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Hoverflies of Assam (Diptera: Syrphidae): New records and their diversity

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Abstract

Hoverflies, generally known as Syrphid flies belongs to family Syrphidae, which is one of the largest families of order Diptera. The adults use to feed on nectar and pollen of many flowering plants and larval stages of some species are predaceous to homopteran insects. The objective of the present investigation was focused on the assessment of the diversity and abundance of hoverfly at Assam Agricultural University, Jorhat, Assam during 2015-16. A total of 225 individual hoverflies were recorded during the study out of which 23 species belonging to 16 genera under 2 sub-families viz., Eristalinae and Syrphinae were observed. Among them, ten species viz., *Eristalinus tristriatus*, *Eristalis tenax*, *Eristalodes paria*, *Lathyrphthalmus arvorum*, *Lathyrphthalmus megacephalus*, *Lathyrphthalmus obliquus*, *Phytomia errans*, *Pandasyophthalmus rufocinctus*, *Metasyrphus bucculatus* and *Sphaerophoria macrogaster* were newly recorded from Assam. Among the species, *Episyrphus viridaureus* and *Lathyrphthalmus arvorum* were found to be the most abundant species with the relative abundance of 16.89 and 10.22% respectively. Two parasitoid viz., *Diplazon sp.* and *Syrphophagus aeruginosus* (Dalman) were also observed as natural enemies for the first time in Assam emerging out from parasitized pupa of hoverflies during the studies. Out of 23 species, 20 were found in horticultural ecosystem with total abundance of n= 119 followed by 18 species (n=106) in agro- ecosystem. The horticultural ecosystem recorded the highest diversity index and evenness (2.84 and 0.95) followed by agro-ecosystem (2.52 and 0.87). The highest number of species was recorded from horticultural ecosystem and the presence of such diversity reflects the composition of different food sources and also indicates the healthiness of the surrounding environment.

Keywords: Hoverfly, natural enemies, species diversity, abundance, ecosystem, Assam

1. Introduction

Hoverflies, commonly known as Syrphid flies or flower flies belongs to family Syrphidae, which is one of the largest families of order Diptera. These flies can be found everywhere except in deserts and tundra at extremely high altitudes, and in Antarctica ^[1]. About 6,008 species of hoverflies under 199 genera were known worldwide ^[2]. Out of which, 357 species under 69 genera are currently recorded from India ^[3]. The size of hoverflies varies from small to large depending on the species, the genus *Baccha*, are small, slender and elongate whereas, *Criorhina* are large, brightly coloured and hairy. Most of the hoverflies are with stripes, spots and bands of yellow or brown covering their bodies ^[4] and some exhibit Batesian mimicry ^[5]. The adult hoverflies used to feed on pollen and nectar of many flowering plants and also act as important pollinators of many crops after bees ^[6]. The adults are often seen hovering at flowers while the maggots (larval stages) have a wide range of food habitat ^[7]. Some larvae are mycetophagous, saprophagous and some species are predaceous to homopteran insects ^[8, 9, 10]. Most of the predatory hoverflies are mainly prey on aphids (Aphidophagous) and therefore they are potential biological control agents for aphids in vegetable crops ^[11].

In India, work on Syrphidae was initiated by Fabricius and elaborated papers on Indian Syrphidae were published by Brunetti. Later, Herve-Bazin, Bhatia, De Silva, Coe, Nayar, Joseph, Parui did notable works on Indian Syrphidae. In the recent past Ghorpade, Mengual, Dutta, Mukherjee, Banerjee and Mitra have made notable contributions to taxonomy of Indian Syrphidae ^[12]. In Assam, little work on Syrphidae was documented and therefore the study was taken up to collect the information on the diversity and abundance of hover flies in Jorhat district of Assam in two different habitat (Agro and Horticultural ecosystem).

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2. Materials and Methods

2.1 Study site

The study was conducted in Jorhat district of Assam located at 26.75°N 94.22°E with the average elevation of 116 metres. The region is located between the mighty Brahmaputra River on the North and the Nagaland state on the South. The average annual temperature in Jorhat remains at 26 °C. The temperature during summer season range between 25-35 °C and in winter between 22-10 °C. The average annual rainfall of Jorhat is 2244 mm and a major portion of this is contributed by the north-west monsoons. The major types of vegetation included grasslands, open scrub forest, tea garden, agricultural lands and orchards.

2.2 Sampling methods

During the study, two sampling sites were selected viz. Agro-ecosystem and Horticultural ecosystem for observing the hoverflies. The hoverflies were observed in the sampling sites for a period of more than 1 year between August-2015 to December-2016. Each study site was visited at fortnightly interval and observed from early morning (8:00 am) to evening hours (4:30 pm) during good weather periods (no heavy rain and strong wind). The adult hoverflies were photographed with DSLR camera (Nikon D3300) and collected with sweep net. The specimens were killed and preserved in ethanol (85%) for identification. Then samples were then sent for identification to Dr. Kumar Ghorpade (Scientist Emeritus & Honorary Research Associate in Systematic Entomology, UAS, Dharwad) and their natural enemies to National Bureau of Agricultural Insect Resources, Bengaluru.

2.3 Statistical analysis

Total abundance, Species richness (number of species), Diversity and Evenness of hoverflies were also studied under Agro-ecosystem and Horticultural ecosystem.

2.3.1 Species diversity

The Shannon-Wiener diversity index was calculated by using (Shannon and Weaver) ^[13] which is defined as $H' = - \sum P_i \ln P_i$ Where, $P_i = n_i/N$, N_i =number of individual of a species at a time i , N = size of whole community and \ln = natural log.

2.3.2 Evenness

Evenness of species was calculated by using (Pielou) ^[14] which is defined as $J' = H'/\ln S$

Where, S = number of species present in the site, \ln = natural log and H' is the diversity index. The value of J' ranges from 0-1.

3. Results and Discussion

A total of 225 individual hover flies were recorded during the study out of which 23 species belonging to 16 genera under 2 sub-families viz., Eristalinae and Syrphinae were observed. The highest number of species was recorded from sub-family Syrphinae (16 species) and Eristalinae recorded 7 species (Table 1). Among them, ten species viz., *Eristalinus tristriatus*, *Eristalis tenax*, *Eristalodes paria*, *Lathyrphthalmus arvorum*, *Lathyrphthalmus megacephalus*, *Lathyrphthalmus obliquus*, *Phytomia errans*, *Pandasyophthalmus rufocinctus*, *Metasyrphus bucculatus* and *Sphaerophoria macrogaster* were newly recorded from Assam. The photographs of the observed hover flies are given in the Plate 1 and 2. Among the species recorded, *Episyrphus*

Viridaureus was observed the highest number with the relative bundance of 16.89 per cent followed by *Lathyrphthalmus arvorum* and *L. obliquus* (10.22 and 8.00 per cent respectively) and *Phytomia errans*, *Melanostoma univittatum* and *Serratoparagus serratus* were observed the lowest number with relative abundance of 0.89 per cent (Table 1). Two parasitoid viz., *Diplazon* sp. and *Syrphophagus aeruginosus* (Dalman) were also observed as natural enemies for the first time in Assam emerging out from parasitized pupa of hoverflies during the studies (Plate 3 and 4). Species abundance, richness, diversity and evenness of different hover flies were also studied in agricultural and horticultural ecosystem of AAU, Jorhat. Out of 23 species recorded, 20 were found in horticultural ecosystem with total abundance of $n=119$ followed by 18 species ($n=106$) in agro-ecosystem (Table 2). The horticultural ecosystem recorded the highest diversity index and evenness (2.84 and 0.95) followed by agro-ecosystem (2.52 and 0.87). The highest number of species was recorded from horticultural ecosystem and the presence of such diversity reflects the composition of different food sources and also indicates the healthiness of the surrounding environment. Similar results were also reported by Mitra *et al.* ^[15] who reported eight species of Syrphidae viz., *Asarkina ericetorum*, *Lathyrphthalmus arvorum*, *L. obscuritarsis*, *L. obliquus*, *Serratoparagus serratus*, *Melanostoma orientale*, *Eoseristalis arbustorum* and *Episyrphus balteatus* from Bhibhuti Bhusan Wild Life Sanctuary, West Bengal. Sengupta *et al.* ^[16] reported 355 species of hover flies under 69 genera in Indian sub-continent. Khan and Riyaz ^[17] also reported 19 species of syrphid flies belongs to 2 sub families, 4 tribes and 12 genera among which, *Eristalis tenax* followed by *Eoseristalis cerealis*, *Eristalis interruptus* and *Episyrphus balteatus* were predominant species of syrphid flies in fruit orchards of Kashmir. Masumeh and Shahrokh ^[18] also reported 31 species with 750 individuals of hoverflies, among which *Sphaerophoria scripta*, *Eristalis arbustorum* and *Eristalis tenax* were found to be the most abundant in Iran. They also reported that species diversity, richness and evenness were high in river side compare to rice field. Humphrey *et al.* ^[19] also reported that hoverflies diversity, within pine and spruce diversity forests in the UK, showed a high correlation with landscape complexity. Due to a need for different habitats during their life and the diversity of different larvae situations the diversity of land cover could play a more important role in diversity of hoverflies, so the rice field is monoculture place and the lack of habitat diversity will lead to a decrease in hoverflies species. Similar results was also reported by Bei Bienko ^[20] who reported that the rice field was less diverse and therefore showed less diversity of hoverflies. Saribiyik ^[21] also reported that the hoverflies were more abundant in forest, mountains and on river banks where the climate was more humid and found more flowering plants. Khoramabadi *et al.* ^[22] reported three species of parasitoids viz., *Diplazon laetatorius*, *Enizemum ornatum* and *Pachyneuron formosum* from the syrphid larvae that were collected and reared under room temperature at Yazd Province of Iran. They also mentioned that Diplazontinae wasps are the main parasitoid that reduced the population and abundancy of the syrphid flies in nature. Krawczyk *et al.* ^[23] also reported four parasitoid viz., *Pachyneuron grande*, *Syrphophagus aeruginosus*, *Aphidencyrus aphidivorus* and *Dendrocerus pupparum* from syrphid pupae at Poland.

Table 1: List of Syrphidae collected from Jorhat district of Assam

Sl. No.	Syrphids species	Sub Family	Ecosystem		Frequency	Relative Abundance (%)	Remarks
			Agro	Hort			
1	<i>Eristalinus tristriatus</i> (de Meijere, 1911)	Eristalinae	15	0	15	6.67	New Record For Assam
2	<i>Eristalis tenax</i> (Linnaeus, 1758)	Eristalinae	1	3	4	1.78	New Record For Assam
3	<i>Eristalodes paria</i> (Bigot, 1880)	Eristalinae	3	0	3	1.33	New Record For Assam
4	<i>Lathyrophthalmus arvorum</i> (Fabricius, 1787)	Eristalinae	14	9	23	10.22	New Record For Assam
5	<i>Lathyrophthalmus megacephalus</i> (Rossi, 1794)	Eristalinae	0	3	3	1.33	New Record For Assam
6	<i>Lathyrophthalmus obliquus</i> (Wiedemann, 1824)	Eristalinae	10	8	18	8.00	New Record For Assam
7	<i>Phytomia errans</i> (Fabricius, 1787)	Eristalinae	2	0	2	0.89	New Record For Assam
8	<i>Allograpta javana</i> (Wiedemann, 1824)	Syrphinae	8	5	13	5.78	
9	<i>Asarkina incisuralis</i> (Macquart, 1855)	Syrphinae	7	9	16	7.11	
10	<i>Betasyrphus isaaci</i> (Bhatia, 1933)	Syrphinae	2	3	5	2.22	
11	<i>Dideopsis aegrota</i> (Fabricius, 1805)	Syrphinae	2	8	10	4.44	
12	<i>Episyrphus viridaureus</i> (Wiedemann, 1824)	Syrphinae	20	18	38	16.89	
13	<i>Ischiodon scutellaris</i> (Fabricius, 1805)	Syrphinae	5	7	12	5.33	
14	<i>Melanostoma orientale</i> (Wiedemann, 1824)	Syrphinae	5	7	12	5.33	
15	<i>Melanostoma univittatum</i> (Wiedemann, 1824)	Syrphinae	0	2	2	0.89	
16	<i>Metasyrphus bucculatus</i> (Rondani, 1857)	Syrphinae	5	7	12	5.33	New Record For Assam
17	<i>Pandasyopthalmus politus</i> (Wiedemann, 1830)	Syrphinae	2	3	5	2.22	
18	<i>Pandasyopthalmus rufocinctus</i> (Brunetti, 1908)	Syrphinae	1	4	5	2.22	New Record For Assam
19	<i>Serratoparagus crenulatus</i> (Thomson, 1869)	Syrphinae	1	5	6	2.67	
20	<i>Serratoparagus serratus</i> (Fabricius, 1805)	Syrphinae	0	2	2	0.89	
21	<i>Sphaerophoria assamensis</i> (Joseph, 1970)	Syrphinae	3	7	10	4.44	
22	<i>Sphaerophoria macrogaster</i> (Thomson, 1869)	Syrphinae	0	5	5	2.22	New Record For Assam
23	<i>Sphaerophoria vockeroth</i> (Joseph, 1970)	Syrphinae	0	4	4	1.78	

Table 2: Ecological indices of Syrphidae at different ecosystem

Ecological indices	Ecosystem	
	Agro ecosystem	Horticultural ecosystem
Total Abundance	106	119
Species richness (S)	18	20
Shannon-Wiener diversity index (H')	2.52	2.84
Pielow's Evenness Index (J')	0.87	0.95

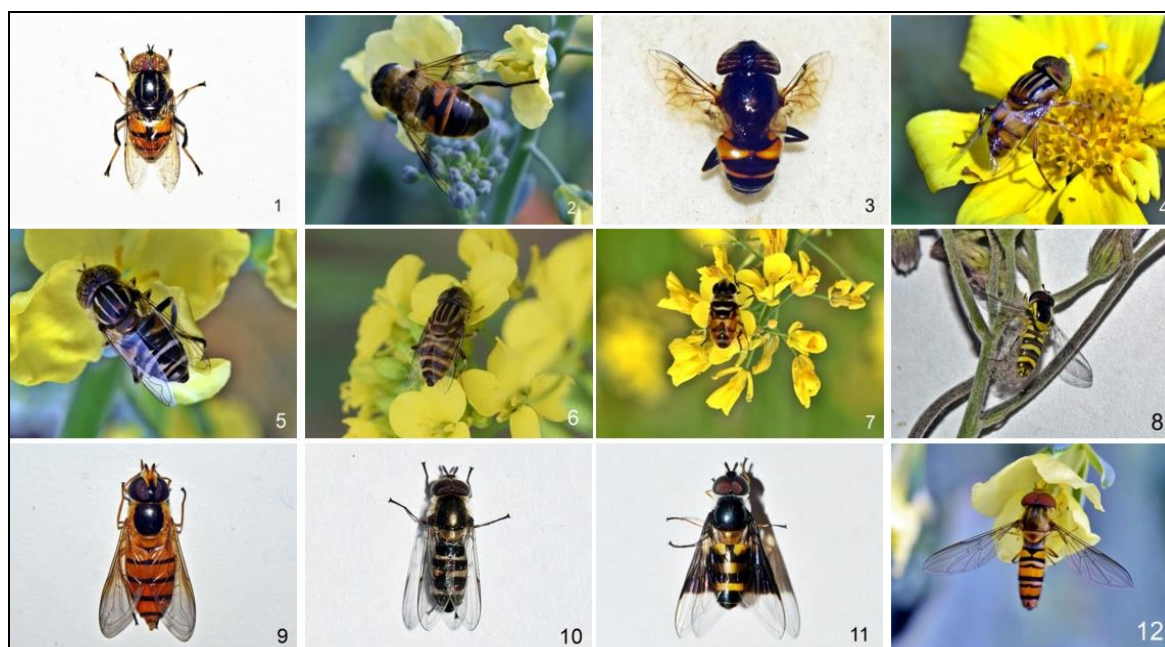


Plate 1: Different species of hover flies reported from AAU, Jorhat. 1. *Eristalinus tristriatus* 2. *Eristalis tenax* 3. *Eristalodes paria* 4. *Lathyrophthalmus arvorum* 5. *Lathyrophthalmus megacephalus* 6. *Lathyrophthalmus obliquus* 7. *Phytomia errans* 8. *Allograpta javana* 9. *Asarkina incisuralis* 10. *Betasyrphus isaaci* 11. *Dideopsis aegrota* 12. *Episyrphus viridaureus*

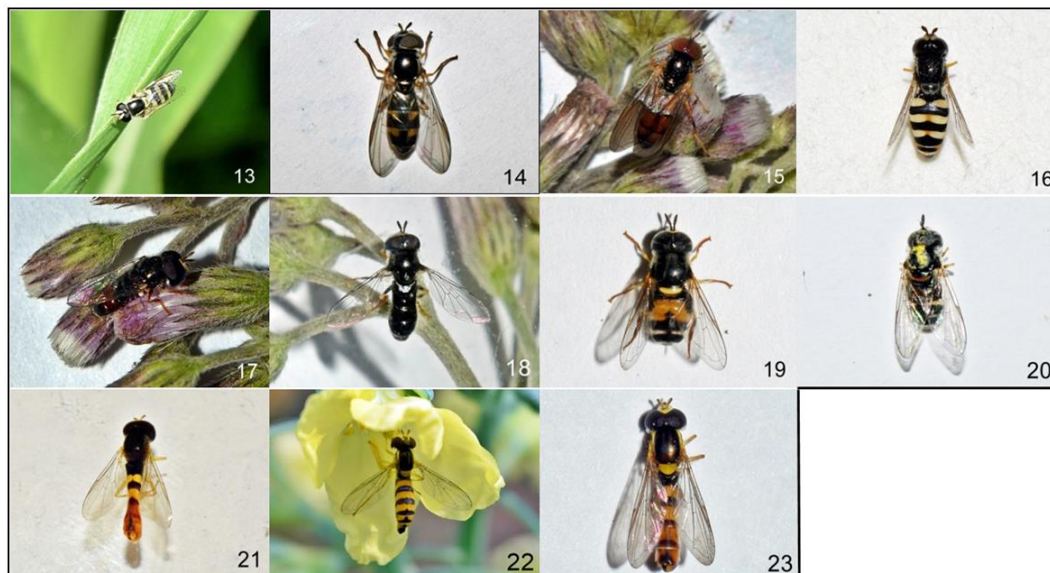


Plate 2: Different species of hover flies reported from AAU, Jorhat. 13. *Ischiodon scutellaris* 14. *Melanostoma orientale* 15. *Melanostoma univittatum* 16. *Metasyrphus bucculatus* 17. *Pandasyopthalmus politus* 18. *Pandasyopthalmus rufocinctus* 19. *Serratoparagus crenulatus* 20. *Serratoparagus serratus* 21. *Sphaerophoria assamensis* 22. *Sphaerophoria macrogaster* 23. *Sphaerophoria vockeroth*.



Plate 3: Pupa of hoverfly parasitized by *Diplazon* sp. (Left); Adult *Diplazon* wasp (Right)



Plate 4: Pupa of hoverfly parasitized by *Syrphophagus aeruginosus* (Left); Adult *Syrphophagus aeruginosus* (Right)

4. Conclusion

Out of 23 species recorded, ten species were reporting for the first time from Assam including two parasitoid *Diplazon* sp. and *Syrphophagus aeruginosus*. The highest number of species was recorded from sub-family Syrphinae and horticultural ecosystem showed highest species abundance, richness, diversity and evenness than the agro- ecosystem. The highest number of species recorded from horticultural ecosystem reflects the composition of different food sources of both the adults and larval stages of hover flies than the agro- ecosystem and this also indicates the healthiness of the surrounding environment.

5. Acknowledgements

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