* and *Menochilus sexmaculatus* at the same instar

Survival Rates

Based on two *A. craccivora* predators survival trial, all larvae of both aphidophagous species survived and succeeded entering pupal stage at prey densities of 40, 60, and 80 individuals. Except *M. sexmaculatus* at prey density of 20 individuals, there were only 45% of *M. sexmaculatus* completed larval stage when they are provided with 20 individuals of prey. In comparison, all *I. scutellaris* successfully entered pupal stage at the same prey density. This statement is accordance with the Rudiyanto *et. al*. (2011) research are concluded that *M. sexmaculatus* had a maximum point of prey capacity at around 20 up to 50 aphids if compared with *I. scutellaris* / Syrphidae larvae had an ever-increasing prey on each instar and was able to adjust its feeding abilities (Amiri-Jami & Sadeghi-Namaghi, 2014). These in accordance with the results of research Edwards *et. al.* (1979) which states that monophagus predators have an increased survival rate in every available prey population compared to polyphagus predators that have a saturation point in the number of prey. If both of these predator placed in the same placed, then syrphidae has greater survival rate than coccinellidae because syrphidae can adjust the predation ability to their prey body size

Developmental Time of Larval Stage

Developmental time of larval stage is significantly affected by prey densities ($F_{(df=3)}$ = 2.75; P<0.001 for *M. sexmaculatus* and $F_{(df=3)}$ = 2.72; P<0.001 for *I. scutellaris*). In general, the development time was shorter when both predator species fed on higher prey densities (Table 2). *I. scutellaris* have the average development time 1−2 days shorter than *M. sexmaculatus* above 20 individuals of prey and significantly on 80 individuals of prey. Some factors may contribute to the performance of aphidophagous insects when feeding on their prey, i.e. optimum foraging behavior by larvae, degree of voraciousness of larvae, the availability of prey (prey density), and larval stage of predator as also shown in other studies by Ofuya (1986) and Chaudary *et al.* (2015) on coccinellid, and Putra and Yasuda (2006) on predatory syrphid. In this study, larvae of *M. sexmaculatus* tends to be more voracious than *I. scutellaris* at the 1st instar larva, although a contrary result was shown at the 3rd instar.

Table 2. Mean developmental time from first instars to pupae in days (± SE) of *Menochilus sexmaculatus* and *Ischiodon scutellaris* when fed on different densities of *Aphis craccivora*

Prey density	Developmental time (days)	
	M. sexmaculatus	*I. scutellaris*
20	8.00 ± 0.00	8.45 ± 0.11
40	7.25 ± 0.10	6.00 ± 0.00
60	7.45 ± 0.10	6.00 ± 1.00
80	7.00 ± 0.00	5.25 ± 0.10

Some studies suggest that the searching ability of predators on prey may contribute to the number of prey consumed. In addition, oviposition behavior of adults may also determine the ability of larvae to find prey. Evans (2003) showed that female aphidophagous ladybird beetles lays their eggs patchily, and does not always correlate with aphid density. In other study, Evans and Dixon (1986) showed that the coccinellids use both individual aphid as well as its odor and honeydew as their cues for oviposition, although the odor and honeydew are proven to be more interesting for the beetle, as was also showed by Das and Dixon (2011) on *Adalia bipunctata*. However, the searching ability of coccinellid is relatively high, although mostly at random. Thus, the effect of oviposition behavior of coccinellid may not strongly correlated with the searching ability of the larva.

In contrary, Kan (1988; 1989) showed that aphidophagous syrphid, *Episyrphus balteatus*, tends to lay eggs on young, small, or early population of aphids; and neglects large colonies and including ones of winged adults. In addition, Tenhumberg and Poehling (1995) revealed that the number of eggs laid by syrphid is positively correlated with aphid abundance. Thus, the oviposition preference-larval performance seems to be strong correlated in syrphid as shown in Putra *et al*. (2009). They found that the number of eggs laid by adult of syrphids was significantly fewer when faced to higher risk of aphid colony with the presence of intraguild predators.

Furthermore, the mechanism of larval movement may also contribute to the success of predation. For example, Rotheray (1987) explained the moving mechanism used by syrphid larvae to reach prey which is determined by the morphological traits of larvae and the shape and structure of plant. although the larvae is acepala, syrphidae larvae move use their stomachs can find the prey use the *seta* around their cuticles (sensillium). On the other hand, a coccinellid larva has true legs by which they move around the surface of plant to find prey much more easily (Hodek & Honek, 1996). Syrphid larvae have more restricted movement than coccinellid. However, study by Bargen *et al*. (1998) showed that prey finding by the 1st instar of syrphid larvae is guided by aphid-borne volatiles which enabling larvae to locate prey more precisely.

This study was also showed that prey availability determined the performance of larvae including the survival rate and development time of larvae. In general, this study showed that the development time of larval stage was shorter when they prey on more dense prey, supporting previous study by other researchers. For example, Schaffner and Anholt (1998) showed that growth of damselfly larvae, *Ischnura elegans* was significantly reduced on lower density of prey. Other study by Putra and Yasuda (2006) revealed that two aphidophagous syrphids, *E. balteatus* and *E. corollae*, the development time more briefly when fed on denser preys and enabled them to survive better.

There are some advantages of using predatory syrphid and coccinellid to control aphid populations. Aphidophagous syrphids enable to suppress the aphid population at early colony development (Kan, 1998; 1989), while coccinellids occupy patches spaces with denser individuals of aphids to fulfill the needs of the larvae (Evans & Dixon, 1986; Hemptinne *et al*., 2000; Das & Dixon, 2011). It's based on the studies about the maximum *A. craccivora* population are able to deplete by first instar Syrphidae amount 20 (Amiri-Jami & Sadeghi-Namaghi, 2014), when the last instar Coccinellidae have ability to deplete every amount of aphids population (Wagiman, 1996). The results from this study are also complementing previous results on the beneficial function of aphidophagous syrphid and coccinellid to control aphid. Thus, efforts to maintain their presence in field should be done, for example with providing extrafood from flowering plants to increase the settlement of natural enemies. Extra food is non-prey foods are important for the insect survival life and recovery metabolism energy after hibernate on the pupal phase (Gurr & Wratten, 1999). Generally, this food are cover crop pollen (Bugg *et al*., 1996) and many of predator insect such as: Syrphidae (Gilbert, 1981), Carabidae (Ahmad *et. al*., 2006), Coccinellidae (Lundgren & Wiedenmann, 2004), Chrysopidae (Villenave *et. al*., 2005), and Formicidae (Wheeler & Bailey, 1920) use them as their extra food.

CONCLUSION

The results showed that *M. sexmaculatus* larvae required more prey than *I. scutellaris* in 1st instar, but *I. scutellaris* ate more prey than *M. sexmaculatus* in the 3rd instar. The results also showed that the addition of prey also reduce significantly the development time of the larvae into pupae. Almost all of 1st and 3rd instar *M. sexmaculatus* and *I. scutellaris* were able to develop into pupae, whereas, only 45% of the 1st instar larvae of *M. sexmaculatus* succeeded to develop into pupae when they were given prey at 20 individuals.

LITERATURE CITED

Agarwala, B.K., P. Bardhanroy, H. Yasuda, & T. Takizawa. 2001. Prey Consumption and Oviposition of the Aphidophagous Predator *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) in Relation to Prey Density and Adult Size. *Environmental Entomology* 30: 1182−1187.

Ahmad, F., S. Banne, M. Castro, G. Chavarria, J. Clarke, L. Collette, C. Eardley, V. Fonseca, B.M. Freitas, C. French, B. Gemmill-Herren., C. Griswold, C. Gross, P. Kwapong, E. Lundall-Magnuson, R. Medellin, U. Partap, S. G. Potts, D. Roth, M. Ruggiero, R. Urban, & G. Willemse. 2006. Adaptive Management of Pollinators for Crop Plants and Wildlife, p. 19−27. *In* C. Eardley, D. Roth, J. Clarke, S. Buchmann, & B. Gemmill-Herren (eds.), *Pollinators and Pollination: A Resource Book for Policy and Practice*, African Pollinator Initiative, Pretoria.

Akre, B.G. & D.M. Johnson. 1979. Switching and Sigmoid Functional Response Curves by Damselfly Naiads with Alternative Prey Available. *Journal of Animal Ecology* 48: 703−720.

Allam, E.K. & E.A. El-Kady. 1966. A Virus Causing a Mosaic Disease of Broad Bean and its Vector *Aphis craccivora* in Egypt. *Entomologia Experimentalis et Applicata* 9: 413−418.

Amiri-Jami, A.R. & H. Sadeghi-Namaghi. 2014. Responses of *Episyrphus balteatus* DeGeer (Diptera: Syrphidae) in Relation to Prey Density and Predator Size. *Journal of Asia-Pacific Entomology* 17: 207−211.

Atiri, G.L. & G. Thottappilly. 1985. *Aphis craccivora* Settling Behaviour and Acquisition of Cowpea-borne Mosaic Virus in Aphid-resistant Cowpea Lines. *Entomologia Experimentalis et Applicata* 39: 241−245.

Bargen, H., K. Saudhof, & H.-M. Poehling. 1998. Prey Finding by Larvae and Adult Females of *Episyrphus balteatus*. *Entomologia Experimentalis et Applicata* 87: 245−254.

Bugg, R.L., G. Mcgourty, M. Sarrantonio, & R. Bartolucci. 1996. Comparison of 32 Cover Crops in an Organic Vineyard on the North Coast of California. *Biological Agriculture and Horticulture* 13: 63−81.

Chaudary, D.D., B. Kumar, G. Mishra, & Omkar. 2015. Resource Partitioning in a Ladybird, *Menochilus sexmaculatus*: Function of Body Size and Prey Density. *Bulletin of Entomological Research* 105: 121−128.

Damiri, B.V., I.M. Al-Shahwan, M.A. Al-Saleh, O.A. Abdalla, & M.A. Amer. 2013. Identification and Characterization of Cowpea Aphid-borne Mosaic Virus Isolates in Saudi Arabia. *Journal of Plant Pathology* 95: 79−85.

Das, B.C. & A.F.G. Dixon. 2011. Assessment of Patch Quality by Aphidophagous Ladybirds: Laboratory Study on the Minimum Density of Aphids Required for Oviposition. *European Journal of Environmental Sciences* 1: 57−60.

Edwards, C.A., K.D. Sunderland, & K.S. George. 1979. Studies on Polyphagous Predators on Cereal Aphids. *Journal of Applied Ecology* 16: 811−823.

Evans, E. & A.F.G. Dixon. 1986. Cues for Oviposition by Ladybird Beetles (Coccinellidae): Response to Aphids. *Journal of Animal Ecology* 55: 1027−1034.

Evans, E.E. 2003. Searching and Reproductive Behaviour of Female Aphidophagous Ladybirds (Coleoptera: Coccinellidae): A Review. *European Journal of Entomology* 100: 1−10.

Gilbert, F. 1981. Foraging Ecology of Hoverflies: Morphology of the Mouthparts in Relation to Feeding on Nectar and Pollen in Some Common Urban Species. *Ecological Entomology* 6: 245−262.

Gilbert, F. 2005. Syrphid Aphidophagous Predators in a Food-web Context. *European Journal of Entomology* 102: 325−333.

Gurr, G. & S. Wratten. 1999. Integrated Biological Control: A Proposal for Enhancing Success in Biological Control. *International Journal of Pest Management* 45: 81−84.

Hemptinne, J.-L., M. Doumbia, & A.F.G. Dixon. 2000. Assessment of Patch Quality by Ladybirds: Role of Aphid and Plant Phenology. *Journal of Insect Behavior*13: 353−359.

Hodek, I. & A. Honek. 1996. *Ecology of Coccinellidae*. Kluwer Academic Publishers, Dordrecht. 464 p.

Holling, C.S. 1965. The Functional Response of Predators to Prey Density and its Role in Mimicry and Population Regulation. *Memoirs of the Entomological Society of Canada* 97: 5−60.

Jalilian, F. 2015. Biology and Larval Feeding Rate of *Episyrphus balteatus* (Diptera:Syrphidae) on *Aphis pomi* (Hemiptera: Aphididae) on Laboratory Conditions. *Biological Forum* 7: 1395−1399.

Kalshoven. L.G.E. 1981. *The Pests of Crops in Indonesia*. PT. Ichtiar Baru-van Hoeve, Jakarta. 701 p.

Kan, E. 1988. Assessment of Aphid Colonies by Hoverflies. I. Maple Aphids and *Episyrphus balteatus* (de Geer) (Diptera: Syrphidae). *Journal of Ethology* 6: 39−48.

Kan, E. 1989. Assessment of Aphid Colonies by Hoverflies. III. Pea Aphids and *Episyrphus balteatus* (de Geer) (Diptera: Syrphidae). *Journal of Ethology* 7: 1−6.

Lundgren, J.G., & R.N. Wiedenmann. 2004. Nutritional Suitability of Corn Pollen for the Predator *Coleomegilla maculata* (Coleoptera: Coccinellidae). *Journal of Insect Physiology* 50: 567–575.

Mari, J.M., S.M. Nizamani, M.K. Logar, & R.D. Khuhro. 2004. Biology of *Menochilus sexmaculatu*s Fab. and *Coccinella undecimpunctata* L. (Coccinellidae: Coleoptera) on Alfalfa Aphid *Therioaphis trifolii* Monell. *Journal of Asia-Pasific Entomology* 7: 297−301.

Nuessly, G.S., M.G. Hentz, R. Beiriger, & B.T. Scully. 2004. Insects Associated with Faca Bean, *Vicia faba* (Fabales: Fabaceae) in Southern Florida. *Florida Entomologist* 87: 204−211.

Ofuya, T.I., 1986. Predation by *Cheilomenes vicina* (Coleoptera: Coccinellidae) on the Cowpea Aphid, *Aphis craccivora* (Homoptera: Aphididae): Effect of Prey Stage and Density. *Entomophaga* 21: 331−335.

Putra, N.S. & H. Yasuda. 2006. Effects of Prey Species and its Density on Larval Performance of Two Species of Hoverfly Larvae, *Episyrphus balteatus* de Geer and *Eupeodes corollae* Fabricius (Diptera: Syrphidae). *Applied Entomology and Zoology* 41: 389−397.

Putra, N.S., H. Yasuda, & S. Sato. 2009. Oviposition Preference of Two Hoverfly Species in Response to Risk of Intraguild Predation. *Applied Entomology and Zoology* 44: 29−36.

Rajamohan, N. & S. Jayaraj. 1973. Studies on the Reproduction of the Coccinellid *Menochilus sexmaculatus* F. on Four Species of Aphids. *Zeitschrift fuer Angewandte Entomologie* 74: 388−393.

Rana, J.S. 2006. Response of *Coccinella septempunctata* and *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) to their Aphid Prey, *Lipaphis erysimi* (Hemiptera: Aphididae) in Rapeseed-mustard. *European Journal of Entomology* 103: 81−84.

Rotheray, G.E. 1987. Larval Morphology and Searching Efficiency in Aphidophagous Syrphid Aphids. *Entomologia Experimentalis et Applicata* 43: 49−54.

Rudiyanto, I., S. Rahayuningtiyas, & E. Widhianingtyas. 2011. Kemampuan pemangsaan *Menochilus sexmaculatus* F. (Coleoptera: Coccinellidae) terhadap *Rhopalosiphum maidis* Fitch (Homoptera: Aphididae) [Predation Ability of *Menochilus sexmaculatus* F. (Coleoptera: Coccinellidae) on *Rhopalosiphum maidis* Fitch (Homoptera: Aphididae)]. *Jurnal Entomologi Indonesia* 8: 1−7.

Saleem, M., D. Hussain, H. Anwar, G. Ghouse, & M. Abbas . 2014. Predation Efficacy of *Menochilus sexmaculatus* Fabricus (Coleoptera: Coccinellidae) against *Macrosiphum rosae* under Laboratory Conditions. *Journal of Entomology and Zoology Studies* 2: 160−163.

Sarmento, R.A., A. Pallini, M. Venzon, O.F.F. de Souza, A.J. Molina-Rugama, & C.L. de Oliveira. 2007. Functional Response of the Predator *Eriopis connexa* (Coleoptera: Coccinellidae) to Different Prey Types. *Brazilian Archives of Biology and Technology* 50: 121−126.

SAS Institute Inc. 2013. SAS 9.1.3 Software.

Satar, S. & N. Onelge. 2009. First Report of the Transmission of Citrus Yellow Vein Clearing by *Aphis craccivora* Koch. *Journal of Plant Pathology* 91: S99.

Schaffner, A.K. & B.R. Anholt. 1998. Influence of Predator Presence and Prey Density on Behavior and Growth of Damselfly Larvae (*Ischnura elegans*) (Odonata: Zygoptera). *Journal of Insect Behavior* 11: 793−809.

Spring. 2001. Holling Disc Equation: Student Manual. *Biology* 1240: 1−14.

Tenhumberg, B. & H. Poehling. 1995. Syrphids as Natural Enemies of Cereal Aphids in Germany: Aspects of their Biology and Efficacy in Different Years and Regions. *Agriculture, Ecosystems and Environment* 52: 39−43.

Villenave, J., D. Thierry, A. Al-Mamun, T. Lode., & E. Rat-Morris. 2005. The Pollens Consumed by Common Green Lacewings *Chrysoperla* spp. (Neuroptera: Chrysopidae) in Cabbage Crop Environment in Western France. *European Journal of Entomology* 102: 547−552.

Wagiman, F.X. 1996. Respon Fungsional *Menochilus sexmaculatus* Fabricius terhadap *Aphis gossypii* Glover [Functional Response of *Menochilus sexmaculatus* Fabricius against *Aphis gossypii* Glover]. *Jurnal Perlindungan Tanaman Indonesia* 2: 38−43.

Wheeler,W.M & I. W. Bailey. 1920. The Feeding Habits of Pseudomyrmine and Other Ants. *Transactions of the American Philosophical Society* New Series 22: 235−279.