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Short Communication

Prevalence and Floral Association of *Paragus bicolor* (Diptera: Syrphidae: Syrphinae) in Relation to Ornamental Host Plants in District Larkana, Sindh, Pakistan

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Authors' Contribution
KKA conceptualized the research, conducted the field investigations, performed the data analysis, and prepared the initial graft. NB provided critical support in the interpretation of findings, undertook literature review, and contributed to the refinement and revision of the paper. MAS assisted in the development of the methodological framework, supervised the statistical analysis, and approved the final version for submission. All authors have and approved the manuscript for publication.

Key words
Prevalence, *Paragus bicolor*, In relation to Ornamental, Plants

ABSTRACT

Syrphinae flies, recognized as migratory hoverflies, disperse in response to environmental cues. *Paragus bicolor* (Ruby flash hoverfly) is a visually distinctive, diminutive species, characterized by vibrant cherry-red pigmentation and rapid erratic flight dynamics. Ecologically significant, it contributes to pollination and biological pest regulation. A total of 455 specimens were trapped during the survey conducted from January-April 2025 using Malaise traps placed across four localities, village Kothi, Dhamrah, Ratokot and Hyder Khan Brohi. Out of the total, 312 were females (68.57 %♀) and 143 were males (31.43 %♂), indicating a significant dominance of females in the population. Specimens were recorded as follows: Kothi-122 (26.81%), Dhamrah-103 (22.64%), Ratokot-117 (25.71%), and Hyder Khan Brohi-113 (24.83%). The species visited six host plant species with the following percentage, *Tecoma stans* (19.12%), *Tagetes erecta* (17.36%), *Allamanda cathartica* (16.48%), *Cassia fistula* (15.82%), *Chrysanthemum* spp. (15.16%), and *Gazania rigens* (16.04%). The exclusive presence of *P. bicolor* in all collections highlights its potential ecological association with mustard/yellow color flowered plants and its possible role as a bio-indicator or good pollinator in the area.

Syrphinae (Diptera: Syrphidae), also known as blooming flies, are a diverse and ecologically significant pollinator found in a variety of ecosystems across the globe, aphidophagous hoverflies are ecologically significant dipterans, renowned for their mimicry of hymenopterans and their dual roles in pollination and biological control regulation (Rotheray and Gilbert, 2011). With over 6,000 described species worldwide, they play a double role, as adults visit variety of many flowers for nectar and pollen, while many larvae prey on crop pest such as aphids and other plant sucking insect pests, thrips, jassids and aphids contributing to bio-control in agroecosystems (Rojo *et al*., 2023). In Pakistan, the hoverflies fauna has received increasing attention. Earlier surveys reported 17 species of hoverflies (Abbas and Shad, 1969), which expanded to 39 species by the late 1990s (Aslam, 1997), and more recent research documented over 70 species across various habitats in province Punjab, Sindh, and Khyber-Pakhtunkhwa (Shehzab *et al*., 2014). Despite this progress, large gaps remain in the regional distribution records and ecological information, especially in the southern parts of the country, respectively. The genus *Paragus latrelle* (Syrphinae: Paragini) includes small sized aphidophagous hoverflies typically ranging from 3.4-5.6 mm in body length and is represented by over 100 valid species globally (Vujic *et al*., 2008). Taxonomically, *Paragus* species are distinguished by subtle traits such as eye color and male terminalia region (Haarto and Kerppota, 2007). In the Oriental and Palearctic regions, around 51 species are founded, but ecological data for most remain scarce (Barkalov and Stahls, 1997). Among these, *Paragus bicolor* is known for its low capture amount and restricted documentation in faunistic records (Barkalov, 2002). Previous reports of *P. bicolor* in Pakistan have been limited to northern regions such

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as Balochistan, KPK, and parts of Azad Kashmir (Khan *et al*., 2019). Moreover, no published records exist from Sindh, despite its wide floral diversity and warm climate condition which may be because of the use of inefficient sampling methods in southern Pakistan (Iqbal *et al*., 2020). Larkana in Sindh is characterized by mixed land use, where agriculture and ornamental plants are common. In particular, yellow flowered ornamentals, *Tecoma stans*, *Tagetes erecta*, *Allamanda cathartica*, *Cassia fistula, Chrysanthemum spp*, and *Gazania rigens* are widely cultivated and attract diverse pollinators (Ahmad *et al*., 2019). Previous research has shown that floral color and structure strongly influence Syrphidae visitation patterns, with pale yellow being a dominant attractant (Foldesi *et al*., 2015). Understanding the local abundance, seasonal prevalence, and plant association of Paragus bicolor is critical for biodiversity documentation and pollinator conservation strategies (Speight, 2022). However, analyzing sex ratios and spatial distribution patterns helps clarify population dynamics, breeding activity, and floral preferences in field conditions (Ali *et al*., 2016; Jauker *et al*., 2012). This research was conducted with three main objectives, to record the presence of *Paragus bicolor* in Larkana for the first time, to quantify its sex-wise population and spatial distribution in four localities, and to assess its floral associations with commonly grown pale yellow blooming ornamentals. The findings aim to contribute novel faunistic records and ecological insights on Paragus bicolor in southern Pakistan (Shahzad *et al*., 2020).

Materials and methods

The field survey was conducted in four selected localities of District Larkana such as Kothi, Dhamrah, Ratokot, and Hyder Brohi. Data collection spanned from January-April 2025, encompassing the active blooming season of major ornamental plants. Larkana located in the north-western zone of Sindh Province, Pakistan (28.56ºN, 69, 22ºE). This district lies within the Indus River Basin and is characterized by fertile alluvial soil that support extensive horticultural and field crop production. The climate of Larkana is semi-arid to arid, with warm summer and mild winters, and seasonal precipitation primarily during the monsoon months.

Adult *P. bicolor* was collected using Malaise traps, a standard passive method for trapping hoverflies. One trap was installed at each site and operated continuously for five consecutive days per month. Traps were near the flowering areas of selected host plants to maximize capture efficiency (Fig. 2). Standard taxonomic keys were used for identification of the hoverfly (Stubbs and Falk, 2002).

The floral associations of ruby flash hoverfly (*P. bicolor)* were recorded by observing its presence on six flowering plant species known for their bright yellow florets these included *Tecoma stans* (yellow bells), *Tagetes erecta* (African marigold), *Allamanda fistula* (golden shower tree), *Chrysanthemum* spp. (golden yellow varieties), and *Gazania rigens* (treasure flowers) hold considerable economic value in urban landscaping, floriculture, and the nursery trade. *Tagetes erects* is known for its pesticidal properties and is used in organic farming practices. *Chrysanthemum* spp are also economically significant in the cut-flower industry due to their extended shelf life and seasonal demand. Collectively, these ornamentals contribute to sustainable urban beautification and local horticultural economies respectively. Percentage visitation to each plant species was calculated based on the total number of individuals observed per floral type.

The total number of males and females was counted, and sex ratio (%) was calculated. Additionally, the number of specimens collected from each site was recorded and presented as percentages to compare local abundance.

To examine the influence of environmental conditions on the population density of *P. bicolor* during the sampling period January-April 2025, correlation analysis was conducted between aphidophagous hoverfly abundance and three key abiotic factors, temperature, (ºC), moisture (%), and precipitation (mm). These metrological data were obtained from the nearest weather regional station in Larkana (Fig. 1). Statistical tests were performed using Pearson's correlation coefficient (r) in SPSS Version 22.0 at significance levels of ($p < 0.05$ and $p < 0.01$).

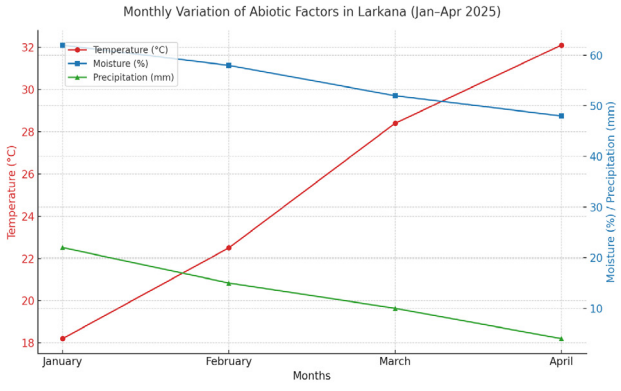

Fig. 1. Monthly variation of abiotic factors in Larkana January-April 2025. Temperature exhibited a gradual increase, while moisture and precipitation levels showed irregular patterns.

Results

During the four-month survey conducted from January, a total of 455 specimens of *Paragus bicolor* were trapped using Malaise traps of which 162 were males (35.6% ♂), and 293 females (64.4% ♀), indicating

strong female-biased population. The highest number of hoverflies specimens were recorded from Kothi village with 148 individuals (32.5%), followed by Dhamrah village with 127 specimens (27.9%), Hyder Brohi village 77 individuals (16.9%), and the lowest from the Ratokot village, which yielded 77 individuals (16.9%). month-wise occurrences data revealed a progressive increase in Ruby Flash (*P. bicolor)* behavior during the survey phase. The lowest count was founded in January (48 individuals, 10.5%), followed by February (92 specimens, 20.2%), March (143 individuals, 31.4%), and the highest in April (172 specimens, 37.8%), indicating a peak in adult activity during late spring (Fig. 2). All specimens were observed in association with six ornamental yellow-flowered host plants, *Tecoma stans*, *Tagetes erecta, Allamanda cathartica, Cassia fistula, Chrysanthemum* spp., and *Gazania rigens*. Among these, the peaked Syrphinae visitation was recorded on *Tagetes erecta* (26.8%) and *Tecoma stans* (24.4%), followed by *Cassia fistula* (17.6%), *Chrysanthemum* spp (12.3%), *Allamanda cathartica* (10.5%), and *Gazania rigens* (8.4%). Correlation analysis revealed that the abundance of Ruby flash hoverfly was significantly and negatively correlated with temperature ($r = 0.624$, $p < 0.05$), while relative moisture showed a moderate but non-significant positive correlation ($r = 0.591$).

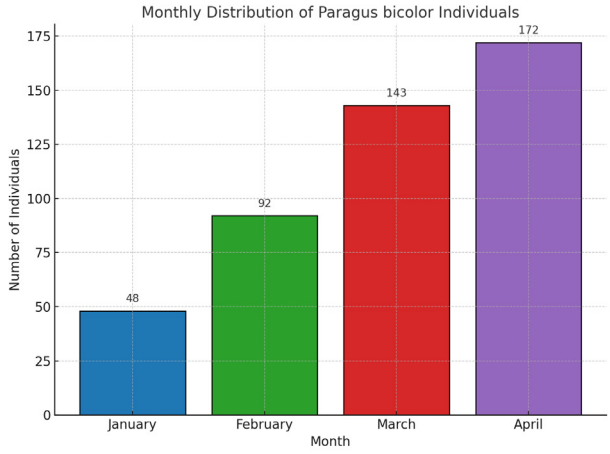

Fig. 2. Monthly abundance of *Paragus bicolor* individuals recorded from January to April 2025 in Larkana district, Sindh, Pakistan. The highest abundance in April coincides with peak aphid infestation and floral resources.

Precipitation exhibited a weak negative correlation ($r = 0.218$, ns). These findings suggest that rising the temperatures may suppress *P. bicolor* performance, while moisture appears to support population growth during early spring seasons.

Discussion

The current investigation documented the first confirmed record of *P. bicolor* (Fabricius, 1794) from Larkana, Sindh, Pakistan, establishing baseline information for its local distribution host plant association, and seasonal abundance. The research revealed multiple ecological insights, which are discussed below. The marked predominance of females (64.4%) over males (35.6%) suggests a skewed sex ratio within the population. Such female-biased distributions are commonly observed in Syrphid population, often attributed to variances in life span, mating strategies, or discrepancy trap attractiveness (Rojo *et al*., 2003). Female *P. bicolor* (hoverflies) are generally more active foraging for oviposition areas, making them more susceptible to passive trapping methods; Malaise traps (Speight, 2014).

Spatial variation among the four sampling localities was evident, with Kothi town, contributing the peaked number of individuals. This locality is relatively richer in ornamental plantings and less disturbed by intensive agriculture, possibly offering better microhabitat conditions for Syrphinae hoverflies. In contrast, town Ratokot recorded the lowest numbers, potentially due to sparse vegetation and drier surroundings. Similar spatial trends in Syrphidae abundance due to landscape-level vegetation variation have been reported by (Mengual *et al*., 2008).

Periodic monitoring revealed a gradual increase in *P. bicolor* activity from January-April, peaked in late spring season respectively. This configuration correlates with warmer temperature, longer photoperiods, and increased blooming of nectar-rich host plants. Comparable springtime behavior peaks have been recorded for other Syrphidae in temperature and sub-tropical zones (Stubbs and Falk, 2002), aligning with the species' life cycle and floral resources accessibility. Host plant association data revealed the highest adult hovering flies visitation on *Tagetes erecta* and *Tecoma stans*. These species offer large, accessible dark yellow and large flowers rich in juice nectar, which are known to be particularly attractive to aphid-flies (Kant *et al*., 2012). The preference toward yellow and orange floral tones is well-recorded in member of Diptera, as these colors serve as visual cues for good nectar foragers. Host plants, *Cassia fistula* and *Chrysanthemum* spp. also played a supporting role, contributing to habitat heterogeneity and floral diversity, both of which enhance pollinators richness (Haenk *et al*., 2009).

Regarding abiotic influences, temperature was record to significantly and negatively correlate with *P. bicolor* occurrences. This a agreement with revisions indicating that excessive heat may restrict Syrphidae flight activity or

reduce flower longevity, thus indirectly affecting foraging (Sutherland *et al*., 2001). On the other hand, the moderate but non-significant positive association with relative moisture suggests that humid conditions may support population development, especially during early spring season when the microclimate is more stable (Jauker *et al*., 2012). Precipitation had little apparent effect, because rainfall during the collection period remained low and sporadic, insufficient to significantly influence Syrphinae flies performance. Overall, this article highlights the strong relationship between *P. bicolor* activity, flowering host plants, and microclimatic conditions. The clear seasonal and spatial patterns observed in *P. bicolor* populations in District Larkana emphasize the importance of conserving ornamental host plant diversity and managing urban green spaces to sustain beneficial insect communities, particularly hoverflies, which contribute to both pollination and pest control.

This study holds considerable ecological and practical significance. By documenting the first abundance and distribution pattern of *P. bicolor* hoverfly in Larkana, it fills a critical gap in the faunal records of Pakistan's hovering flies' diversity. Overall, the research lays a foundation for future ecological study and promotes sustainable agricultural practices through the conservation of beneficial insect fauna respectively.

Conclusion

The findings emphasize the ecological importance of conserving diverse flowering habitats and monitoring climate variables to sustain beneficial insect populations. Future research should incorporate long-term monitoring, include larval stages, and explore the pollination or biological control regulator of ruby flash hoverfly to better understand its role in agroecosystems health respectively.

DECLARATIONS

Acknowledgement

Paragus bicolor has been nick-named Ruby Flash Hoverfly dazzling for its ruby-red coloration and lightning-fast flight patterns that characterize its unique behavioral ecology.

Generative AI and AI-assisted technology statement

The authors declare that no Generative AI or AI-assisted technologies were used in the writing, data analysis, or manuscript preparation of this article.

Statement of conflict of interest

The authors have declared no conflicts of interest.

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