

## Mosquito diversity (Diptera: Culicidae) of Baddi, Himachal Pradesh and surrounding areas

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### ABSTRACT

During mosquito larval surveys as many as 42 mosquito species belonging to 11 genera belonging to 2 subfamilies of family Culicidae were collected from Baddi and adjoining areas. A list of these species along with collection site and date of collection has been provided in this article. 18 species have been reported for the first time from Himachal Pradesh.

**Key words** : Baddi, diversity, mosquito.

### INTRODUCTION

Mosquitoes are considered to be the contiguous enemies of man. These miniature insects are accountable for the transmission of Malaria, Yellow fever, Dengue, Dengue hemorrhagic fever, Filariasis, Chikungunya and several viral Encephalitides. Tropical world including India faces great challenges from emerging, re-emerging and spread of mosquito borne diseases. Due to rapid development, overpopulation, urbanization, excessive use of insecticides, unplanned and intemperance development, India has become more vulnerable to these diseases. It is therefore, very essential to have a detailed knowledge of this medically important group of insects particularly in the changed ecological scenario in the various parts of India.

The hasty industrialization followed by the expansion of urban area and amplified construction activities needing hefty migrant labour has created conducive environment for mosquito survival in Baddi area of Solan district. The indecorous dumping of industrial and domestic water waste has redesigned the ecology of these medically important insects. Therefore, the objective of the present study is to find out the definite breeding range of these insects and species diversity for the suppression of malaria and other mosquito borne diseases. Due to the earlier mentioned anthropogenic

activities, numerous Culicidae species have invaded this area to amplify the mosquito fauna that required intensive collection cum survey tours to be conducted to study the exact status of mosquito fauna of this region. The earlier records of mosquito diversity of Himachal Pradesh dates back to Christophers (1933) and Barraud (1934). 44 species of mosquitoes were reported from Sirmour, Shimla, Kinnaur, Mandi, Kullu, Kangra, Chamba, Lahul & Spiti areas of Himachal Pradesh in Rao *et al.* (1973) and 15 species belonging to 5 mosquito genera from Dalhousie, Mandi, Chamba, Kullu, Kangra, Palampur and Chail areas were reported by Kaur (2001). This area of Himachal Pradesh was never explored for its mosquito diversity earlier.

### MATERIALS AND METHODS

**Study area** : Baddi is a part of industrial corridor stretching from Barotiwala to Nalagarh along the western border of Solan district of Himachal Pradesh. Industrial development in this area is followed by the aggregation of labourers, substandard housing, inadequate water supply and improper sewage management. Keeping these factors in mind, various places in the neighbourhood of Baddi *i.e.*, Katha, Charanea, Barotiwala, Tipra, Jharmajri, Mandhala, Kishanpur, Dammuwal, Lakkarpul, Soorajmajra, Malkumajra, Maranwala, Nalagarh, Karuni, Sanerh, Sattiwala, Sainsiwal, Khud Kurahwala, Bhudd and Nawan Nagar were

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surveyed to collect various mosquito species from March 2017 to November, 2018.

**Collection and Identification :** Immature stages of mosquitoes were collected with the help of soup ladle from temporary ground pools, riverbed pools, flowing stream, marshy places, blocked drains, ponds, irrigation channels, rice fields discarded tires and puddles etc. in the sampling bottles. The bottles were properly labelled describing the name of breeding site, date and time. These immature stages of mosquitoes were brought to the laboratory to rear them into the adults. The adult specimens were preserved in the insect cabinets after mounting them on paper triangle. The various morphological traits were examined to identify them up to species level with the help of relevant keys given by Barraud (1934), Wattal and Kalra (1961), Srivanakarn (1976), Huang (1972, 1979), Reuben *et al.* (1994), Reinert (2004) and Tyagi *et al.* (2015).

## RESULTS AND DISCUSSION

Immature stages of mosquitoes collected from various types of water bodies emerged into 42 mosquito species belonging to 11 genera, *i.e.*, *Culex* Linnaeus, *Anopheles* Meigen, *Mimomyia* Theobald, *Lutzia* Theobald, *Stegomyia* Theobald, *Rhinoskusea* Edwards, *Fredwardsius* Reinert, *Armigeres* Theobald, *Aedimorphus* Theobald, *Mansonia* Blanchard and *Collessius* Reinert, Harbach & Kitching. The genus *Culex* emerged as the largest taxon with 18 species embracing 43% of total mosquito species diversity, followed by *Anopheles* with 12 species comprising 29% of the total recorded species. The genera *Mimomyia*, *Lutzia* and *Stegomyia* are represented by 5% of the species each. Only one species referable to each of genera *Rhinoskusea*, *Fredwardsius*, *Armigeres*, *Aedimorphus*, *Mansonia* and *Collessius* were encountered during the surveys (Table 1; Fig. 1).

Among the Anopheline mosquitoes, *Anopheles* (*Cellia*) *subpictus* Grassi and *Anopheles* (*Cellia*) *culicifacies* Giles were found to be the dominant species followed by *Anopheles* (*Cellia*) *fluviatilis* James & *Anopheles* (*Cellia*) *maculatus* Theobald, while the rest of species could be collected in one month only. *Culex* (*Culex*) *quinquefasciatus* Say, *Culex* (*Culex*) *vagans* Wiedemann, *Culex* (*Oculeomyia*) *bitaeniorhynchus* Giles among the

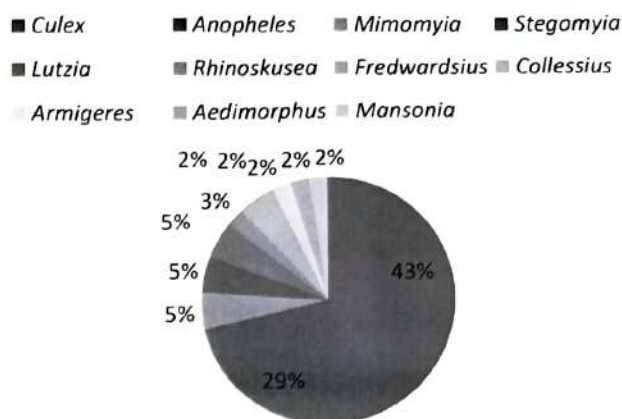


Fig. 1. Composition of mosquito species under different genera.

Culicines were recorded as prevalent species throughout the year. *Culex* (*Culex*) *mimulus* Edwards and *Culex* (*Eumelanomyia*) *malayi* (Leicester) were least encountered culicine species.

As far as percentage of abundance at different sampling sites is concerned, Nawan Nagar and Tipra villages (2.5 km. from Baddi) jointly comprise 28% of the mosquito diversity. 12 species were collected from Baddi town which amounts to 8% of the total identified mosquito species. In Mandhala (a small village located at a distance of 13 km from Baddi), a rain fed perennial pond was found that provided favorable environment for mosquito survival throughout the year. Larvae collected from this pond, emerged into 11 mosquito species *i.e.*, 7% of the collected mosquito species. In Sainsiwal village, small puddles were dug by the migrant inhabitants to store rain water for various domestic purposes, which were found to be the niches of 10 mosquito species. The same numbers of species were reported from Karuni village (near Nalagarh). The other areas like Katha, Khud Kurahwala, Lakkarpul and Dammuwala were surveyed for 8 mosquito species each. The pond of village Sattiwala receives industrial water waste directly from nearby industry that serves as habitat of 7 *Culex* species. Whereas, 6 mosquito species were reported each from Barotiwala and Malkumajra (Fig. 2).

The most favourable temperature for mosquito larval endurance has been observed to be 25 - 30°C, as 25 species were collected at this temperature range. Whereas, 18 species were collected at the

**Table 1.** Mosquito species collected from different sites along with date of collection.

S. No.	Name of mosquito species	Date of collection	Site of collection
1	<i>Culex (Culex) quinquefasciatus</i> Say, 1823	7/5/17, 28/5/17, 14/6/17, 16/7/17, 2/9/17, 1/10/17, 5/11/17, 30/3/18, 15/4/18, 29/4/18, 13/5/18, 20/5/18, 23/6/18, 2/9/18, 7/10/18, 24/10/18	Baddi, Nawan Nagar, Barotiwala, Mandhala, Tipra, Sattiwala, Lakkarpul, Katha, Malkumajra, Bhudd
2	<i>Culex (Culex) vagans</i> Wiedemann, 1828	7/5/17, 28/5/17, 14/6/17, 16/7/17, 2/9/17, 30/3/18, 15/4/18, 29/4/18, 20/5/18, 15/7/18, 14/10/18, 24/10/18	Baddi, Nawan Nagar, Barotiwala, Dammuwal, Sattiwala, Tipra, Lakkarpul, Karuni, Kishanpur
3	<i>Culex (Culex) univittatus</i> Theobald, 1901	28/5/17, 16/7/17, 29/4/18, 24/10/18	Barotiwala, Tipra, Baddi
4	<i>Culex (Culex) fuscocephala</i> Theobald, 1907	30/3/18, 15/4/18, 29/4/18, 13/5/18, 23/6/18, 14/10/18, 4/11/18	Tipra, Nawan Nagar, Sattiwala, Lakkarpul, Kishanpur, Khud Kurahwala
5	<i>Culex (Culex) theileri</i> Theobald, 1903	1/10/17, 15/4/18, 29/4/18, 20/5/18	Malkumajra, Tipra, Katha
6	<i>Culex (Culex) pseudovishnui</i> Colless, 1957	7/5/17, 1/10/17, 5/11/17, 16/9/18	Nawan Nagar, Tipra, Katha
7	<i>Culex (Culex) vishnui</i> Theobald, 1901	7/5/17, 14/6/17, 23/7/17, 12/8/17, 1/10/17, 23/6/18, 5/8/18, 19/8/18, 24/10/18	Nawan Nagar, Katha, Nalagarh, Tipra, Mandhala, Lakkarpul, Sainsiwal, Baddi
8	<i>Culex (Culex) tritaeniorhynchus</i> Giles, 1901	7/5/17, 23/7/17, 12/8/17, 5/11/17, 8/7/18, 29/7/18, 5/8/18, 19/8/18, 7/10/18, 14/10/18, 24/10/18, 11/11/18	Nawan Nagar, Katha, Nalagarh, Tipra, Dammuwal, Lakkarpul, Mandhala, Baddi
9	<i>Culex (Culex) gelidus</i> Theobald, 1901	7/5/17, 23/7/17, 10/6/18, 19/8/18, 2/10/18	Nawan Nagar, Katha, Karuni, Tipra, Sainsiwal
10	<i>Culex (Culex) whitmorei</i> (Giles, 1904)	1/10/17, 10/6/18, 8/7/18, 16/9/18, 2/10/18	Tipra, Nawan Nagar, Baddi, Katha
11	<i>Culex (Culex) edwardsi</i> Barraud, 1923	7/5/17, 28/5/17, 14/6/17, 12/8/17, 1/10/17, 5/11/17, 10/6/18, 23/6/18, 8/7/18, 29/7/18, 2/9/18, 16/9/18, 2/10/18, 7/10/18, 24/10/18	Nawan Nagar, Barotiwala, Katha, Sanerh, Tipra, Karuni, Sattiwala, Dammuwal, Lakkarpul, Soorajmajra, Bhudd, Sainsiwal, Charanea, Baddi
12	<i>Culex (Culex) barraudi</i> Edwards, 1922	23/6/18, 8/7/18, 29/7/18, 5/8/18, 19/8/18, 2/9/18, 14/10/18	Sattiwala, Nawan Nagar, Mandhala, Sainsiwal, Lakkarpul, Baddi, Karuni, Dammuwal, Tipra
13	<i>Culex (Culex) sitiens</i> Wiedemann, 1828	23/7/17, 1/10/17, 5/11/17, 23/6/18, 8/7/18	Tipra, Nawan Nagar, Mandhala, Baddi,
14	<i>Culex (Culex) mimulus</i> Edwards, 1915	24/10/18	Khud Kurahwala
15	<i>Culex (Oculeomyia) bitaeniorhynchus</i> Giles, 1901	16/7/17, 12/8/17, 2/9/17, 1/10/17, 5/11/17, 29/4/18, 13/5/18, 10/6/18, 23/6/18, 8/7/18, 29/7/18, 5/8/18, 19/8/18, 2/9/18, 16/9/18, 2/10/18, 14/10/18, 11/11/18	Soorajmajra, Sanerh, Nawan Nagar, Tipra, Malkumajra, Dammuwal, Mandhala, Karuni, Sainsiwal
16	<i>Culex (Oculeomyia) infula</i> Theobald, 1901	14/10/18, 11/11/18	Karuni, Khud Kurahwala
17	<i>Culex (Eumelanomyia) pulvialis</i> Barraud, 1924	30/3/18, 15/4/18, 10/6/18	Tipra, Karuni
18	<i>Culex (Eumelanomyia) malayi</i> (Leicester, 1908)	5/11/17	Jharmajri

Table 1 contd...

S. No.	Name of mosquito species	Date of collection	Site of collection
19	<i>Rhinoskusea longirostris</i> (Leicester, 1908)	29/4/18	Tipra
20	<i>Fredwardsius vittatus</i> (Bigot, 1861)	12/8/17, 23/6/18, 15/7/18, 29/7/18, 5/8/18, 19/8/18	Sanerh, Mandhala, Karuni, Nawan Nagar, Sattiwala, Sainsiwal, Malkumajra
21	<i>Mimomyia (Ingramia) fusca</i> (Leicester, 1908)	30/3/18	Tipra
22	<i>Mimomyia (Ingramia) chamberlaini</i> Ludlow, 1904	5/11/17	Tipra
23	<i>Stegomyia albopicta</i> (Skuse, 1895)	16/7/17, 2/9/17, 29/7/18, 14/10/18	Barotiwala, Mandhala, Dammuwala, Malkumajra
24	<i>Stegomyia (Stegomyia) aegypti</i> (Linnaeus, 1762)	23/7/17, 1/10/17, 15/7/18, 14/10/18	Baddi, Kishanpur
25	<i>Collessius (Alloeomyia) pseudotaeniatus</i> (Giles, 1901)	29/7/18	Dammuwala
26	<i>Lutzia (Metalutzia) fuscana</i> (Wiedemann, 1820)	1/10/17, 5/8/18, 2/10/18, 24/10/18, 4/11/18	Baddi, Sainsiwal, Tipra, Bhudd, Nawan Nagar
27	<i>Lutzia (Metalutzia) raptor</i> Edwards	19/8/18	Malkumajra
28	<i>Armigeres (Armigeres) kuchingensis</i> Edwards, 1915	16/7/17	Barotiwala
29	<i>Aedimorphus culicinus</i> (Edwards, 1922)	5/8/18	Sainsiwal
30	<i>Mansonia (Mansonioides) annulifera</i> (Theobald, 1901)	5/8/18	Sainsiwal
31	<i>Anopheles (Anopheles) barbirostris</i> Van der Wulp, 1884	2/9/18	Nawan Nagar
32	<i>Anopheles (Anopheles) peditaeniatus</i> (Leicester, 1908)	14/10/18	Baddi
33	<i>Anopheles (Cellia) annularis</i> Van der Wulp, 1884	23/6/18	Mandhala
34	<i>Anopheles (Cellia) culicifacies</i> Giles, 1901	16/7/17, 2/9/17, 5/11/17, 15/7/18, 29/7/18, 7/10/18, 14/10/18, 24/10/18, 4/11/18, 11/11/18	Nawan Nagar, Maranwala, Tipra, Sainsiwal, Karuni, Dammuwala, Lakkarpul, Khud Kurahwala, Mandhala
35	<i>Anopheles (Cellia) fluviatilis</i> James, 1902	16/7/17, 12/8/17, 7/10/18	Nawan nagar, Sanerh
36	<i>Anopheles (Cellia) maculatus</i> Theobald, 1901	7/10/18, 24/10/18, 4/11/18	Nawan nagar, Khud Kurahwala
37	<i>Anopheles (Cellia) pseudojamesi</i> Stickland & Chowdhury, 1927	2/9/18	Nawan Nagar
38	<i>Anopheles (Cellia) psudowillmori</i> (Theobald, 1910)	24/10/18, 4/11/18	Khud Kurahwala, Nawan Nagar
39	<i>Anopheles (Cellia) stephensi</i> Liston, 1901	15/7/18	Nawan Nagar
40	<i>Anopheles (Cellia) subpictus</i> Grassi, 1899	16/7/17, 2/9/17, 1/10/17, 5/11/17, 29/7/18, 5/8/18, 2/9/18, 16/9/18, 24/10/18, 4/11/18, 11/11/18	Tipra, Sattiwala, Mandhala, Nawan Nagar, Katha, Khud Kurahwala, Sainsiwal
41	<i>Anopheles (Cellia) vagus</i> Donitz, 1902	1/10/17, 2/10/18	Tipra
42	<i>Anopheles (Cellia) willmori</i> (James, 1903)	4/11/18	Khud Kurahwala

\* New records from Himachal Pradesh

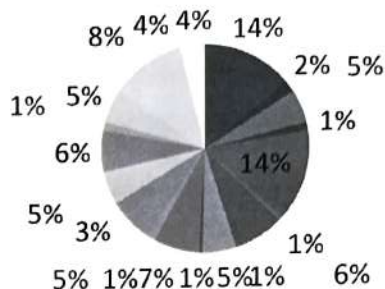


Fig. 2. Composition of mosquito species in different places.

temperature of 30.1 - 35°C. As the temperature decreases the survival of most of the mosquito species is affected. No mosquito larva could be collected in the months of December to February. Maximum number of mosquito species (26) were collected in the month of October, followed by July (21 species), November (16 species), June & September (13 species), August (12 species), May (11 species), April (8 species) and March with minimum no. of 5 mosquito species (Fig. 3).

The previous faunal records of 44 mosquito species of Himachal Pradesh belonging to the district

of Chamba, Kangra, Mandi, Kullu, Lahul & Spiti, Mahasu, Kinnaur, Shimla, Bilaspur and Sirmour were made by Rao *et al.* (1973). Kaur (2001) reported 15 mosquito species from Dalhousie, Mandi, Chamba, Kullu, Kangra, Palampur and Chail areas. There are no records of the mosquito faunal studies from Solan district despite of the fact that Baddi and adjoining area of this district has undergone many developmental and demographic changes due to industrialization in the last few decades, which has led to availability of new breeding places for mosquitoes. As a result, numerous culicidae species have invaded in this area to amplify the mosquito fauna. The reporting of 18 new records (Table 1) from this area of Himachal Pradesh is the result of invasion by mosquito species due to the establishment of new-fangled breeding places.

The prevalence of the vectors of zika, dengue, dengue hemorrhagic fever and chikungunya *i.e.* *Stegomyia aegypti* (Linnaeus, 1762), *Stegomyia albopicta* (Skuse, 1895) and *Frewardsius vittatus* (Bigot, 1861) (Potential vector) is a threatening signal towards the prospect of these diseases (Tyagi *et al.*, 2015). The vectors of malaria *i.e.* various Anopheline species indicate the resurgence of this deadly disease in future. The species referable to genus *Culex i.e.* *vishnui*, *pseudovishnui*, *tritaeniorhynchus* may lead to the transmission of Japanese encephalitis, once the virus gets introduced from the neighbouring states (Kaur, 2020).

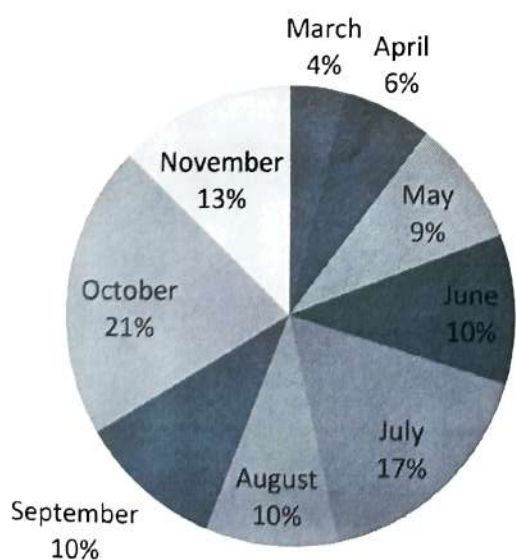


Fig. 3. Composition of mosquito species in different months.

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