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ORIGINAL RESEARCH ARTICLE

DIVERSITY OF SYRPHID FLIES IN DISTRICT SIALKOT

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ABSTRACT

Syrphid or hoverflies play crucial role in the ecosystem. As larvae, they are the active predators of aphids, which are notorious pests of agricultural crops while when they become adults these flies act as pollinators. In the absence of natural enemies, many insects cross their threshold number and gain the status of pests eventually causing more loss in agriculture sector. The present study is aimed to determine the diversity of syrphid flies in district Sialkot by sampling through the sweep net and handpicking methods from Wheat, Brassica, Fodder and Vegetable crops. Seven syrphid species were found throughout the sampling period and *Episyrphus balteatus* was considered to be one of the most abundant species with 222 out of 692 specimens while *Melanostoma mellinium* with 53 out of 692 specimens was found to be the least abundant one in district Sialkot.

INTRODUCTION

A country's prosperity and welfare, depends on food security is of strategic significance (Alston and Pardey, 2014). Biodiversity consists of a variety of living organisms including the terrestrial, marine, and other ecosystems with every living being in it (Sobti et al., 2023; Asghar, 2013). With human interference, biodiversity has suffered as the aims of agriculture has changed from "self-reliance" to "Commercialization" and the objective of agricultural production is nothing but maximization of the production by every possible mean. To achieve sustainability in nature, there is an urgent need to conserve and maintain biodiversity, especially in agriculture (Guerrero et al., 2022; Syed et al., 2012).

Pest is defined as any species, and pathogenic agent, which is injurious to plants specially the crops consumed by human beings at abundance and the damage caused by the insect pests, is an undeniable fact (Josephrajkumar et al., 2022; Sharma et al., 2017).

The intensive use of fertilizers and monocultures drastically favors insect pests. The Green revolution technology is the concept in agriculture, which relies on increased use of chemicals and irrigation and it is emerging with time thus causing the synthetic chemicals to be abundant in crops and soil (Richard et al., 2022; Dhaliwal et al., 2010).

One of the major pests of crops worldwide is aphids and are an alarming issue for the agricultural sector (Hussain et al., 2022). Among 4000 species in the world, 100 aphid species have been successful in destroying the agricultural ecosystem to such an extent that they become important economically and gain the attention of science. An analysis of data indicates that aphids constitute 26% of 45 major insect pests worldwide.

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They have small and soft bodies with size range between 1.5 and 3.5 mm with piercing sucking mouthparts that they use to feed on plant fluids leaving the plant damaged or destroyed completely (Dedryver et al., 2010; Miller and Foottit, 2017).

In ecosystems, the population of all organisms is kept under control by the actions of their predators, parasites, and pathogens. This process known as natural control or biological control and the controlling agents are called as natural enemies (Lahlali et al., 2022; Hajek and Eilenberg, 2018).

Aphid feeding Syrphidae known as flower flies, also sometimes called hoverflies is an example of such predatory insects (Bellefeuille et al., 2021). They are distributed all over the world including the Neotropical, and Palaeotropical areas with 6674 species in 284 genera with adult syrphid flies as important pollinators, while the larvae are natural biological control agents as they feed on aphid populations voraciously to complete their development into adults (Dunn et al., 2020). Syrphids on average range in size from 4 to 35 mm. On the basis of their specialized wings, syrphidae can be easily recognized and distinguished from all other dipterans particularly by the presence of a 'vena spuria'. Vena spura is a fold in the middle area of the wing. (Hopper et al., 2011; Hadrava, 2018). From Pakistan, there are around 84 species of syrphids being reported. However, their full potential has not been explored in IPM (Irshad, M. 2014). Syrphids are the most effective aphidopgaha as they distribute their eggs over large and wide areas earlier in the season. A single larva to complete its development consumes around 400 aphids (Singh et al., 2020). Their mechanism of predation includes colonizing the aphid-infested plants (Martin et al., 2015).

Present study aims to determine the diversity of syrphid flies in district Sialkot in order to determine their potential as effective pollinators and aphidophagy so that they can be utilized in integrated pest management.

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METHODOLOGY

Sampling area:

The selection was based on randomly (Martino et al., 2018) selecting the sites from grasslands and croplands with wheat-Fodder dominated cropping system in four Tehsils of district Sialkot i.e., Sambrial, Sialkot, Pasroor and Daska.

Collection and identification:

The specimens were collected by two methods; sweep net and hand picking. Sampling was done from selected crops fortnightly (Nadeem et al., 2023; Tamkeen et al., 2015; Hussain et al., 2017) from March-June 2021. Adult Syrphid flies were sampled from each site at dawn and dusk. To attain a uniform data from all sites, 40 sweeps were made. The collected specimens were then identified to species level and preserved in airtight glass
vials with 70% alcohol and few drops of glycerin to prevent brittleness and evaporation of colors (Maalik et al., 2013).

Table 1.1: Diversity of Syrphid Species from Sialkot District.

Sub-Family	Species	No. of Specimens
Syrphinae	*Episyrphus balteatus*	222
	Eupeodes corolla	82
	Melanostoma scalare	119
	Syrphus ribesii	62
	Melanostoma mellinium	53
Eristalinae	*Eristalinus arvorum*	82
	Eristalis tenax	72
	Total	**692**

The specimens were examined under compound microscope and identified to the species level by (Borror and Delong, 2005) while referring to taxonomic literature, internet sources and identification keys available readily online (Van, 2010; Abdullah, 2020; Speight and Sarthou, 2012).

Statistical Analysis:

The data obtained as a result of sampling from various locations within the study area was used to apply different statistical analysis in order to determine the diversity and abundance of syrphid species in Sialkot. Shannon Diversity Index was used to determine the diversity, distribution, abundance and richness of syrphids.

RESULTS AND DISCUSSIONS:

Diversity of Syrphid flies in district Sialkot:

Sialkot is rich in syrphid species as only four months sampling resulted in 692 syrphid specimens with 07 species being found. *Episyrphus balteatus* was the most abundant species with total 222 specimens, *Melanostoma scalare* was second most abundant species with 119 specimens found, *Eristalis tenax* with total 72 specimens, *Eristalinus arvorum* with total 82 *Syrphus ribesii 62 Eupeodes corollae 82 Melanostoma mellinium* was with 53 specimens being the least abundant during this study period (Table 1.1).

Tehsil-wise Distribution of Syrphids:

From total 692 specimens the number was distributed in rich cropland of Sialkot as 218 specimens in Sialkot Tehsil, 160 specimens in Sambrial Tehsil, 141 specimens in Pasroor Tehsil and 173 specimens in Daska Tehsil as shown in Table 1.2, thus Sialkot being slightly richer in syrphid abundance.

Statistical Analysis of tehsil wise diversity of syrphids:

In Table 4.3 Variation is seen among the results of different locations/tehsils. Between Sialkot and Sambrial, highly insignificant results came out for diversity, and evenness with p value 0.54. In Sialkot Vs Pasroor, highly significant results came out for diversity, evenness and dominance with p value 0.003 (<0.05).

In Daska Vs Pasroor, highly significant results came out for diversity, evenness and dominance with p value 0.000 (<0.05). In Sialkot Vs Daska, significant results obtained for the diversity, evenness and dominance with p value 0.002 (>0.05). In Sambrial Vs Pasroor, highly significant results came out for the diversity, evenness and dominance with p value 0.000 (>0.05).

Month wise Distribution of Syrphids:

692 specimens belonging to family syrphidae; order diptera with 07 species were recorded in four months study period. Table 1.1 shows the number of all the syrphid species recorded during study. *Episyrphus balteatus* was the most dominant species with 222 specimens while *Melanostoma mellinium* was least dominant with 53 specimens recorded during the study period. The data obtained in present study was subjected to statistical analysis for Shannon diversity index(Nolan and Challan, 2006). Between March and April, highly significant results came out for diversity, evenness and dominance with p value 0.0007 (<0.05). In March, Vs May, significant results came out for diversity, evenness, and dominance with p value 0.03 (<0.05). In March Vs June, insignificant results came out for the diversity, evenness, and dominance with p value 0.17 (>0.05). In April Vs May, highly insignificant results came out for the diversity, evenness and dominance with p value 0.43 (>0.05). In April Vs June, highly significant results came out for diversity, evenness, and dominance with p value 0.006 (<0.05). In May, Vs June

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Table 1.2: Tehsil-wise number of Syrphid Species from district Sialkot.

Species	Sialkot	Sambrial	Pasroor	Daska	Total
Episyrphus balteatus	68	47	50	57	222
Eupeodes corollae	30	25	12	15	82
Melanostoma scalare	39	32	20	28	119
Syrphus ribesii	22	15	11	14	62
Melanostoma mellinium	11	10	13	19	53
Eristalinus arvorum	25	18	20	19	82
Eristalis tenax	23	13	15	21	72
Total	218	160	141	173	692

Table 1.3: Shannon Diversity Index indicating tehsil wise variation of syrphid flies.

Tehsil	**N1**	**H'1**	**E1**	**N2**	**H'2**	**E2**	**df**	**t- test**	**p value**
Sialkot vs Sambrial	196	1.685	0.7703	138	1.731	0.806	304.97	-0.604	0.545
Sialkot vs Pasroor	196	1.685	0.7703	166	1.452	0.610	337.12	2.946	0.003*
Sialkot vs Daska	196	1.685	0.7703	192	1.865	0.921	320.17	-3.063	0.002*
Sambrial vs Pasroor	138	1.7311	0.8067	166	1.452	0.610	303.67	3.334	0.000*
Sambrial vs Daska	138	1.7311	0.8067	192	1.865	0.921	213.3	-2.060	0.040*
Daska vs Pasroor	192	1.865	0.9219	166	1.452	0.610	244.95	6.070	4.82E-09

significant results came out for diversity, evenness and dominance with p value 0.01 (<0.05).

Crop-wise Relative Abundance of Syrphid Species from Sialkot City

As shown in the Table the syrphids showed a prominent variation among four crops under study.

Highest relative abundance was observed in Fodder crop with a value 39.16, while the Brassica was second most abundant with a value of 29.05, Wheat also showed considerable number of specimens with an abundance of 17.92 while the least abundance of 13.87 was shown in vegetables.

In Sialkot Vs Pasroor, highly significant results came out for diversity, evenness and dominance with p value 0.003 (<0.05).

In Daska Vs Pasroor, highly significant results came out for diversity, evenness and dominance with p value 0.000 (<0.05). In Sialkot Vs Daska, significant results obtained for the diversity, evenness and dominance with p value 0.002 (>0.05). In Sambrial Vs Pasroor, highly significant results came out for the diversity, evenness and dominance with p value 0.000 (>0.05).

With present study, it is clear that district Sialkot is rich in syrphid species as in only four months 692 syrphid specimens with 07 species were observed. Present study reveals that *Episyrphus balteatus* was the most abundant species with total 222 specimens and its abundance as compared to other species have been reported by (Irshad, 2014). *E. balteatus* was one of the most common zoophagous hoverflies in Europe in field studies by (van and Wäckers,2016). According to (Hatt *et al.,* 2019) *E. balteatus* and *E. corollae* were abundant in open fields with inflorescence and nectar.

The variation on monthly basis was observed as the highest number of syrphids was recorded in March, the spring season while the lowest number of specimens were recorded in June, the summertime in Pakistan. The pattern of variation shows that syrphid flies prefer the moderate temperature as their number declined with progressing months i.e., extreme temperatures of May and June. According to (Dib *et al.,* 2016) the syrphids are most abundant and active in early spring. They are known to be abundant in spring season according to many other

researchers (Sajjad and Saeed, 2010; Jalilian *et al.*, 2010). Tehsil wise diversity results revealed that Sialkot is slightly richer in syrphid species, while no such study have been reported from Sialkot.

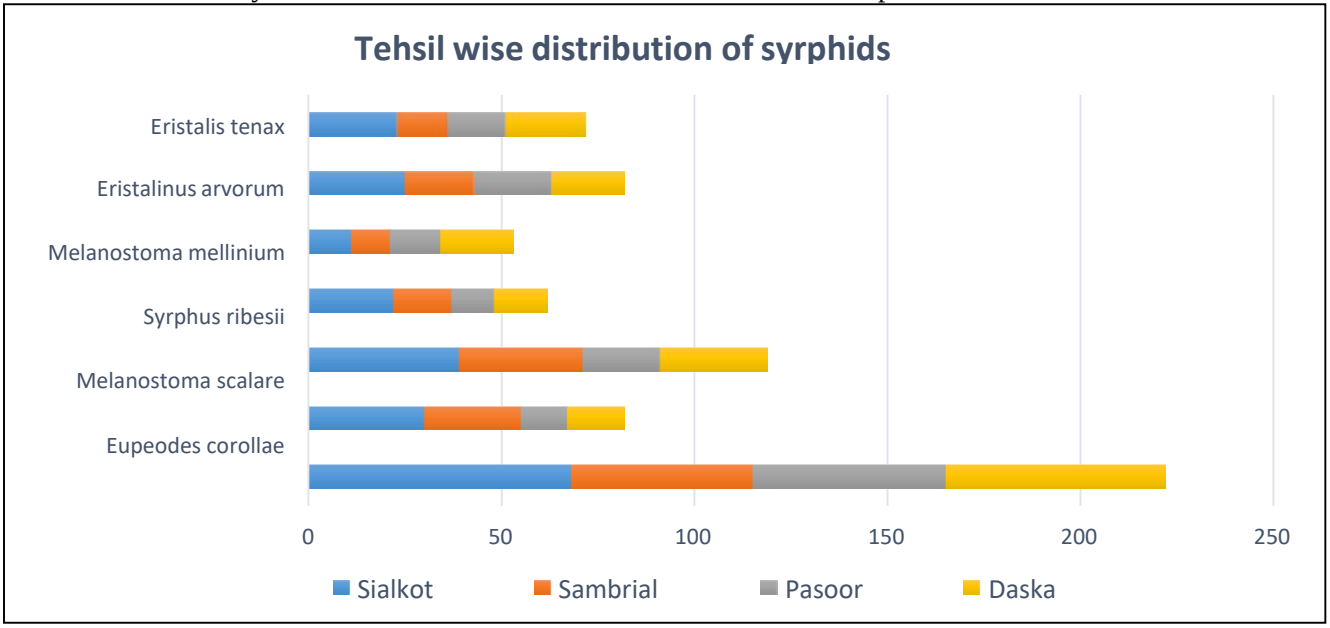

Figure: 1.1 Graphical representation of tehsil-wise distribution of syrphids

Table 4.2: Month-wise diversity of Syrphid Species from district Sialkot.

Species	March	April	May	June	Total
Episyrphus balteatus	129	59	27	7	**222**
Eupeodes corollae	41	35	4	2	**82**
Melanostoma scalare	31	60	24	4	**119**
Syrphus ribesii	21	32	9	0	**62**
Melanostoma mellinium	20	17	13	3	**53**
Eristalinus arvorum	33	31	18	0	**82**
Eristalis tenax	27	25	15	5	**72**
Total	**302**	**259**	**110**	**21**	**692**

Table 4.3: Shannon Diversity Index indicating monthly variation of syrphid flies.

Months	N1	H'1	E1	N2	H'2	E2	df	t- test	p value
March vs April	302	1.691	0.775	259	1.863	0.920	480.22	-3.408	0.0007*
March vs May	302	1.691	0.775	110	1.823	0.883	311.41	-2.097	0.0367*
March vs June	302	1.691	0.775	21	1.526	0.919	28.115	1.404	0.1711
April vs May	259	1.863	0.920	110	1.823	0.883	184.06	0.782	0.4351
April vs June	259	1.863	0.920	21	1.526	0.919	23.356	3.002	0.0062*
May vs June	110	1.823	0.883	21	1.526	0.919	28.596	2.507	0.0180*

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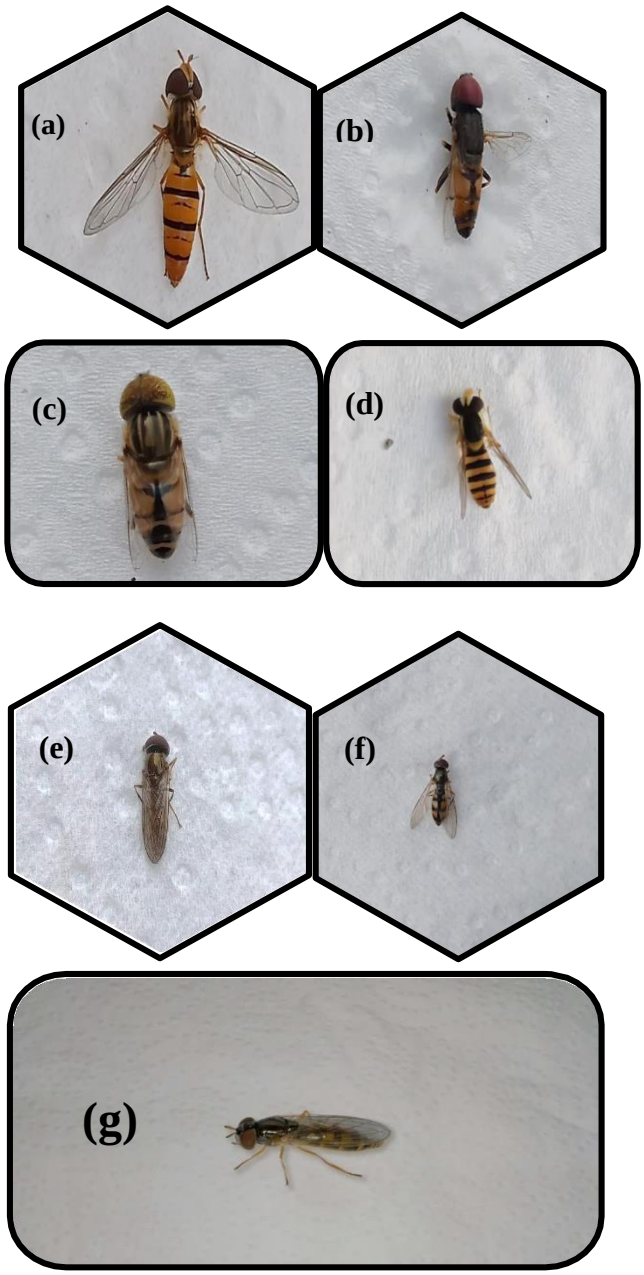

Figure: 1.2 Group of seven syrphid species *(a) Episyrphus balteatus (b) Eristalis tenax* (c) *Eristalinus arvorum (d) Syrphus ribesii (e) Melanostoma scalare (f) Eupeodes corollae* (g) *Melanostoma mellinium*.

The present study showed a glimpse of diversified presence of syrphid flies in district Sialkot and these flies have an enormous potential to be used in natural control or integrated pest management. Using the full potential of these flies could result in less use of synthetic chemicals for pest control thus the farmers should be made aware of the importance and identification of these flies.

CONCLUSION

Seven species of syrphids were found in district Sialkot in four months of sampling: March 2021-June 2021. Their presence proved that they play a vital role in pollination of important crops i.e., wheat, brassica, fodder and vegetables. Syrphid were more abundant in fodder followed by wheat and then brassica, vegetables showed least abundance. *Episyrphus balteatus* was the most abundant species in Sialkot cropland. *Melanstoma mellinium* was the least abundant species. March was the month of highest diversity of syrphids. June was the month with the least diversity. Four tehsils of district Sialkot were rich in syrphid diversity while tehsil Sialkot was a little richer in syrphid diversity as compared to other tehsils.

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