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Seasonal Variation in Abundance and Composition of Hoverfly (Diptera: Syrphidae) Communities in Multan, Pakistan

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Abstract.- Species composition and population dynamics of hoverflies (Diptera:Syrphidae) in relation to some abiotic and biotic factors were studied over a year long period in the District Multan, Pakistan. The community of hoverflies was composed of 14 species which were recorded from 59 plant species. Among Syrphinae, *Ischiodon scutellaris*, *Episyrphus balteatus* and *Sphaerophoria bengalensis* were the most abundant whereas among Milesiinae, *Eristalinus aeneus* and *Eristalinus laetus* were the most frequent floral visitors. The peak abundance and richness of hoverflies was observed in spring (March-April), the time when the maximum numbers (35) of plant species were in flowering. Only four species *i.e. E. aeneus*, *E. laetus*, *Mesembrius bengalensis* and *Paragus serratus* remained active all through the year in variable abundance. Among agricultural and wild plant species, *Mangifera indica* and *Launaea procumbens* were visited by the maximum number of syrphid species or in highest abundance, respectively. On the basis of similarity in floral host plant visitation frequencies, Syrphinae could easily be distinguished from Miliesiinae. Abundance of hoverflies was positively correlated with the floral abundance and flowering plant species, while temperature and relative humidity were negatively or only weakly correlated.

Key words: Hoverflies, population dynamics, seasonal variation.

INTRODUCTION

Hoverflies are a very important group of insects because their ecosystem services are manifold. Their larvae exhibit a variety of feeding modes *i.e*. aphidophagous, saprophagous, zoophagous and phytophagous (Sommaggio, 1999), whereas adults are floral visitors of hundreds of different plant species (*e.g*. Tooker *et al.*, 2006). Adults use nectar for energy and/or pollen for proteins, lipids and vitamins (Fægri and Van Der Pijl, 1979). These floral resources enhance the longevity and fecundity of adult dipterous flies (Shahjahan, 1986). Many syrphid species also have been documented as efficient crop pollinators (Sajjad *et al.*, 2008). Hoverflies are a characteristic feature of spring season (March-April) in the sub-tropical areas of Pakistan where the average temperature and relative humidity ranges from 23°C to 59%, respectively.

The basic biology of most of the fly pollinators is poorly understood (Kearns, 2001), more so for oriental species, and which may be responsible for the minimal conservation focus for this order (Kearns, 2001). Knowledge of seasonal abundance and diversity of pollinators in relation with floral abundance and abiotic factors has generally been documented as helpful in setting up their conservation strategies (Souza-Silva *et al.*, 2001; Hegland and Boeke, 2006; Shebl *et al.*, 2008). At the landscape level, positive relationships between the richness and abundance of floral resources and pollinator diversity and activity have been found (Dewenter *et al.*, 2002; Potts *et al.*, 2003). But on a micro scale very little is known about the overall activity patterns of pollinator in relation to the distribution of floral resources and ultimately its effect on the carrying capacity of pollinator populations (Hegeland and Boeke, 2006). Bees are the only taxon which is thoroughly considered in this context (Juker and Wolters, 2008) and very little attention has been given to Diptera pollinators (Kearns, 2001; Ssymank *et al.*, 2008). The abundance of flower visitors varies with the seasons which could be linked to variation in abundance of floral resources (number of flowering plant species and availability of flowers) (Barret and Helenurm, 1987). Population dynamics of some pollinator

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species are positively correlated with wet and hot periods (Carvalho *et al*., 1991) though, many factors other than climate can influence the diversity of existing seasonal patterns, such as food abundance and predation (Wolda, 1988).

Various methods of measuring species composition of syrphids associated with arable crops have been investigated (Sobota and Twardowski, 2004). These include yellow traps, direct collection and sweeping. Since our study was on a very small scale, we directly observed and identified syrphid species on the flowers. Previously there was no information available representing the yearly variation in abundance and composition of syrphid fly species from any part of Pakistan.

The current study was intended to determine: the year-long variations in abundance and composition of hoverfly species; the plant species which share the maximum number of hoverfly species in their highest abundance; the similarity of resources use among different hoverfly species; the relationship between abundance and species composition and abiotic (temperature and relative humidity) and biotic factors (number of flowering plant species and floral abundance).

MATERIALS AND METHODS

Study site

The study was conducted from January to December, 2008 in a planted forest of 20 hectares and adjacent agricultural farm at Bahauddin Zakariya University campus Multan, Pakistan (30.255°N; 71.513°E; 114±6 meter above sea level). The climate of the area is subtropical with mean daily maximum and minimum temperatures range from 38 to 46°C and 8°C to 12°C, respectively (Fig.1).

Plant species and floral units

Besides planted trees, a variety of natural vegetation grows in the forest including annual wild plants and perennial shrubs (Table I). We focused on the available plant species in flower, including crop plants in the adjacent agricultural landscape during the full course of our study. As different plant species had different kinds of inflorescence types, we defined the floral units for each plant species separately and each time recorded observations from those floral units.

Floral abundance was estimated by randomly selecting and tagging 15 plants of each plant species and counting total floral units fortnightly.

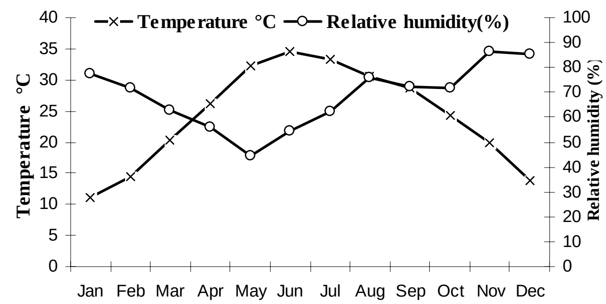

Fig. 1. Monthly mean temperature °C and Relative humidity (%) at Bahauddin Zakariya University Campus, Multan, Pakistan, during January to December, 2008.

Hoverfly visitor census

In the forest, we conducted random walks and focused only single plant species at a time during its anthesis. Fifteen plants of each plant species were randomly selected and each plant was observed for 60 seconds, recording syrphid visitation at its floral unit. In this way there was a total of 15 minute of observation per plant species in one census. For agricultural crops, 15 plants were selected randomly from the margins of the field.

For each plant we counted the number of visiting individuals per syrphid species by visual observation. A fortnightly census of each flowering plant species was carried out throughout the flowering period. The observations were done on clear sunny days, while rainy or cloudy days were avoided. To avoid the phenomenon of floral constancy (insects tend to visit single plant species even in the presence of many other flowering plant species in that particular area) among syrphid flies (Goulson and Wright, 1998), we selected the plants of a particular species at a considerable distance from each other (>5m).

Statistical analysis

We used linear regression analysis to find the relationship between the abundance and diversity of hoverflies during the year and to test the relationship

Table I.- **Syrphid fly species and their abundance on flowering plants at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.**

Sub-family	Syrphid species	Abundance	Plant species visited
Syrphinae	*Ischiodon scutellaris* (Fabricius, 1805)	206	37
(Total=545)	*Episyrphus balteatus* (Degeer, 1776)	122	30
	Eupeodes corollae (Fabricius, 1794)	50	23
	Sphaerophoria bengalensis (Macquart, 1842)	126	26
	Melanostoma sp. (Schiner, 1860)	25	9
	Scaeva latimaculata (Brunetti, 1923)	2	2
	Paragus serratus (Fabricius, 1805)	14	10
Milesiinae	*Eristalinus aeneus* (Scopoli, 1763)	212	40
(Total=344)	*Eristalinus laetus* (Wiedemann, 1824)	99	28
	Eristalinus taeniops (Wiedemann, 1818)	2	2
	Eristalinus arvorum (Fabricius, 1787)	17	7
	Eristalis tenax (Linnaeus, 1758)	2	1
	Syritta pipiens (Linnaeus, 1758)	3	2
	Mesembrius bengalensis (Wiedemann, 1819)	9	3

between abundance and diversity of hoverflies, and the availability of floral resources (Number of plant species in flowering and floral density per month).

To estimate the similarity in the hoverfly guilds with similar floral food requirements, we used multidimensional scaling analysis. Bray-Curtis index of similarity was used instead of Euclidean distance as input since many of the cells in the data matrix were zero (Beals, 1984). To achieve accuracy we excluded from analysis those syrphid species that visited two or fewer plant species. XLSTAT computer software (XLSTAT, 2008) was used for all analysis.

RESULTS

The community of hoverflies consisted of 14 species, representing two sub-families and 11 genera (Table II). The members of the sub-family Syrphinae were in greater abundance (545 individuals) than members of Milesiinae (344 individuals) in the overall study period. All the seven species in sub-family Syrphinae belonged to seven different genera whereas the seven species of Milesiinae were attributed to only four genera.

Among Syrphinae, *Ischiodon scutellaris* (Fabricius) proved to be the most frequent floral visitor followed by *Sphaerophoria bengalensis* (Macquart) and *Episyrphus balteatus* (Degeer) *i.e.* 37, 23 and 22% of total abundance, respectively. Likewise these three most abundant species also visited the maximum number of plant species *i.e.* 37, 26 and 30, respectively. Only 2 individuals of *Scaeva latimaculata* (Brunetti) were recorded during the full study period.

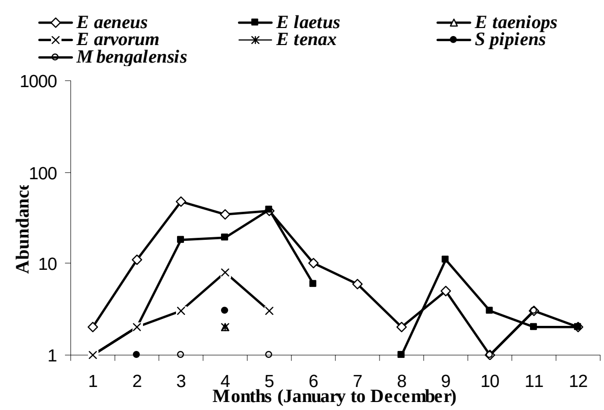

Fig. 2. Monthly abundance of the members of Sub-family Milesiinae at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

The genus *Eristalinus i.e. E. aeneus,* (Scopoli) *E. laetus* (Wiedemann), *E. arvorum* (Fabricius) and *E. aetniops* (Wiedemann), was comprised of 96% of the total abundance of Milesiinae. *E. aeneus* and *E.*

Table II. Monthly syrphid fly abundance (number of census) on flowering plants from January to December, 2008 at Bahauddin Zakariya University Campus, Multan, Pakistan.

Plant species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Aizoaceae												
Trianthema portulacastrum					0(1)	1(3)	0(1)	0(1)	4(2)			
Sesuvium sesuvioides			0(1)	9(1)	0(1)							
Amaranthaceae												
Achyranthes aspara	1(1)						0(1)	0(1)	0(2)	0(1)	1(2)	1(1)
Anacardiaceae												
Mangifera indica			9(1)	23(1)								
Apiaceae												
Coriandrum sativum		7(1)	33(2)									
Daucus carota			19(1)	17(1)	4(1)							
Torilis japonica		2(1)	5(1)									
Asclepiadaceae												
Calotropis procera			0(1)	19(2)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)		
Asphodelus tenuifolius		1(2)	1(2)									
Asteraceae												
Sonchus asper			3(3)	17(2)	0(1)	0(1)						
Cirsium arvense			9(2)	23(2)								
Launaea procumbens			3(2)	60(2)	1(2)	1(2)	0(2)	0(1)	0(1)			
Ageratum conyzoides			1(1)	34(3)	1(2)							
Helianthus annuus				7(1)	10(1)							
Conyza bonariensis				12(2)	0(2)	0(2)	0(2)	0(1)				
Carthamus persicus				5(2)	1(2)							
Pulicaria crispa			0(1)	4(2)								
Boraginaceae												
Heliotropium europaeum			1(1)	1(1)	7(3)	0(2)	0(1)					
Brassicaceae												
Brassica campestris		0(1)	15(2)									
Sisymbrium irio		0(1)	1(2)									
Malcolmia africana		1(2)	0(1)									
Raphanus stivus		1(1)	31(2)									
Capparidaceae												
Capparis decidua			3(1)	20(2)		0(1)	0(1)	0(1)	0(1)	0(1)		
Cleome viscosa							0(3)	0(2)	1(2)			
Caryophyllaceae												
Spergula arvensis		1(1)	2(1)									
Chenopodiaceae												
Chenopodium album				10(2)	0(1)	0(2)	0(1)					
Salsola baryosma									3(2)			
suaeda fruticosa									4(2)	0(1)	0(1)	
Haloxylon recurvun									9(2)			
Convolvulaceae												
Convolvulus arvensis			2(2)	16(2)	7(2)	2(2)	0(1)					
Convolvulus sp.			0(1)	13(2)	2(1)	1(1)	0(2)	1(1)	3(1)	2(2)		
Cucurbitaceae												
Momordica charantia				15(1)	14(2)	10(2)	2(1)					
Cucumis prophetrum				5(1)	0(2)	0(2)	1(2)	0(1)	1(2)			

Continued

Plant species	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Euphorbiaceae												
Euphorbia helioscopia		5(1)	0(1)									
Chrozophora tinctoria				5(2)	1(1)							
Fabaceae												
Prosopis juliflora			0(1)	15(1)	8(1)	0(1)	0(1)	0(1)	0(1)			
Albizzia procera				6(1)								
Dalbergia sissoo			4(1)	16(1)								
Medicago sativa				2(2)	1(2)							
Leucaena leucocephala				18(2)	3(1)							
Parkinsonia aculeata				35(1)	16(1)	9(1)			2(1)			
Melilotus indica		0(1)	3(3)									
Gentianaceae												
Centaurium pulchellum				0(1)	4(2)							
Liliaceae												
Allium cepa			8(1)	12(1)	5(1)							
Malvaceae												
Abutilon indicum	2(1)		5(2)	12(2)	0(1)							
Malvastrum coromandelianum	2(1)	1(1)	9(2)	2(1)	0(2)	0(1)	0(1)	0(1)	0(1)	0(1)		
Grewia subinaequalis				22(2)								
Marsiliaceae												
Marsilia minuta	0(1)	0(2)	0(1)	6(1)								
Meliaceae												
Melia azedarach			3(2)									
Mimosaceae												
Acacia nilotica							0(1)	0(2)	0(2)	1(2)	4(1)	3(1)
Myrtaceae												
Eucalyptus camaldulensis				11(2)								
Portulacaeae												
Portulaca oleracea						0(1)	2(2)	0(1)				
Primulaceae												
Anagallis arvensis		0(1)	3(2)	1(1)								
Ranunculaceae												
Ranunculus muricatus			44(2)									
Rhamnaceae												
Ziziphus jujuba					2(2)			1(1)	0(1)	1(2)	1(1)	
Rutaceae												
Citrus medica			5(1)									
Solanaceae												
Solanum surattense				1(1)	0(2)	0(1)	0(1)	0(2)				
Verbenaceae												
Lantana camara					1(2)	0(2)	0(1)	0(1)	1(2)	1(1)	4(1)	2(1)
Zygophyllaceae												
Tribulus terrestris					2(2)	2(2)	2(2)	0(1)	3(2)			
Total Monthly	5(4)	19(16)	\232(50)	469(54)	91(45)	30(30)	7(28)	2(20)	31(28)	5(12)	10(6)	5(3)

Note: The observation months for each plant species represent the flowering period of that particular plant species.

laetus were the most abundant floral visitors and visited the maximum number of plant species *i.e*. 40 and 28, respectively. The remaining species of Milesiinae had much lower abundance and also visited only a few plant species.

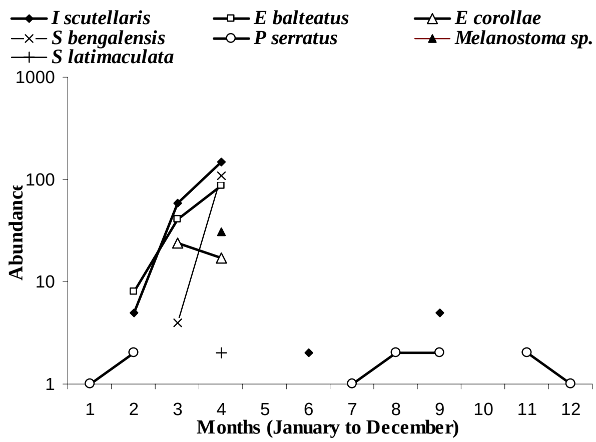

Fig. 3. Monthly abundance of the members of Sub-family Syrphinae at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

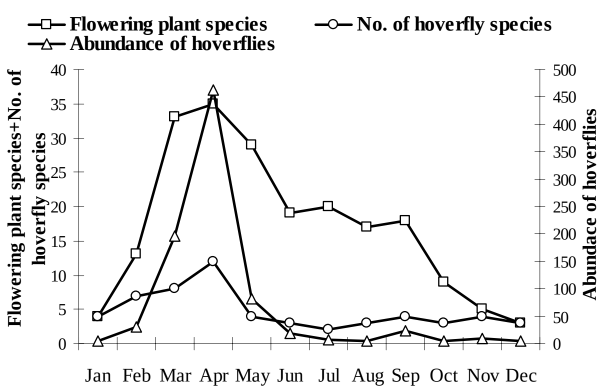

Fig. 4. Monthly dynamics of number of flowering plant species, number of hoverfly species and their abundance at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

The seasonal dynamics revealed that syrphids remain active around the year with remarkable fluctuations in abundance and species diversity. The peak in abundance and diversity was observed in the month of April (Figs. 2, 3). This coincided with the month when the maximum number (35) of plant species was in flower (Fig. 4).

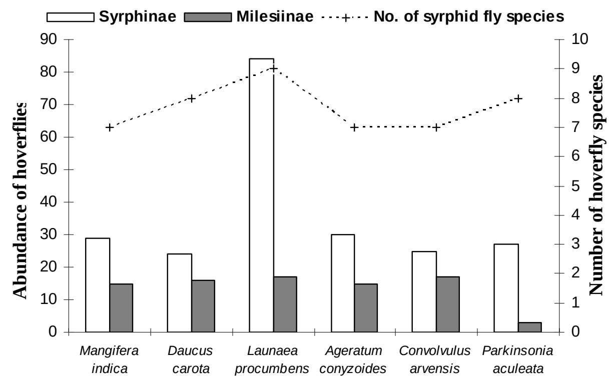

Fig. 5. Plant species visited by more than 6 syrphid species along with their number and abundance at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

Among Milesiinae, *E. laetus* and *E. aeneus* remained active throughout the year in variable abundance. Both the species attained their peak population in March to May. Though in the month of July *E. laetus* was not recorded but its population increased again in the later half of the year. Other less abundant Milesiinae *i.e. Eristalis tenax* (Linnaeus), *E. taeniops* and *Syritta pipiens* (Linnaeus) were active only in the month of April. *Mesembrius bengalensis* (Wiedemann) proved to be a more abundant floral visitor in the month of November than March, May and October.

Like Milesiinae, most of the Sryphinae were restricted to the spring season (March-April) *i.e. E. balteatus*, *Eupeodes corollae* (Fabricius), *S. bengalensis*, *Melanostoma* sp. (Walker) and *S. latimaculata.* Although *E. balteatus* and *S. bengalensis* were highest in abundance but no longer observed after spring season. Only two species proved to be persistent throughout the year *i.e*. *Paragus serratus* (Fabricius) and *I. scutellaris*.

Four observed species *i.e. E. aeneus*, *E. laetus*, *P. serratus* and *I. scutellaris* were observed to be weather tolerant to variable extents, since these were recorded foraging in the coldest (12°C) months of December and January to the hottest (32°C) months of July and August.

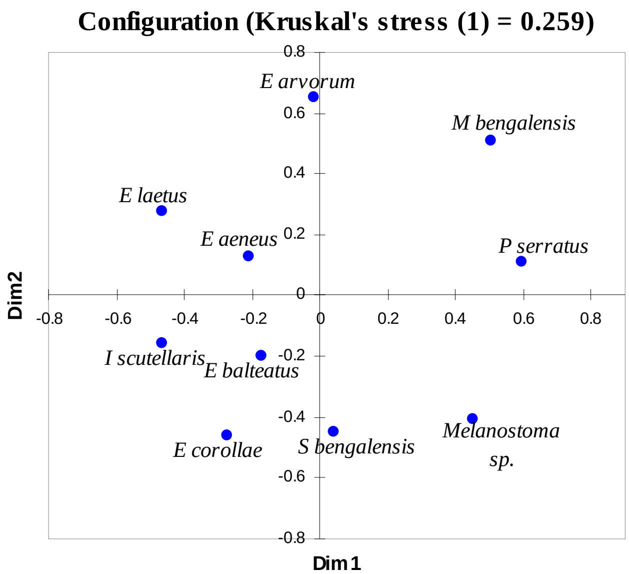

Fig. 6. Multidimensional scaling analysis of 10 syphid species with Bray and Curtis distance based on their abundance on 59 flowering plants at Bahauddin Zakariya University Campus, Multan, Pakistan from January to December, 2008.

Six plant species receiving greater than six syrphid visitor species were identified (Fig. 5). Out of these six species two were agricultural crops (*Mangifera indica* and *Daucus carota*) and remaining four (*Launaea procumbens*, *Ageratum conyzoides*, *Convolvulus arvensis* and *Parkinsonia aculeate*) were wild plant species. *L. procumbens* was visited by the highest number (9) of syrphid species with highest abundance. In all six selected plant species, the proportion of Syrphinae abundance was greater than that of Milesiinae (Fig.5).

On the basis of similarity in the floral host plant preferences, multidimensional scaling analysis separated the members of Milesiinae (in upper half of ordination plot) from Syrphinae (in the lower half of ordination plot) except *P. serratus* (Fig. 6).

The plant profile was composed of 59 plant species in 29 families (Table I). Flowering periods of these species varied with a high degree of overlap. A large number (35) of plant species were observed flowering in the month of April (the peak spring season). This is the month in which there

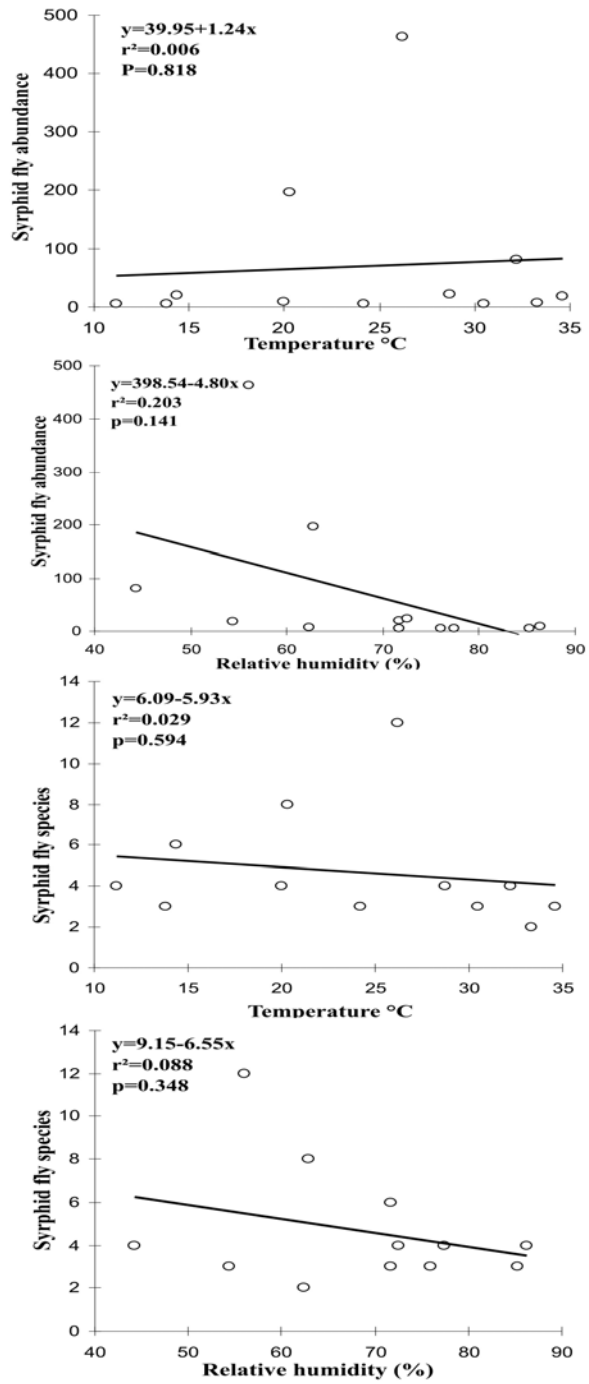

Fig. 7. Relationship between abiotic factors (average temperature °C and relative humidity %) and number of syprhid fly species and their abundance over the year at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

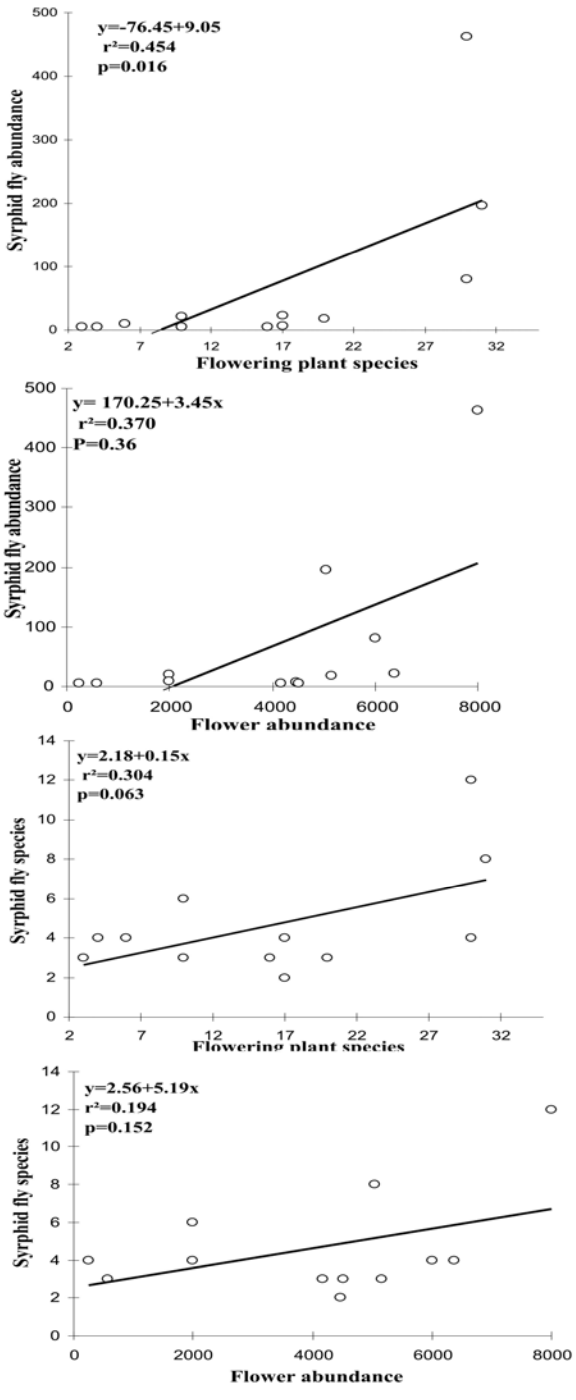

Fig. 8. Relationship between biotic factors (number of flowering plant species and floral abundance per month) and number of syprhid fly species and their abundance over the year at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

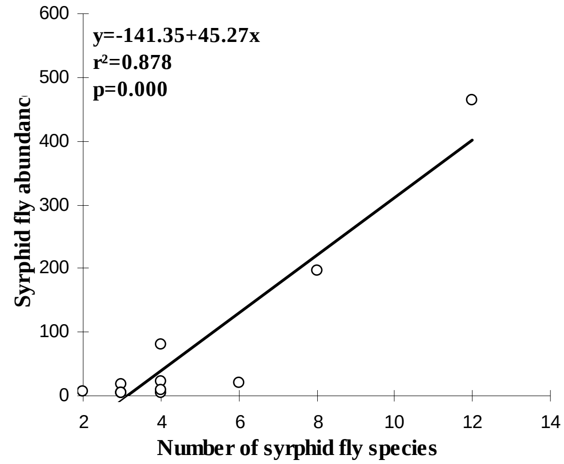

Fig. 9. Relation between number of syrphid fly species and their abundance at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

were maximum number of hoverfly species at peak abundance (Fig. 4).

The winter season (Nov-Feb) proved to be unfavorable for syrphid flies since the average temperature did not exceed 20°C and relative humidity did not lower below 70%. Temperature had a weak negative effect on the number of syphird species, whereas it had a slightly positive relation to the abundance of syrphid flies throughout the year (Fig. 7). Likewise, relative humidity was negatively correlated with both the species abundance and species number of Syrphidae over the year (Fig. 7). The biotic factors (number of flowering plant species and flower abundance per month) were also positively correlated with the number of syrphid species and their per month abundance (Fig. 8). Floral abundance decreased with the decrease in number of flowering plant species whereas syrphid abundance also decreased with the decrease in their species number over the year (Figs. 9-10).

DISCUSSION

All the species encountered from the sub-family Syrphinae were aphidophagous whereas all those from the sub-family Milesiinae were saprophagous. The abundance of aphidophagous species was greater than that of saprophagous species in this study. The abundance of any species in a particular habitat and particular interval of time

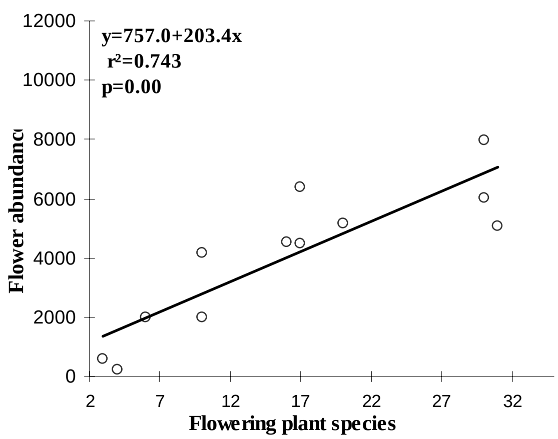

Fig 10. Relation between flowering plant species and their floral abundance at Bahauddin Zakariya University Campus, Multan, Pakistan during January to December, 2008.

depends on availability of breeding places and hosts. Most of the members of Milesiinae breed in marshes, damp places and rotting materials (Sommaggio, 1999). For example, Hartley (1961) described *E. aeneus* as more frequent in estuarine marsh pools. Since the Melisiinae are entirely aphidophagous, they lay eggs near or in the aphid patches on the plants. Almost all the aphid species in the southern part of Punjab appear in spring (Feb-March), suggesting that larval diet is also very much important in determining population dynamics of aphidophagous species. Among Syrphinae, *I. scutellaris*, *S. bengalensis* and *E. balteatus* and among Milesinae, *E. aeneus* and *E. laetus*, had the greatest abundance. *I. scutellaris*, *E. balteatus* and *E. aeneus* are widely distributed over many parts of the world (Ghahari *et al*., 2008). These species have adapted to a wide range of geographic patterns, therefore they could be considered as the most successful syrphid species not only in terms of distribution, but also in exhibiting the greatest host plant range in this study. In nature the organisms with more generalization in mutulistic interactions are more successful than the organisms with more specialized and limited types of mutulistic interactions (Fenster *et al*., 2004). The observations in the field might be undermined by well studied marked floral constancy among many hoverfly species (Goulson and Wright, 1998) and daily blooming pattern of the plant species (Freitas and Sazima, 2003). To overcome these problems we selected individual plants (at time of anthesis) at a considerable distance (>5m) from each other only during their anthesis.

P. serratus is zoophagous and feeds on soft bodied insects other than aphids (Sommaggio, 1999) and we observed *P. serratus* throughout the year even in the months of winter (January, November and December); *i.e*. the time which is unfavorable for the development of almost all kinds of aphid species. The two other biotic factors in this study (the availability of flowering plant species and floral abundance) have shown a positive relation to syrphid abundance and diversity. Many pervious studies have also exhibited a positive correlation between availability of floral resources and abundance of pollinators (Barret and Helenurm, 1987; Wolda, 1988; Inouye and Kearns, 1993; Souza-Silva *et al*., 2001). As with landscape level studies, a positive relation between richness and abundance of floral resources and pollinator diversity and activity has also been observed at a micro scale *i.e*. within a plant community (Klein *et al*., 2003).

The composition of floral community may also be an important factor in predicting diversity and abundance of pollinators (Potts *et al*., 2003). Likewise, Hegland and Boeke (2006) also reported that small scale spatial variations in the density and diversity of floral resources can positively affect pollinator activity.

Syrphidae are typically generalists in their floral visitation (Memmot, 1999; Dupont *et al*., 2003) and therefore have a stronger positive response to floral abundance rather than plant species richness. Another study (Dewenter and Tscharntke, 1999) also failed to link syrphid fly activity to landscape scale variables. Altogether, this suggests that the availability of floral resources may be a poor predictor of syrphid activity. There may be some other spatial factors *e.g*. color and floral host preferences (Haslett, 1989; Sutherland *et al*.,

1999) may also work at small scale that might explain the lack of response to the more general characteristics of plant richness or blossom density.

All six plant species which were visited by a maximum number (greater than 6) of syrphid species had open type of flower morphs with shallow nectarines. According to pollination syndromes concept, dipterous flies prefer actenomporphic yellow or white coloured flowers with shallow nectar (Fægri and Van der Pijl, 1979). Flies unlike bees, can not manipulate the complex zygomorphic and tubular flowers with hidden nectar and deep nectarines. Milesiinae are more bulky than most Syrphinae with longer proboscis (5-10 mm) enabling them to feed from tubular flowers with rather deep nectars e.g. *M. bengalensis* in this study fed on tubular *Lantana camara* in which corolla depth was 10.4±0.03 mm.

The knowledge of similarity in the floral host plants among the pollinators can help us to develop conservation strategies for pollination or biological control. The members of Milesiinae were clustered together in the upper half of ordination plot. This is because they have long mouthparts and can feed from almost all kinds of open flower morphs with corolla depth less than 10 mm. In this study, all the flowers had nectar depth less than 10 mm, except *L. camara*. Whereas most of the Syrphinae were clustered in the lower half of ordination plot which might be because of their shorter mouthparts, since they cannot exploit nectar from deeper corollae (Fenster *et al*., 2004). Furthermore, pollen feeding is also more common in Syrphinae than Milesiinae, particularly from flowers with deeper nectar *i.e.* pollen placed well above the nectar which is easily assessable by Syrphinae (Holloway, 1976). Many Syrphinae usually feed nectar from very short and shallow flowers *e.g.* umbelliferous flowers (Apiaceae).

Temperature and humidity were negatively correlated with the number of syrphid species per month. The relation between Diptera and environmental factors may vary with geographical distinction *e.g.* Carvolho *et al*. (1991) documented a positive relationship between temperature and number of Diptera in tropics but this relationship could be negative in hotter areas of the world *e.g.* sub-tropical areas of Pakistan. In hot and humid climates with no dry seasons, temperature and humidity do not significantly fluctuate as much round the year *e.g.* Abaete, Salvador (Brazil). Under such climatic conditions bees have been studied extensively (Viana and Kleinert, 2005) and found to be unaffected by temperature and humidity but positively related with the availability of floral resources.

The seasonal variation in floral visitors is almost certainly related to resources availability. And higher species richness is positively correlated to higher resource diversity. Less frequently visitors are possibly related to specific plants or have a short activity period (Inouye and Kearns, 1993).

In an ecosystem, the importance of any syrphid fly species cannot be estimated solely on the basis of its abundance. The pollination potential of the most abundant syrphid may be less than that of the least abundant syrphids. These facts suggest the importance of deeper studies of insect-plant interaction in this habitat with the perspective of maintaining natural and agricultural plant communities. Unfortunately, such detailed studies on pollination by Diptera are rare, especially in Pakistan, but hopefully the present work can serve as groundwork for further such research.

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