J. Biol. Control, 1 (1), 23–31, 1987

Bionomics of Major Aphidophagous Syrphids Occurring in Mid-Hill Regions of Himachal Pradesh

H. D. MAKHMOOR[1] and A. K. VERMA
Department of Entomology & Apiculture
Dr. Y. S. Parmar University of Horticulture & Forestry,
Solan, Nauni 173 230

ABSTRACT

The bionomics of four aphidophagous syrphids, viz., *Scaeva pyrastri* (L.), *Episyrphus balteatus* (DeG.), *Metasyrphus confrater* (Wied.) and *M. corollae* (F.) was studied under laboratory conditions. Important morphological characters and size of developmental stages were studied for easy identification in the field. Repeated matings, each lasting for 1 to 2 sec. were observed except in *M. corrollae* where each mating lasted for 4-8 h. The eggs were laid either singly or in small groups among *Brevicoryne brassicae* (L). colonies infesting cauliflower plants. A maximum of 721 eggs were laid by *E. balteatus* during December-January, whereas, during March-April, *M. corollae* female laid an average of 704 eggs. *S. pyrastri* adults failed to mate in confinement during winters. There were three larval instars. The larva of *S. pyrastri* was the most voracious feeder consuming 592 aphids in winter and 499 in the spring generation. Longevity of mated males was reduced considerably whereas that of females increased slightly after mating. *E. balteatus* lived very long in both the seasons. Based on various biological attributes, *M. corollae* was considered most suitable for laboratory rearing.

Key words: Cabbage aphid *Brevicoryne brassicae*, Syrphids *Scaeva, Episyrphus, Metasyrphus*, Bionomics

Among the natural enemies of the cabbage aphid, *Brevicoryne brassicae* (L.), a serious pest of crucifers in the mid-hill regions of Himachal Pradesh, syrphid larvae are more effective predators in comparison to their coccinellid counterparts (Kotwal *et. al.*, 1984). In a population dynamics study of this aphid on cauliflower, four species of syrphids, *viz.*, *Scaeva pyrastri* (L.), *Episyrphus balteatus* (DeG.) *Metasyrphus confrater* (Wied.) and *M. corollae* (F.) were found commonly occurring in the seed crop ecosystem at Solan (Kotwal, 1982). The biology and behaviour of these syrphid flies have been studied earlier on various aphid hosts. (Siddiqui and Krishnaswamy, 1972; Schmutterer, 1974; Tawfik *et, al.*, 1974; Roy and Basu, 1977). However, not much information on these useful insects was available under environmental conditions prevailing in Himachal Pradesh. A detailed study was therefore undertaken at Solan during 1984-85 and the results are presented in this contribution.

1. Present address: Entomologist, Sher-e-Kashmir University of Agricultural Sciences & Technology, Regional Agricultural Research Station, R. S. Pura, Jammu 181 102

MATERIALS AND METHODS

The bionomics of syrphid flies was studied under laboratory conditions for two generations, December - February and March-April, except in the case of *M. corollae* which was reared only during March-April since the adults appeared in the field during the spring season. The average daily maximum and minimum temperatures were 14.3 and 9.1°C and relative humidity 75 per cent during winter and 19.4 and 13.6°C with relative humidity 65 per cent during spring season.

Adult flies collected from cauliflower were confined in nylon net cages (50 × 50 × 50 cm) to initiate the laboratory culture. Each cage was provided with 45 cauliflower plants grown in two plastic pots (12 cm diameter), and infested with *B. brassicae*. To record fecundity, individual pairs of flies were released in glass chimneys (20 × 15 cm) with their tops covered with muslin cloth. A cotton swab soaked in 10% honey solution and a few flowering shoots of mustard were kept inside each chimney to provide food for flies. Mustard bloom provided pollen to mated females which is reported essential for the development of ovaries and normal egg production in most syrphid flies (Barlow, 1961).

The eggs were picked up from among the aphid colonies and kept in petri dishes for hatching. Observations were recorded on shape, size, colour, incubation period and hatchability of eggs. Eggs were picked up within 2h of laying and transferred individually to glass specimen tubes (9 × 2.5 cm) over a piece of cauliflower leaf. Soon after hatching, the larva was provided with first or second instar nymphs of *B. brassicae* as food However, in the later instars, aphids were provided irrespective of their developmental stage. In general, each larva was daily provided with at least three times the number of aphids it consumed on the previous day in clean heat-sterilized tubes to ensure aseptic conditions. Observations were recorded on the number of instars and their durations, shape, size and colour of the larva. Some important morphological characters of the larva were noted for field identification. The number of aphids consumed by the larva during its entire life was noted to ascertain its predation potential. The final instar larva was provided with additional leaves in a petri dish for pupation. Observations were recorded on the size of pupa and duration of period. Some characteristics like site of pupation in the field, colour and shape were also recorded.

The sex ratio of emerging adults was ascertained. Observations were recorded on abdominal patterns for field identification of the adults. The adults were reared as described earlier and observations were recorded on the longevity of both sexes in confinement either in pairs or alone. The mating behaviour and fecundity were also studied and the data were recorded on the pre-mating, pre-oviposition and post-oviposition periods.

RESULTS AND DISCUSSION

Egg : The eggs of *S. pyrastri* were oval in shape and white when freshly laid but turned dark brown before hatching, whereas those of *E. balteatus* were pale white when laid turning greyish before hatching. The eggs were oval in shape and slightly arched. The eggs of *M. confrater* were greyish white, elongate, oval, subspherical, tapering towards bluntly rounded micropylar end. The eggs of *M. corollae* were also oval in shape and white in colour when freshly laid but turned light brown after one day. Microscopic examination of the eggs showed reticulations on the chorion but the four species could not be identified on the basis of chorion patterns. Data presented in Table 1 show that the mean length of eggs varied between 1.15 and 0.81 mm while the breadth ranged between 0.40 and 0.28 mm. The eggs of *S. pyrastri* were the biggest in size followed by *M. confarter, E. balteatus* and *M. corollae.* Similar dimensions were reported by Roy and Basu (1977) for *E. balteatus* and *M. confrater.* The mean hatchability varied between 89% in *M. confrater* and 79% in *M. corollae.* These results are in conformity with those reported by Sharma (1983) who worked under similar environmental conditions. The incubation period averaged 3 days during December-February, whereas, it was 2 days during March-April. However, some variations in the present results and those reported by other workers exist (Tawfik *et al.*, 1974; Roy and Basu, 1977; Sharma, 1983: Siddiqui and Krishnaswamy, 1972) which may be attributed to differences in ambient temperature and relative humidity under which the flies might have been reared.

Larva : The full grown larva of *S. pyrastri* was dark green with three white stripes running from head to the last abdominal segment, one each on the lateral sides and one in the centre. The larva of *E. balteatus* was colourless with five white lobes of fat bodies arranged in a definite pattern between fourth and seventh abdominal segment. In addition, there were two pinkish lobes in the centre of the abdomen. The larva thus looked whitish due to arrangement of fat bodies on its body. The full grown larva of *M. confrater* was brownish grey with pale orange patches on abdominal segments. Dark brown striped oblique bands ran symmetrically from either side of the dorsal vessel to pleural region on abdominal segments. The integument was covered with microscopic spinules. The full grown larva of *M. corollae* was light brown in colour. There were three black stripes running from the head to last abdominal segment, one each on lateral sides and one in the centre. The stripes were interrupted by yellow areas making peculiar patterns. All the four species included in this study could be identified in the field on the basis of larval characters. The full grown larva of *S. pyrastri* was the biggest in size with mean length of 16.01 mm and mean breadth (at the widest part of the body) of 3.89 mm followed by *M. confrater, M. corollae* and *E. balteatus* (Table 2). Siddiqui and Krishnaswamy (1972) reported smaller sized larvae of *E. balteatus and M. confrater* from western Himalayan regions. The difference may be attributed to poor nutrition provided by *Adelges* spp. on which the larvae were fed. However, our results are

TABLE 1. The size, hatchability and incubation period of eggs of aphidophagous syrphids under laboratory conditions.

Species	*Size of egg (mm) Length	Breadth	* *Hatchability (%)	Period of study	* *Incubation period (days)
S. pyrastri	1.15	0.40	81	Dec-Feb	3.0
				Mar-Apr	2.0
E. balteatus	1,01	0.36	80	Dec-Feb	3.0
				Mar-Apr	2.0
M. confrater	1.12	0.39	89	Dec-Feb	3.0
				Mar-Apr	2.0
M. corollae	0.81	0.28	71	Mar-Apr	2.0

*Mean of 15 observations. * *Mean of 100 observations.

TABLE 2. The size, duration of instars and aphid consumption by larvae of aphidophagous syrphids under laboratory conditions

Species	*Size of full grown larva (mm)		Period of study	* *Duration of larval instar (days)			Total larval duration (days)	* *Number of aphids consumed/larva
	Length	Breadth		First	Second	Third		
S. pyrastri	16.01	3.89	Dec-Feb	4.0	5.6	6.5	16.1	592
			Mar-Apr	3.5	4.5	4.6	12.6	499
E. balteatus	11.61	3.91	Dec-Feb	3.1	4.5	5.8	13.4	218
			Mar-Apr	3.2	4.3	4.3	11.8	202
M. confrater	15.76	3.67	Dec-Feb	4.0	5.5	6.5	16.0	393
			Mar-Apr	3.0	4.1	4.2	11.3	350
M. corollae	12.94	3.45	Mar-Apr	3.0	3.5	3.5	10.0	274

*Mean of 15 observations. * *Mean of 50 observations.

in fair agreement to those of Roy and Basu (1977) who reared the larvae on *Lipaphis erysimi* Kalt.

There were three larval instars in all the four species. During winter season, the larval duration was prolonged, the maximum being 16.1 days in case of *S. pyrastri* and minimum 13.4 days in case of *E. balteatus*. However, during March - April, the maximum duration was 12.6 days in *S. pyrastri* and minimum of 10.0 days in *M. corollae* (Table 2).

S. pyrastri was the most voracious feeder consuming a mean number of 592 aphids during winter and 499 during spring season. A single larva of *M. confrater* consumed an average of 393 and 350 aphids in two seasons, respectively. *M. corollae* reared during spring season had an average consumption of 274 aphids. The least potential was found in the case of *E balteatus*, a larva of which consumed an average of 218 and 202 aphids, during winter and spring season, respectively. Our findings are in agreement with Wnuk and Fuchs (1977) who reported the average consumption of *S. pyrastri* and *E balteatus* as 549.0, and 461.2, but differed from those reported by Kotwal (1982) and Sharma (1983). Various factors like temperature, relative humidity, prey density, etc., are responsible for variation in feeding potential. Larvae consumed more aphids during winter season in comparison to spring season probably due to longer larval period. Similar observations were reported by Sundby (1966) in the case of *Syrphus ribesii* (L.).

Pupa: The pupa of *S. pyrastri* was green in the beginning but changed to darker green later. It was tear drop shaped anteriorly and highly inflated at the posterior end. The pupation took place in soil or among plant debris in the field The pupa of *E. balteatus* was whitish to greyish white, broad and round anteriorly and narrower at the posterior end which was somewhat oval in shape. The pupation generally took place on plants The pupa of *M confrater* was dark brown to reddish brown with medial region on dorsum tinged with brick red colour. It was tear drop shaped with anterior end highly inflated and subspherical while the posterior end was sharply tapered at an acute angle. The pupation occurred in soil. The pupa of *M. corollae* was dark brown in colour. The anterior end was inflated and the posterior end was slightly tapered The pupation took place generally in soil.

The mean length of pupa varied between 6.97 and 8.79 mm while mean breadth (at the widest part) varried between 3.28 and 4.50 mm (Table 3). The pupa of *S. pyrastri* was biggest in size followed by *M. confrater*, *M. corollae* and *E. balteatus*. These dimensions are more than those reported by Siddiqui and Krishnaswamy (1972) and Roy and Basu (1977). The variation may be attributed to poor nutritional status of prey species as well as environmental conditions under which the syrphids were reared. The duration of pupal period varied with season, being longer (16.2-18.9 days) during winter as compared to 10.3-11.4 days during March-April. These results are in conformity with Kotwal (1982) and Sharma (1983) but differed slightly

TABLE 3. The size and pupal period of aphidophagous syrphids under laboratory conditions.

Species	*Size of pupa (mm) Length	Breadth	Period of study	* *Pupal period (days)
S. pyrastri	8.79	4.50	Dec-Feb	18.9
			Mar-Apr	10.8
E. balteatus	6.97	3.28	Dec-Feb	16.2
				11.1
M. confrater	7.77	3.84	Dec-Feb	18.8
			Mar-Apr	11.4
M. corollae	7.01	3.33	Mar-Apr	10.3

*Mean of 20 observations. * *Mean of 50 observations.

TABLE 4. The size, sex ratio, fecundity, longevity, pre-mating, pre-oviposition, oviposition, and post-oviposition periods of adults of aphidophagous syrphids under laboratory conditions

Species	*Size of adult (mm)		Sex ratio (female:-male)	Period of Study	* *Fecun-dity	* *Longevity (days)				* *Duration (days)			
						Unmated		Mated					
	Length	wing expanse				Male	Female	Male	Female	Pre-matting	Preovi-position	Ovi-position	Postovi-pcstition
S. pyrastri	13.0	25.3	1:1	Dec-Feb	—	23.1	24.7	mating not observed					
				Mar-Apr	355	20.4	22.3	7.6	27.1	3.1	2.2	17 4	4.4
E. balteatus	9.6	19.5	0.99:1	Dec-Feb	721	44.2	54.9	19.8	60.2	3.3	5.1	49.7	2.1
				Mar-Apr	400	27.4	31.8	8.7	35.0	1.4	3.5	27.4	2.7
M. confrater	11.5	23.7	1.01:1	Dec-Feb	535	20.9	23.0	11.0	24.9	4.5	2.3	16.9	1.2
				Mar-Apr	245	13.2	14.6	8.9	16.0	2.1	2.5	9.8	1.6
M. coroalle	8.3	17.0	1.16:1	Mar-Apr	704	22.3	24.5	13.4	28.2	4.6	3.0	16.8	3.5

*Average of 20 Observations. * *Average of 50 observations.

from Roy and Basu (1977) who reported pupal period of 10 days for *E. balteatus* and 14 days of *M. confrater*. This may be due to difference in aphid species on which syrphids were reared. Such a reason has been ascribed earlier to explain difference in pupal period after feeding on different prey species (Cornelius and Barlow, 1980)

Adult : The adult of *S. pyrastri* had narrow to broadly oval abdomen, flattened, strongly margined from just beyond the base of tergite 2 to apex of tergite 5. Each tergite from 2 to 4 had a pair of slightly to strongly oblique, narrow to broad, whitish yellow spots which were clear y separated from the lateral margins. Spots on tergite 4 touched the base of the tergite. The adult of *E. balteatus* had abdomen unmargined and broadest at the end of tergite 2, and had parallel sides. Tergite 2 had a broad yellow band, broadly divided and extending forward laterally. Tergites 3 and 4 had yellow bands with narrow sub-basal black band and a narrow to broad black apical band produced slightly forward medially. The anterior yellow portion of each of these tergites was metallic in colour and the yellow areas were much reduced. The adult of *M confrater* had abdomen narrow to moderately broad, usually distinctly flattened above, with strong margin from middle of tergite 2 to end of tergite 5. Tergite 2 had a yellow band, narrow in the centre on lower side and also in the lateral sides towards the apex. Tergites 3 and 4, each had a single yellow band and the bands were nearly rectangular.

The mean body length and wing expanse was maximum (13.0 and 25.3 mm, respectively) in case of *S. pyrastri* and minimum (8.3 and 17.0 mm, respectively) in case of *M. corollae* (Table 4). Vockeroth (1969) reported body length of important genera : *Scaeva* (8.5-14.8 mm), *Episyrphus* (8.1-12.9 mm) and *Metasyrphus* (7.0-13.7 mm), which is in general agreement with the present observation. Dusek and Laska (1980) reported body length of *M. corollae* between 4-10 mm and wing expanse of 6.6-8.6 mm from samples collected in Afghanistan.

Sex ratio did not deviate much from the normal proportion of equal numbers of either sex (Table 4). These observations support the findings of Waage (1982) who reported that insect predators generally exhibit stable primary sex ratios of 0.5 (proportional males) and the proximate cause of this sex ratio is the simple process of Mendelian assortment of heterogametic diploids.

Mean longevity varied slightly among unmated males and females when provided with 10 per cent honey solution and a pollen source as food However, mated males were comparatively short lived. Mated females, on the other hand, had slightly more longevity in comparison to their unmated counterparts. Similar observations were reported by Lal and Gupta (1953) and Tawfik *et al.* (1974). These workers, however, did not report decrease in the longevity of mated males The present observation also seeks support from the findings of Barlow (1961) who reported mean longevity of *M. corollae* as 18 days, but do not agree with that of Khan and Yunus (1970), Patnaik and Bhagat (1976) and Roy and Basu (1977), all of whom reported very short adult lives of syrphid species. This variation may be due to differences in prey species and the amount of food eaten by the larva throughout its life span which are reported to influence size and longevity of the emerging adult (Cornelius and Barlow, 1980).

The mating behaviour of syrphid flies in confinement (glass chimney) was almost similar except in the case of *M. corollae* The females required a brief pre-mating period during which development and maturation of gonads occurred. Such a phenomenon has earlier been reported in syrphid flies (Lal and Gupta, 1953). Repeated matings occurred in flight each lasting for 1 to 2 sec. *E. balteatus* adults were, however, observed pairing while in resting position. The adults of *S. pyrastri* failed to mate during winter season but could do so during March-April The adults of *M. corollae* mated in flight as well as while sitting and each mating lasted for 1 to 6 h. The adults were observed pairing 8 to 15 times over a period of 4 to 8 days Females were found feeding on pollen or honey syrup during copulation. A short pre-oviposition period was required by the females after copulation, the duration of which varied between 2.2 and 5.1 days

The eggs were generally laid on aphid infested cauliflower plants. The oviposition period varied considerably among different species. Under laboratory conditions during winter season, the mean oviposition period was highest (49.7 days) in case of *E. balteatus* followed by *M. confrater* (16.9 days). During spring season, the maximum oviposition period averaged 27.4 days, also in case of *E. balteatus* followed by *S pyrastri*, *M. corollae* and *M. confrater* (Table 4). These results, however, do not agree with the findings of Khan and Yunus (1970) who reported 4-5 days oviposition period of *E. balteatus*. Such large variation can only be explained on the basis of longer longevity of adults (60.2 days during winter season) in the present studies as against 15.5 days reported by these workers. A short post-oviposition period was also observed for all the syrphid species before the adults died.

REFERENCES

Barlow, C. A. 1961. On the biology and reproductive capacity of *Syrphus corollae* Fab. in the laboratory. *Entomol Exp. Appl*, 4, 91-100.

Cornelius, M. and Barlow, C. A. 1980. Effect of aphid consumption by larvae on development and reproductive efficiency of a flower fly *(Syrphus corollae)* (Diptera : Syrphidae). *Can, Ent.*, 112, 989-992.

Dusek, J. and Laska, P. 1980 Species of *Metasyrphus* from Afghanistan and Krighizia with keys and descriptions of three new species. *Acta Entomol. Bohemosl.*, 77, 118-130.

Khan, S and Yunus, M. 1970. Biology of *Syrphus balteatus* DeG. *Pakistan J. Zool.*, 22, 215-217.

Kotwal, D. R. 1982. Population dynamics of the cabbage aphid, *Brevicoryne brassicae* (L.) (Hemiptera : Aphididae) on cauliflower seed crop. Ph.D. Thesis, Himachal Pradesh Agric. Univ., Palampur, pp 141.

Kotwal, D. R., Bhalla, O. P. and Verma, A.K. 1984. Natural enemies of the cabbage aphid, *Brevicoryne brassicae* (Linn.) in the mid-hill regions of Himachal Pradesh. *Indian J. Agri. Sci.*, 54, 1011-1012.

Lal, R. and Gupta, S. B. L. 1953. Morphology of the immature stages of *Sphaerophoria scutellaris* (Fabr.) (Syrphidae, Diptera) with notes on its biology. *Indian J. Entomol.*, **15**, 208-218.

Patnaik, N. C. and Bhagat, K. C. 1976. Observations on the syrphid fauna of Puri district (Orissa) and bio-ecology of *Ischiodon scutellaris* Fabr. and *Bumerus* sp.nr. *albifrons* Walk. (Diptera, Syrphidae). *Utkal Univ J. Sci.*, **13**, 43-50.

Roy, P. and Basu, S. K. 1977. Bionomics of aphidophagous syrphid flies. *Indian J. Entomol.*, **39**, 165-174.

Schmutterer, H. 1974. Ecological studies on entomophagous Syrphid species and their parasites in the Kenya Highlands (East Africa). *Z. Angew. Entomol.*, **65**, 42-67.

Sharma, K. C. 1983. Bionomics of syrphids occurring on seed cauliflower. M.Sc. Thesis Himachal Pradesh Agric. Univ., Palampur, pp. 61.

Siddiqui, R. K. and Krishnaswamy, S. 1972. Diptera Syrphidae. In: *Studies on predators of Adelges spp. in the Himalayas.* (Ed.) V. P. Rao and M. A. Ghani. *Commonwealth Inst. Biol. Control, Bangalore,* Pub. No. 3, pp. 14-22.

Sundby, R. A. 1966. A comparative study of the efficiency of three predatory insects, *Coccinella septumpunctata* L. (Coleoptera, Coccinellidae), *Chrysopa carnea* St. (Neuroptera, Chrysopidae) and *Syrphus ribesii* L. (Diptera, Syrphidae) at two different temperatures. *Entomophaga*, **11**, 395-404.

Tawfik, M. F. S., Azab, A. K. and Awadallah, K. T. 1974. Studies on the life-history and description of the immature forms of the Egyptian aphidophagous Syrphids. I. *Syrphus corollae* Fabr. (Diptera : Syrphidae). *Bull. Soc. Entomol. Egypte*, **58**, 1-16.

Vockeroth, J. R. 1969. *A revision of the genera of the Syrphini (Diptera : Syrphidae). Mem. Entomol Soc Canada. Ottawa*, No. 62, pp. 176.

Waage, J. K. 1982. Sex ratio and population dynamics of natural enemies: some possible interactions. *Ann. Appl. Biol.*, **101**, 156-164.

Wnuk, A. and Fuchs, R. 1977. Observations on the effectiveness of the limitation of *Brevicoryne brassicae* (L.) by syrphids (Diptera, Syrphidae). *Polskie Pismo Entomol.*, **47**, 147-155.

Biol. Control 1(1), 31 - 36, 1987

Environmental Persistence of Granulosis Virus Infecting Sugarcane Shoot Borer, *Chilo infuscatellus* Snellen

S. EASWARAMOORTHY
Sugarcane Breeding Insitute, Coimbatore 641 007
and
S. JAYARAJ
Centre for Plant Protection Studies, Tamil Nadu Agricultural Univeristy
Coimbatore 641 003

ABSTRACT

Thermal inactivation of the granulosis virus (GV) of *Chilo infuscatellus* Snellen occurred in the temperatures between 80 and 90°C. The pH 4 to 6 and 10 showed adverse effect on the virus infectivity and the ultraviolet light inactivated the virus completely within 20 minutes of exposure. The dry deposit of the virus was not inactivated as readily as virus in aqueous suspension. The persistence of shoot borer GV was inversely related to the exposure time and the half life was found to be 6.8 days.

Key words : *Chilo infuscatellus*, GV, environmental persistence