Journal of Entomology

ISSN 1812-5670

Academic Journals Inc.

www.academicjournals.com

Journal of Entomology 8 (3): 240-249, 2011
ISSN 1812-5670 / DOI: 10.3923/je.2011.240.249

The Survey of Green Lacewings and Occurrence of *Apertochrysa* sp. (Neuroptera: Chrysopidae) on Various Plants in Malaysia

M.A.A. Alasady, D.B. Omar, R.B. Ibrahim and Y.B. Ibrahim
Department of Plant Protection, Faculty of Agriculture, University Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia

Corresponding Author: M.A.A. Alasady, Department of Plant Protection, Faculty of Agriculture, University Putra Malaysia, 43400 UPM, UPM Post Office P.O. Box 407, Serdang, Selangor, Malaysia

ABSTRACT

To determine the species of green lacewings, determine the parasitism of parasite *Telenomus* sp. on the eggs of *Apertochrysa* sp. and study the occurrence of *Aper-tochrys* sp. within the field of corn plants, the experiments were carried out during 2007-2008 in Malaysian agro ecosystem. Collection and direct eggs observation were used in this investigation. Only 18 plants have the eggs of *Apertochrysa* sp. from 43 surveyed plants. Highest percentage of eggs collected of *Apertochrysa* sp. 65.84% was collected from citrus trees followed by 26.47% was collected from vegetable plants. The *Telenomus* sp. was highly affected on the eggs of *Apertochrysa* sp. and the highest parasitism was re-corded on the eggs which found on corn plant (14%). While, the parasitism was 9.2% on eggs that found in citrus tree. The females of *Apertochrysa* sp. preferred to lay their eggs on corn plants planted at the east sits of the field. All methods used like handmade white plastic collision trap, sticky traps, knockdown (sondage sampling), shaking, food attractant traps, air blower, spray the adult's food, color plastic card board traps failed to capture the adults and to sample the immature stages except the eggs directly observation.

Key words: Predator, biological control, *Telenomus* sp., parasite, Malaysia

INTRODUCTION

The green lacewings (Neuroptera: Chrysopidae) are an important group of insect predators (Dean and Satasook, 1983), that can be mass reared in the laboratory and used against insect pests (Ashfaq *et al*., 2002; Syed *et al*., 2008). Their ability to adapt to a wide range of ecological factors (Ulhaq *et al*., 2006) and tolerance to insecticides (Bigler, 1984; Nasreen *et al*., 2003) has made them important in research and field application.

Predators play an important role in the complex ecosystem and the green lacewing (Neuroptera: Chrysopidae) is one of these important predator (Zeleny, 1984), which is a powerful biological control agent against various homopterous, lepidopterous and others soft bodied insect pests in field and green house (Duelli, 2001).

The host plant preferences and ovipositional preferences of the chrysopid predators are factors which decide the effectiveness of the predators on the different host plants (Ballal and Singh, 1999)

The species of the family Chrysopidae such as *Chrysopa* sp., *Ankylopteryx trimaculata* Gerst., *Ankylopteryx octopunctata* F., *Nothochrysa evanescens*, Mch. and *Italochrysa ae-qualis* Walk (Yunus and Ho, 1980) and the recent recorded green lacewing *Apertochrysa* sp. (Alasady *et al*., 2010) have been recorded from Malaysian agro-ecosystem and *Gleno-chrysa* sp. has been reported

from Malaysian lowland tropical rain forest (Sajap *et al*., 1997) and these natural enemies can play a very important role in agriculture and forest ecosystem in Malaysia (Yunus and Ho, 1980; Sajap *et al*., 1997; Alasady *et al*., 2010).

The *Apertochrysa* sp., is one of the important species of Madagascan Chrysopidae that is found wide spread African south of the Saharan and eastward of African continent to the Pacific Region (Ohm and Holzel, 2002). It is also distributed and well known in India (Ramani *et al*., 2002). However this genus is poorly known in South East Asia and is newly record in Malaysia (NHM, 2008).

The hosts of *Apertochrysa* sp., include the mealy bug *Maconellicoccus hirsutus* (Green) (Krishnamoorthy and Mani, 1989), the spiralling whitefly, *Aleurodicus disperses* Russell (Ramani *et al*., 2002) and the eggs of *Helicoverpa armigera*. This predator can be reared successfully on eggs of *Crocyra cephalonica* in the laboratory (Bakthavatsalam *et al*., 1994).

Such information about Chrysopidae just isn't available in Malaysia. Thus, the objectives of this study are to sample population of green lacewings from agro-ecosystem, to determine the important species of green lacewing, survey the occurrence of green lacewing on various plants in the field, study the occurrence of *Apertochrysa* sp. within the field and determine the percentage of parasitism of *Telenomus* sp. on eggs of *Apertochrysa* sp. in citrus and corn field.

MATERIALS AND METHODS

Study site: The study was carried out at University Putra Malaysia (UPM) fields, Serdang, Selangor, Malaysia (3°02 N, 101 42 E, 31 m elevation), during 2007-2008 in agro ecosystem area planted with diversity of plants, vegetables, grains, horticultures, various types of or-chards and herbs. The monthly rainfall average was (235±100.7) mm and daily mean temperature was 31°C±5.6.

Survey methods: Methods used to capture the adults and to sample the immature stages was as follows:

Handmade white plastic collision trap: Each trap (25 cm dia., 42 cm ht.) was provided with cotton ball which had been infused with 25 mL of methyl eugenol. The cotton balls were changed weekly. The traps were hung between trees at different heights above ground. Same traps used by Sajap *et al*. (1997) for capturing the *Glenochrysa* sp. at lowland tropical rain forest.

Sticky traps: The trap consisting of square nylon screen measuring, 30×30 cm, smeared with trapping adhesive, a 5 mL glass vial containing eugenol plugged with a cotton wick was placed on the screen. The traps were hung on various heights above ground between the trees. The same sticky trap used by Sajap *et al*. (1997) for capturing the *Glenochrysa* sp. at lowland tropical rain forest.

Sweep net: Standard sweep net was used for capture the adults on herbs, vegetables, corn and or-chards.

Knockdown (Sondage sampling): Groundsheets were used around the cocoa and citrus trees and then each tree was sprayed with cypermethrin at 2 ml L^{-1} to kill the insects. The ground sheets were left for 2 h before the insects were collected. This to ensure that as many as possible insects knocked down were collected (Southwood, 1978).

Shaking: A sheet of cloth (3×3 m) was laid out under the cocoa and citrus trees and then branches of the tree were shacked fast to bring down the immature stages of insects. They were collected and killed immediately using glass killing bottles.

Food attractant traps: White plastic collision traps, sticky plastic traps, delta traps were utilized with artificial diet (3 g sugar, 2.5 g yeast, 2.5 mL honey, 3 g powder milk) to attract the adults of green lacewings in citrus orchards field.

Air blower: Air blower was used to blow the immature stages from one side of tree and collect the insect using large plastic container (0.7×0.55 m) on the other side of tree. The collected insects were immediately killed using glass killing bottle.

Spray the adult's food: Artificial diet was sprayed on the branches of citrus trees to encourage the adults of green lacewing to lay their eggs on citrus trees.

Color plastic card board traps: White, black, green, red, orange, brown, maroon and yellow plastic card boards (40×30 cm) smeared with trapping adhesive were hung on citrus orchards to attract the adults of green lacewings.

Eggs handmade collection: Direct eggs observation of green lacewing was conducted and then collected and counted by light microscope. The eggs were reared separately in plastic petri dishes on *Corcyra cephalonica* frozen eggs at 25±1°C, 55-85% RH and 12: 12D photoperiod conditions.

Survey the occurrence of *Apertochrysa* sp. on various plants: Forty three plants were surveyed by direct egg observation of green lacewing on leafs, trunks and fruits. The plants as listed in Table 1.

The parasitism of *Telenomus* sp. on the eggs of *Apertochrysa* sp. collected from citrus trees and corn plants: The eggs of green lacewing on leaves of citrus trees and corn plants were collected, counted, recorded and kept in the laboratory. The eggs were isolated based on the color, white, green, brown and black eggs and then placed in plastic cylindrical containers (12×17.5 cm). The eggs were monitored daily until hatching while un-hatch eggs especially the brown and black eggs were monitored until the parasitoids emerged. The numbers of parasitoids were recorded.

The eggs were collected at 6:45 am to 7:45 am to avoid other predators on eggs of green lacewing especially ants.

The percentage of parasitism of *Telenomus* sp. on the eggs of green lacewing on corn plants and citrus trees was calculated using the following equation:

$$\text{The percentage of parasitism} = \frac{\text{The infested eggs}}{\text{All eggs collected}} \times 100$$

The eggs of green lacewing from citrus trees were collected between 31-7-2007 to 19-7-2008, while the eggs from corn plants were collected in January, February, March and April of 2008.

Table 1: List of selected plants surveyed for green lacewings during 2007-2008

Name of plant	Scientific name	No. of plant tested	Name of plant	Scientific name	No. of plant tested
Citrus	*Citrus aurantium* (*Citrus sisnensis*)	506	Sweet corn	*Zea mays* var. *saccharata*	8072
Chili pepper	*Capsicum frutescens*	37	Maize	*Zea mays indenta*	865
Water melon; anguria	*Citrullus vulgaris* (*Cucurbita citrullus*)	63	Okra	*Hibiscus esculentus*	216
Cucumber	*Cucumis sativus*	103	French bean	*Phaseolus coccineus*	39
Eggplant or aubergine	*Solanum melongena* (*S. esculentum*)	52	Long bean	*Viqna unquiculata*	33
Grape	*Vitis cordifolia*	23	Tomato	*Solanum lycopersicum*	45
Mustard (sawi)	*Brassica juncea rugosa*	422	*Asystasa infrusa*	*Asystasa infrusa*	1566
Stevia	*Stevia* sp.	453	Banana	*Musa* sp.	272
Elueisen indica	*Elueisen indica*	1213	Durian (sour sop)	*Durio zibethinu* (*Annona muricata*)	11
Radish	*Rhaphanns sativus*	33	Jackfruit (Nangka)	*Artocarpus hetrophyllus*	12
Pulasan	*Nephelium mutabile*	16	Pineapple	*Ananas comosus*	65
Rambutan	*Nephelium lapaceum*	41	Cauliflower	*Brassica oleracea*	76
Mangosteen	*Garcinia mangostana*	23	Tea shrub	*Camellia sinensis*	210
Ciku (Sapodilla)	*Manikara achras*	11	Dragon fruit	*Hylocereus* sp.	48
Cocoa tree	*Theobroma cacao*	65	Tobacco	*Nicotiana* sp.	473
Palm oil	*Arecaceae* Elaeis	110	Bamboo	*Phyllostachys* sp.	67
Coconut tree	*Cocos nucifera*	84	Carnation	*Dianthus caryophyllus?*	337
Papaya or melon tree	*Carica papaya*	98	Bougainvillea	*Bougainvillea*	54
Stare fruit or carambola	*Averrhoa carambola*	23	Kenaf	*Hibiscuse cannbinus*	123
Cempedak	*Artocarpus champeden*	8	Pieria	*Pieria* (*Syria*)	244
Guava	*Psidium* sp.	20			
Jatropha plant	*Jatropha* sp.				
	Jatropha curcas	373			
Strawberry	*Fragaria ananassa*	665			

The occurrence of *Apertochrysa* sp. within the field: The area of the corn field was 17×28 m. Randomized Complete Block Design (RCBD) with 3 replicates were used in the experiment. The distribution of eggs of green lacewing in the corn field was observed by collecting the eggs from the plants at intervals of 2 m from the east to west of the field. The eggs were collected from 10 randomly selected plants. The eggs were also collected from the corn plants at all four borders of the field.

Identification of collected specimens: The eggs of green lacewing collected from citrus orchards were reared separately until emergence of the adults. Eggs cluster collected from the same leaf was considered belonging to the same species. Some of the adults obtained from rearing culture were killed and kept in specimen vials containing 70% alcohol. The vials were labeled accordingly (Date of collection, locality, common and technical name).

The eggs of green lacewing that were primarily infected by parasitoid (black eggs) were collected, reared in laboratory until the adults of parasitoids emerged. These parasitoids were collected, killed and kept in vials containing 70% alcohol. These specimens were sent to Natural History Museum (NHM) in Britain for identification.

Statistical analysis: The mean of eggs per plant of *Apertochrysa* sp. and the percentage of eggs occurred were used to determine the occurrence of *Apertochrysa* sp. on various plant species.

The data collected on distributions of eggs of green lacewing *Apertochrysa* sp. within the field of corn plant were analyzed by using analysis of variance (ANOVA) followed by LSD test.

The percentages of parasitism of *Telenomus* sp. on the eggs of *Apertochrysa* sp. found on citrus trees and corn plants were assessed with chi-square test, depend on the deviations from a 4% parasitism level obtained by Ruberson *et al.* (1995) ($df = 2$, $\chi^2 calc. = 31.66$, $p<0.05$).

RESULTS AND DISCUSSION

Survey methods: All methods used to survey the green lacewing failed to capture the adults. This was attributed to three reasons; firstly the low percentage of green lacewing in the survey area, secondly no much information on the green lacewing behaviors in the field and thirdly most of these methods needed more optimizations. These results were confirmed by many previous studies for instance using water traps baited with fruits in Gombak Forest Reserve did not catch any green lacewings (McLure, 1980) and using the sweep net by Wong (1984) also failed in Pasoh Forest Reserve. Similar results were obtained by Stork (1987) and Sajap and Kotulai (1992) when using the pyrethrum knockdown in lowland tropical rain forest of Bukit Sulang. Nevertheless the sticky traps and white plastic collision traps baited with eugenol succeeded to attract the adults of *Glenochrysa* sp. in Malaysian low-land tropical forest (Sajap *et al.*, 1997). It is extremely difficult to observe the adults of green lacewings in the field because of unknown flight behaviors, small body size and nocturnal flight activity (Chapman *et al.*, 2003).

The specimen's identification: All green lacewing specimens send to the Natural History Museum in Briton were identified as follow:

Order : Neuroptera
Family : Chrysopidae
Genus : *Apertochrysa*
Species : Indet

While the parasite specimens on the eggs of green lacewing were identified as follow:

Order : Hymenoptera
Family : Scelionidae
Genus : *Telenomus*
Species : Suvae Johnson and Bin (NHM, 2008).

The occurrence of green lacewings on various plants: Table 2 shows that the citrus orchards contained the highest number of eggs of *Apertochrysa* sp. (3.98 eggs/plant) followed by chili pepper (0.54 eggs/plant), water melon (0.33 eggs/plant) and cucumber (0.25 eggs/plant). The rest of the plants recorded 0.13 or less eggs/plant.

No eggs were found on Durian, Jakfruit (Nangka), Pulasan, Rambutan, Mangosteen, Ciku (Sapodilla), Cocoa, Palm oil, Coconut, Papaya, Star fruit, Cempedak, Guava, Jatro-pha, Strawberry, Pineapple, Cauliflower, Tea shrub, Dragon fruit, Tobacco, Bamboo, Car-nation, Bougainvilla, Kenaf and Pieria plant.

Table 2: The occurrence of green lacewing *Apertochrysa* sp. eggs on various plant species (eggs Plant^{-1})

Name of plant	Scientific name	No. of tested plants	No. of all eggs	Mean eggs density/ plant	% of eggs
Citrus	*Citrus aurantium* (*Citrus sisnensis*)	506	2013	3.978	65.840
Chili pepper	*Capsicum frutescens*	37	20	0.540	8.937
Water melon	*Citrullus vulgaris* (*Cucurbita citrullus*)	63	21	0.333	5.511
Cucumber	*Cucumis sativus*	103	26	0.252	4.170
Eggplant	*Solanum melongena* (*S. esculentum*)	52	7	0.134	2.217
Grape	*Vitis cordifolia*	23	3	0.130	2.151
Mustard (sawi)	*Brassica juncea rugosa*	422	43	0.101	1.671
Stevia	*Stevia* sp.	453	42	0.093	1.539
Elueisen indica	*Elueisen indica*	1213	112	0.092	1.523
Radish	*Rhaphanns sativus*	33	3	0.090	1.489
Sweet corn	*Zea mays* var. *saccharata*	8072	702	0.0869	1.438
Maize	*Zea mays indenta*	865	47	0.054	0.893
Okra	*Hibiscus esculentus*	216	11	0.050	0.827
French bean	*Phaseolus coccineus*	39	2	0.050	0.827
Long bean	*Viqna unquiculata*	33	1	0.030	0.496
Tomato	*Solanum lycopersicum*	45	1	0.020	0.331
Asystasa infrusa	*Asystasa infrusa*	1566	6	0.004	0.066
Banana	*Musa* sp.	272	17	0.004	0.066

The results also showed that all green lacewing specimens collected belong to single species which is *Apertochrysa* sp.

The variation in percentages of occurrence of eggs of green lacewing on various plants may be attribute to influence of females attraction to lay their eggs on the plant because of the odor of plant and prey (Zhu *et al*., 2005; Hagen *et al*., 1976) or may be because of plant architecture (Clark and Messina, 1998; Ahmad and Ali, 1989). The current results confirmed the results obtained by Ballal and Singh (1999) when they reported the variations of ovipositional preferences and occurrences of *Ch. carnea* (Stephens), *Mallada boninensis* (Okamoto) and *M. astur* (Banks) on three plants; cotton, sunflower and pigeon pea.

However many biotic factors and environment factors working together to obligate the females of green lacewing to lay their eggs on specific plant, for instance in our field, it is been noticed that numbers of preys like mealy bugs and citrus black flies *Alerocanthus woglumi* may increase the preference of females of green lacewing to lay their eggs on citrus orchards, at the same time, it is been noticed huge number of white flies *Aleurodicus disperses* Russell on guava trees but no eggs of green lacewing were noticed.

Table 3 shows that 65.84% of eggs collected were on citrus trees while 26.48% of eggs were on vegetables plants. Although high number of eggs were collected from corn plants (sweet and cereal), the percentage of eggs *Apertochrysa* sp. were very low (2.33%) comparing with eggs collected from citrus trees. The lowest percentage was recorded on herbs plants (1.59%). These results show clearly that the females of *Apertochrysa* sp. preferred to lay their eggs on citrus trees and the vegetables plants more than other plants. It seems the odor of citrus trees has special effect.

However the percentage of eggs of green lacewing per plant was very low, because of two main raisons; 1- the predation on eggs of *Apertochrysa* sp. especially by the ants and dragon fly, as was

Table 3: Percentage of occurrence of *Apertochrysa* sp. on various types of plants

The plants	Percentage of eggs
Citrus orchards	65.840
Vegetable plants	26.476
Corn	2.331
Herbs	1.589
Other plants	3.756

Table 4: The percentage of parasitism of *Telenomus* sp. on eggs of *Apertochrysa* sp. found on citrus orchards and corn plants

The plant	Period of survey	No. of eggs collected	No. of eggs infested	The percent of infestation
Corn plants	January, February, March and April. 2008	485	68	14a
Citrus trees	Around the year from 31-7-2007 to 19-7-2008	2049	193	9.2b

Within the same columns, means followed by the different letters are significantly different from each other at $p<0.05$ ($df = 2$, $\chi^2_{calc.} = 31.66$)

documented by Silva *et al.* (2007) and 2- the parasitism by *Telenomus* sp. (Hymenoptera: Scelinoidae) on the eggs of *Apertochrysa* sp. as confirmed by Krishnamoorthy and Mani (1989) and Ruberson *et al.* (1995).

The parasitism of *Telenomus* sp. on the eggs of *Apertochrysa* sp. in citrus trees and corn plants fields: Table 4 shows that there is high percentage of parasitism of *Telenomus* sp. parasitoid on the eggs of green lacewing *Apertochrysa* sp. and shows the significant differences be-tween the percentage of parasitism on the eggs of green lacewing found on citrus trees and corn plants. The highest percentage of parasitism was recorded on the eggs of *Apertochrysa* sp. on corn plants. This study showed higher level of percentage parasitism than the results of previous research by Ruberson *et al.* (1995).

These results also confirmed the previous results by Alrouechdi *et al.* (1984) and Krishnamoorthy and Mani (1989) that the *Telenomus* sp. is an important parasitoid that can reduce the effectiveness of biological control. However the effect of *Telenomus* sp. on chrysopids populations still unclear in the field (Ruberson *et al.*, 1995).

The occurrence of *Apertochrysa* sp. eggs within the field: Table 5 shows the occurrence of eggs of *Apertochrysa* sp. was different from site to site within the field.

Observations showed the females of *Apertochrysa* sp. prefer to lay their eggs on the corn plants planted in the east sites of the field, especially the first 10th m after east border recorded 57.13% off eggs collected, followed by west sites (from 20 m after east border to west border) 21.73%, while lowest percentage were noticed in central sites (10 to 20 m after east border) 19.86%. Within the field, the east border (12.42%), 2nd m (19.25%), 8th m (21.74%) and 28th m (11.80%) after east border recorded the highest percentage of eggs of *Apertochrysa* sp. with no significant differences between them. While significantly differences were recorded between east border, 2nd m, 8th m and 28th m compared with other sites. The highest occurrence of *Apertochrysa* sp. was found in east border recorded significant differences compared with west, north and south border.

These variations of occurrence in field attribute to two main reasons, the sun light and availability of food. These findings agree with the results obtained by Klein *et al.* (2002) when they

Table 5: The Mean±SD and the percentage of egg's occurrence of *Apertochrysa* sp. on different locations within the corn field.

Position	N	ΣXi	X	Percentage
East border	30	20	6.66±8.7abc	12.42
1 m	30	1	0.33±0.58c	0.62
2 m	30	31	10.33±17.9ab	19.25
4 m	30	2	0.66±0.58c	1.24
6 m	30	3	1.00±1c	1.86
8 m	30	35	11.66±20.2a	21.74
10 m	30	8	2.66±3.8c	4.96
12 m	30	14	4.66±4.61bc	8.70
14 m	30	2	0.66±0.58c	1.24
16 m	30	2	0.66±0.58c	1.24
18 m	30	3	1.00±1c	1.86
20 m	30	3	1.00±1c	1.86
22 m	30	1	0.33±0.58c	0.62
24 m	30	6	2.00±1c	3.72
26 m	30	1	0.33±0.58c	0.62
28 m	30	19	6.33±8.39abc	11.80
West border	30	8	2.66±2.89c	4.97
North border	30	1	0.33±0.58c	0.62
South border	30	1	0.33±0.58c	0.62
Total	540	161		

Within the same column, means followed by the different letters are significantly different from each other at p = 0.05 (LSD = 6.637, F = 2.457, d.f = 18, 36)

found the positively effect of light intensity on the cacao arthropod community in cacao agro forestry system. While the effect of food availability were noticed by Zheng *et al.* (1993).

CONCLUSIONS

All captured specimens belong to a single species in this research area during the survey period that is the *Apertochrysa* sp.

The *Apertochrysa* sp. is newly recorded in Malaysian agro ecosystem can be found on different type of plants, orchards, vegetables, grains, horticulture and herbs with different percentages occurrence and the highest eggs density of *Apertochrysa* sp. was recorded on citrus orchards.

The *Telenomus* sp. is also newly recorded as a very important parasitoid on the eggs of green lacewing *Apertochrysa* sp. and with other predator especially the ant and dragon fly can made the occurrence of it very low in the field of citrus and corn.

The sun light and availability of food are the main important factors that can affect the distribution *Apertochrysa* sp. within the field.

All methods used to capture the adults and to sample the immature stages failed except the direct observation of eggs mainly because the low percentage of green lacewings in the field.

REFERENCES

Ahmad, T.R. and M.A. Ali, 1989. Effect of plant type cover and pheromone concentration on movement of codling moth *Cydia pomonella* (L.) (Lep.: Olethreutidae). J. Appli. Entomol., 108: 312-316.

Alasady, M.A.A., D.B. Omar, Y.B. Ibrahim and R.B. Ibrahim, 2010. Life table of the green lacewing *Apertochrysa* sp. (Neuroptera: Chrysopidae) reared on the rice moth *Corcyra cephalonica* (Lepidoptera: Pyralidae). Int. J. Agric. Biol., 12: 266-270.

Alrouechdi, K., Y. Semeria and T.R. New, 1984. Natural Enemies. In: Biology of Chrysopidae, Canard, M., Y. Semeria and T.R. New (Eds.). Dr. W. Junk Publishers, Hague, Netherlands, pp: 187-193.

Ashfaq, M., A. Nasreen and G.M. Cheema, 2002. A new technique for mass rearing of green lacewing on commercial scale. J. Applied Sci., 2: 925-926.

Bakthavatsalam, N., S.P. Singh, N.A. Pushpalatha and B.S. Bhummannavar, 1994. Life tables of four species of chrysopids (Neuroptera: Chrysopidae). J. Entomol. Res., 18: 357-360.

Ballal, C.R. and S.P. Singh, 1999. Host plant-mediated orientational and ovipositional behavior of three species of chrysopids (Neuroptera: Chrysopidae). Biol. Control, 16: 47-53.

Bigler, F., 1984. Biological Control by Chrysopids Integration with Pesticides. In: Biology of Chrysopidae, Canard, M., Y. Semeria and R.T. New (Eds.). Dr. W. Junk Publishers, Boston, pp: 233-245.

Chapman, J.W., D.R. Reynolds and A.D. Smith, 2003. Vertical-looking radar: A new tool for monitoring high-altitude insect migration. Bioscience, 53: 503-511.

Clark, T.L. and F.J. Messina, 1998. Foraging behavior of lacewing larvae (Neuroptera: Chrysopidae) on plants with divergent architectures. J. Insect Behav., 11: 303-317.

Dean, G.J. and C. Satasook, 1983. Response of *Chrysoperla carnea* (Stephens) (neuroptera: Chrysopidae) to some potential attractants. Bull. Entomol. Res., 73: 619-624.

Duelli, P., 2001. Lacewings in Field Crops. In: Lacewings in the Crop Environment, McEwen, P.K., T.R. New and A.E. Whittington (Eds.). Cambridge University Press, Cambridge, pp: 158–171.

Hagen, K.S., P. Greany, E.F. Sawall and R.L. Tassan, 1976. Tryptophan in an artificial honeydew as a source of an attractant for adult *Chrysopa carnea*. Environ. Entomol., 5: 458-468.

Klein, A.M., I. Steffan-Dewenter and T. Tscharntke, 2002. Predator-prey ratios on cacao along a land-use gradient in Indonesia. Biodiversity Conserv., 11: 683-693.

Krishnamoorthy, A. and M. Mani, 1989. Records of green lacewing preying on mealy bug in India. Curr. Sci., 58: 155-157.

McLure, H.E., 1980. Some arthropods of the dipterocarp forest canopy in Malaysia. Malaysian Nat. J., 32: 31-55.

Nasreen, A., M. Ghulam and A. Muhammad, 2003. Selectivity of some insecticides to *Chrysoperla carnea* (stephen) (neuroptera: chrysopidae) in laboratory. Pak. J. Biol. Sci., 6: 536-538.

Natural British Museum (NHM), 2008. Insect samples. Ref. IIS 2008-292-295.

Ohm, P. and H. Holzel, 2002. Zoogeographical patterns in Chrysopidae of the Madagas-can Subregion (Insecta: Neuroptera). Acta Zoologica Academiae Scientiarum Hungaricae, 48: 229-252.

Ramani, S., J. Poorani and B.S. Bhumannavar, 2002. Spiralling whitefly, *Aleurodicus dis-persus*, in India. Biocontrol. News Inform., 23: 55-62.

Ruberson, J.R., C.A. Tauber and M.J. Tauber, 1995. Developmental effects of host and temperature on *Telenomus* app. (Hymenoptera; Scelionidae) parasitizing chrysopid eggs. Biol. Control, 5: 245-250.

Sajap, A.S. and J.R. Kotulai, 1992. Insect Diversity in Acacia Mangium Canopies in Peninsular, Malaysia. In: Research and Development Priorities, Muhamad, M.A.N., H. Ismail, M. Zaki and J. Kamaruzaman (Eds.). Kuching Sarawak Publishers, Malaysia, pp: 234-238.

Sajap, A.S., K. Maeto, K. Fukuyama, F. Ahmad and Y.A. Wahab, 1997. Chrysopidae attraction to floral fragrance chemicals and its vertical distribution in a Malaysia Lowland Tropical Forest. Malaysian Applied Biol., 26: 75-80.

Silva, P.S., G.S. Albuquerque, C.A. Tauber and M.J. Tauber, 2007. Life history of a widespread Neotropical predator, *Chrysopodes (Chrysopodes) lineafrons* (Neuroptera: Chrysopidae). Biol. Control, 41: 33-41.

Southwood, T.R.E., 1978. Ecological Methods with Particular Reference to the Study of Insect Populations. 2nd Edn., Chapman and Hall, London, pp: 524.

Stork, N.E., 1987. Arthropod faunal similarity of *Bornean rain* forest trees. Ecol. Entomol., 12: 219-226.

Syed, A.N., M. AShfaq and S. Ahmad, 2008. Comparative effect of various diets on development of *Chrysopela carnea* (Neuroptera: Chrysopidae). Int. J. Agric. Biol., 10: 728-730.

Ulhaq, M.M., A. Sattar, Z. Salihah, A. Farid, A. Usman and S.U.K. Khattak, 2006. Effect of different artificial diets on the biology of adult green lacewing (*Chrysoperla carnea*) Stephens. Songkanakarin J. Sci. Technol., 28: 1-8.

Wong, M., 1984. Understory foliage arthropods in the virgin and regenerating habitats of Pasoh forest reserve, West Malaysia. Malayan For, 47: 43-69.

Yunus, A. and T.H. Ho, 1980. List of Economic Pests, Host Plants, Parasites and Predators in West Malaysia (1920-1973). Ministry of Agriculture, Malaysia, pp: 538.

Zeleny, J., 1984. Chrysopid Occurrence in West Paleartic Temperate Forest and Derived Biotopes. In: Biology of Chrysopidae, Canard, M., Y. Semeria and T.R. New (Eds.). Dr. W. Junk Publishers, Hague, Netherlands, pp: 151-159.

Zheng, Y., K.M. Daane, K.S. Hagen and T.E. Mittler, 1993. Influence of larval food consumption on the fecundity of the lacewing *Chrysoperla carnea*. Entomol. Exp. Appl., 67: 9-14.

Zhu, J., J.J. Obrycki, S.A. Ochieng, T.C. Baker, J.A. Pickett and D. Smiley, 2005. Attraction of two lacewing species to volatiles produced by host plants and aphid prey. Naturwissenschaften, 92: 277-281.