POPPULATION DYNAMICS OF SIX SPECIES OF CULEX PIPiens L. GROUP (DIPTERA: CULICIDAE) FROM CHANDIGARH*

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ABSTRACT

During the present study, detailed mosquito surveys were carried out from various habitats of developed areas, gardens, slums and surrounding villages of Chandigarh from June 2017 to November 2019 to explore the mosquito fauna. Six species of Culex pipiens L group were recorded with maximum distribution of Culex quinquefasciatus Say (89.61%) followed by Culex univittatus Theobald (6.39%) while, rest of the species viz; Culex vags Wiedemann, Cx. hutchinsoni Barraud, Cx. theileri Theobald and Cx. fuscocephala Theobald collectively formed only 3.99% in almost in all habitats. The population dynamics was analyzed from regular surveys to assess the relationship between abundance of six vector species of Cx. pipiens group with meteorological variables. The data revealed varied abundance of species of Cx. pipiens group in different seasons. Survey of literature revealed that no data is available on the species of Cx. pipiens group in the region with particular reference to weather parameters. Hence, the present study on the seasonal abundance and population dynamics of Culex pipiens group in Chandigarh and its surroundings has been carried out.

Key words: Culex pipiens, Chandigarh, species diversity, vectors, weather parameter, abundance, population dynamics, correlation coefficients, distribution, seasonal abundance

The earlier taxonomic workers differentiated the species of Culex into groups, subgroups and complexes. Edwards (1932) categorized the species of Culex into two groups namely the pipiens group and sitiens group in first catalogue of mosquitoes of the world. Later on Sirivanakarn (1976) arranged the species under Culex pipiens group into four subgroups i.e., pipiens subgroup, trifilatus subgroup, theileri subgroup and univittatus subgroup and placed the closely related species into these subgroups accordingly. The present studies are subjected to seasonal dynamics of six species i.e., Culex quinquefasciatus Say (pipiens subgroup), Cx. vagans Wiedemann and Cx. hutchinsoni Barraud (trifilatus subgroup), Cx. theileri Theobald (theileri subgroup), Cx. univittatus Theobald and Cx. fuscocephala Theobald (univittatus subgroup). The first catalogue of Indian mosquitoes given by Tyagi et al. (2015) also mentioned these six species of Cx. pipiens group out of 404 species collected from various geographical areas of India. The species under Culex pipiens group especially Cx. quinquefasciatus and Cx. fuscocephala are particularly important in public health in India due to their potential to transmit various diseases like Japanese encephalitis, periodic filariasis, West Nile virus, St. Louis encephalitis, Rift Valley fever viruses, and Sindbis virus (National Center for Vector Borne Diseases Control, 2022; Amara et al. 2016). However, Cx. univittatus and Cx. theileri are responsible for carrying West Nile virus, Sindbis virus, bancrofti fever, Bagaza virus, Western Equine encephalitis virus and other viral pathogens globally (Walter Reed Biosystematics Unit 2022). It is worthwhile to mention that the environmental factors such as temperature, rainfall and relative humidity play a very significant role in the transmission of various pathogens. Hence, keeping in view the medical importance of species of Cx. pipiens group, the present study explored the species distribution and seasonal prevalence in Chandigarh and its adjoining areas.

MATERIALS AND METHODS

The survey cum collection of mosquitoes was carried out during morning as well as evening hours from June 2017 to November 2019 from different habitats in and around Chandigarh (30° 44’ N, 76° 46’ E). Hand collection method was followed in which hand sweep nets and oral aspirators were used. The collected samples were brought to laboratory, pinned and preserved in the insect storage boxes. The standard taxonomic keys of Barraud 1934, Sirivanakaran 1976

*Table 1-3 are supplementary and are available only in online version.
and Reuben 1994 were used to identify mosquitoes. Further, slides of male genitalia were prepared using the method given by Siverly and Shroyer (1974) and photographed. Meteorological data was collected for the period June 2017 to November 2019 from Meteorology Department, Sector 39, Chandigarh, India. The standard parameters like temperature (maximum and minimum), rainfall and relative humidity were taken. The data was analyzed to know relationship of these weather factors with population density, using Pearson correlation coefficient. Regression analysis including p value and correlation coefficient (r) was performed to evaluate the statistical significance (p< 0.05) using SPSS® 16.0.

RESULTS AND DISCUSSION

During June 2017 to November 2019, a total of 2802 mosquitoes belonging to six species of Culex pipiens group namely Cx. quinquefasciatus, Cx. univittatus, Cx. fuscocephala, Cx. vagans and Cx. hutchinsoni and Cx. theileri were collected and studied. The results revealed that Cx. quinquefasciatus and Cx. univittatus were the most prevalent species. The density of Cx. quinquefasciatus was maximum in garden belts (37.6%) followed by developed urban areas (26.1%), villages (25%) and slum areas (10%) whereas, Cx. univittatus exhibited its highest density in villages (39.1%) followed by developed areas (25.6%), garden belts (20.1%) and slums (15%). The Cx. vagans was also prevalent mostly in villages (40.4%) followed by developed areas (33.3%), slums (21.4%) and garden belts (4.76%). Cx. hutchinsoni too was highest in villages (43.3%) followed by developed areas (20%), garden areas (20%) and then slums (16.6%). The Cx. theileri also showed its maximum density in villages (42.3%) followed by developed areas (23.07%), garden belts (23.07%) and slums (11.53%). Cx. fuscocephala showed its high abundance in villages (62.5%) followed by garden belts (18.75%), slums (12.5%) and urban areas (6.26%) (Fig. 1).

The seasonal incidence of both Cx. quinquefasciatus and Cx. univittatus were observed with peak in July to August, when maximum and minimum temperature was 33.39°C and 26.69°C, relative humidity 68% and rainfall 8.31mm. Cx. vagans showed its appearance in June, when temperature range was 27-35.2°C and reached at its highest peak in July to August, when maximum and minimum temperature was 33.41°C and 26.69°C, relative humidity was 68.05% with 8.31mm of rainfall and remained very low during September to November. Cx. hutchinsoni too started appearing with its highest peak in June to July when maximum and minimum temperature was 35.08°C and 26.88°C, relative humidity 54.4% and rainfall (5.61mm) and its abundance declined in August to September, but it again appeared in October and November. Cx. theileri was found with very low density in June to August and reached to highest peak in October and November when maximum and minimum temperature was 29.11°C and 18.32°C, relative humidity was 52.92% with 0.81mm rainfall. Cx. fuscocephala appeared in July with peak

![Fig. 1. Diversity of species of Culex pipiens group in habitats of Chandigarh (2017-2019)](image-url)
in October, when maximum and minimum temperature was 31.83°C and 21.38°C, relative humidity 47.94% with 0.10 mm rainfall. Its density was observed very low in August with negligible appearance in June and September. The pooled data revealed that all the species were diversified in different habitats and its seasonal abundance in an area firstly appeared in June, gradually increased and reached to peak during July to August while, declined gradually in September to November (Fig. 2).

The coefficient of determination exhibited a negative correlation of Cx. 

vagans with relative humidity \( r=-0.86 \) in 2017. In 2018, Cx. 

hutchinsoni was strongly positive correlated with relative humidity \( r=0.81 \). While in 2019, it was found to be negatively correlated with maximum temperature \( r=-0.79 \) and minimum temperature \( r=-0.83 \). The incidence of Cx. 

fuscoccephala was strongly positive correlated with minimum temperature \( r=0.84 \). Cx. 

quinquefasciatus and Cx. 

vagans found to be positively correlated with rainfall \( r=0.9, r=0.82 \) (Fig. 3). However, no significant correlations were observed among species with weather parameters in remaining years of study. Hence, the present data revealed that the relative changes in population density of collected mosquito species is complex and can be affected by prevailing weather parameters.

Various other workers who worked on mosquito abundance in relation to climate factors also observed a similar pattern. Bhat and Kulkarni (1983), recorded Cx. 

quinquefasciatus and Cx. 

fuscoccephala in October-November, while Cx. 

theileri and Cx. 


quinquefasciatus in July and August in Gurgaon (Haryana) and in Mysore (Karnataka) respectively. Kanojia and Geevarghesh (2005) observed first peak density of Cx. 

quinquefasciatus in March-April followed by September-October in Gorakhpur. However, in Saudi Arabia, Alahmed (2012) observed peak density of Cx. 

quinquefasciatus and Cx. 

univittatus in June, when temperature reached 36°C, its abundance started declining with decrease in temperature (15°C). It further increased in rainfalls during January to March. It could be due to increase in breeding sites in these months. Roiz et al. (2014) found abundance of Cx. 

theileri in April to August in Placibo, Mediterranean wetlands. They also revealed negative correlation of Cx. 

theileri with relative humidity. In Agra, Shad and Andrew (2016) during three years study, noticed peak larval density of Cx. 

quinquefasciatus from July to September during first year, August to October during the second year and August to September during the third year. Bashar et al. (2016), observed Cx. 

hutchinsoni along with dominant species Cx. 

quinquefasciatus during May to June months of Dhaka, Bangladesh in semi-urban areas. In Bareilly, Pantawane et al. (2017) too noticed two peak density months of Cx. 

quinquefasciatus, first in Feburary to March when temperature range was 12-29°C and second peak in September to October. They revealed that mosquito population increased with overall increase in maximum temperature (21-39°C), rainfall and relative humidity (40-60%). The Cx. 

fuscoccephala was also seen highest in monsoon season i.e. July to September and in post-monsoon seasons. Mohamed et al. (2020), studied seasonal variation of both Cx. 

quinquefasciatus and Cx. 

univittatus from Khartoum state of Sudan, Saudi Arabia and found high peak incidence during pre-rainy season (April–July). Manzoor et al. (2020), studied Cx. 

vagans along with Cx. 

quinquefasciatus, and observed its maximum prevalence during September 2014 to August 2015 in Lahore, Pakistan in different breeding habitats.

Present study revealed that collected species marked their peak relative abundance majority in garden belts, followed by villages, developed urban areas and then slums. It might be due to the availability of suitable breeding sites like vegetation, bamboo trees, ditches, flower pots, catch basins, water logs and puddles with diverse water quality in gardens. In villages, irrigated agricultural lands, cattle sheds, small water bodies with algal blooms provide more breeding habitats than in developed urban areas with semi water logs conditions during rainy seasons. The slums which contributed one fourth of its abundance could be due to the reason that majority of the species of ppiens group breeds in fresh water, whereas the polluted water bodies, garbage storage lands, waste muddy water bodies in slums provided less breeding sites. Hence, it can be inferred that out of all climatic parameters, the rainfall pattern has a strong influence on the breeding of Cx. 

quinquefasciatus and Cx. 

vagans whereas, population density of Cx. 

fuscoccephala and Cx. 

hutchinsoni was strongly associated with temperature changes. The relative humidity influenced incidences of Cx. 

vagans and Cx. 

hutchinsoni in urban and rural areas of Chandigarh. The influence of climatic variables on the seasonal dynamics of vector species of ppiens group can be useful for predicting future transmission pattern and to strengthen vector control strategies with
Fig. 2. Seasonal incidence of *Culex pipiens* group (pooled data)- Chandigarh (2017-2019)
surveillance programme in and around Chandigarh proximities in an effective manner.

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AUTHOR CONTRIBUTION STATEMENT

AS and RR devised and designed research. AS and RR conducted surveys and experiments. SK suggested
statistical analysis. AS, RR, and SK analyzed data and wrote the manuscript. All of the authors read and approved the manuscript.

CONFLICT OF INTEREST

There are no conflicts of Interest.

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