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The fauna and ecology of *Anopheles* (*Diptera*: *Culicidae*) at Agra district (U.P), India

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Abstract
Ecological data are important in integrated vector management. Studies were conducted on the fauna and ecology of *Anopheles* in western Uttar Pradesh. Samples of species were collected over the period of eight months (from February 2024 to 20 September 2024) at two villages of Agra district. The two species of *Anopheles* collected- one is *Anopheles culicifacies* and second is *Anopheles stephensi*. These species usually rest outdoors. It has different level habitats. Both the species were active throughout that time period with different peaks of activity, April-May and August-September. Different time shows different response for both species. Light traps captured a large number of mosquitoes in indoor habitat as compared to cattle shelter in darkness places. The species were mainly exophilic in outlet window traps.

Keywords: Ecology, *Anopheles*, Malaria vector, Agra

Introduction

Anopheles are characterized by slender elongated body covered with scales and the position of piercing and sucking type mouth parts. *Anopheles* belongs to the phylum Arthropoda, order *Diptera*, suborder Nematocera, family *Culicidae*, and subfamily Anophelinae. The genus *Anopheles* consists of about 420 species of which 50 are well known vectors of malaria. Malaria is the one most important *Anopheles*-borne disease, especially in the western areas of U.P. *Anopheles* is found in all 12 zones with maximum distribution in Malaysian (56 species) and a minimum from an Afrotropical. zone (11 species).

Anopheles differs morphologically from other genera by virtue of an elongated slender palpus length equal to that of the proboscis. Male consists of club-shaped palpi. *Anopheles* has four stages- egg, larva, pupa, and adult. The diversity in characters and their ability to transmit the disease have prompted entomologists to conduct faunistic, ecological, vector incrimination and other studies. According to the most classification of mosquitoes (*Diptera*: *Culicidae*), the family includes two subfamilies, 11 tribes, 111 genera (43 genera based on the earlier classification), and 3528 species in the world fauna, the genus *Anopheles* Meigen includes 7 subgenera and at least 463 species (Harbach, 2007) [3].

The checklist of the mosquitoes of Iran includes 7 genera and 64 species (Azari-Hemidian,2007a) [1], Osbagh *et al*. (2008) [4] recently identified *Anopheles superpictus.* In India, 58 species of Anophelines are found, of which 6 are primary vectors - *Anopheles culicifacies, Anopheles stephensi, Anopheles fluviatilis, Anopheles dirus, Anopheles sundaicus,* and *Anopheles* minimus, and 4 secondary vectors are - *Anopheles annularis*, *Anopheles philippinensis*, *Anopheles jeyporiensis* and *Anopheles varuna.*

There is a very little information about the ecology of *Anopheles*, including their habitats, at Agra district and in a broader sense in western Uttar Pradesh. Ecological data such as *Anopheles* habitat, species composition and active season, play an important role in integrated vector management. These data are used in source reduction through environmental manipulation and modification. In order to study the fauna and some aspects of the ecology of *Anopheles* including habitats, species composition, association occasions, and percentages an investigation was carried out in Agra district.

Materials and Methods

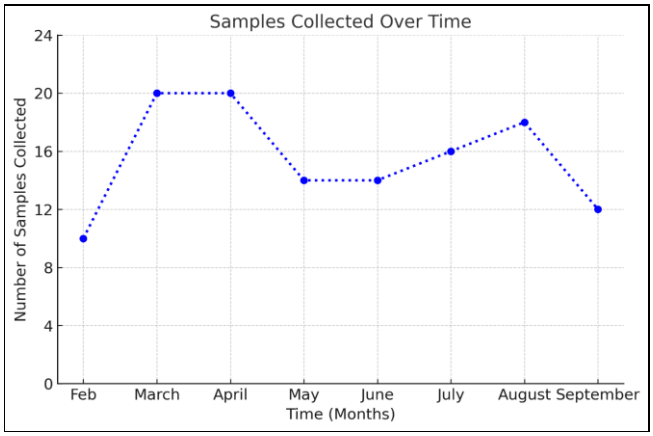
Study Area: The study areas are located at Agra district with surface area of 188.4 KM^2 located on bank of river Yamuna in the Indian state, Uttar Pradesh (between 27.11° latitude north and 78.0° to 78.2° longitude East). Agra district located to which Mathura is in the north-west, Dholpur in the south, Firozabad in the east and Bharatpur in the west. *Anopheles* collections were made in around two villages (fixed sites) at Agra district. *Anopheles* collection was carried out using a range of methods suggested by WHO (1975) [8].

Adult *Anopheles* were collected by hand catch (manual aspirator), night landing catch using human bait, total catch (spray sheet collections), a shelter pit trap, bednet trap and a window trap (WHO 1975) [8]. The adult *Anopheles* were pinned. The specimens were identified using the keys of Shahgudian (1960) [5].

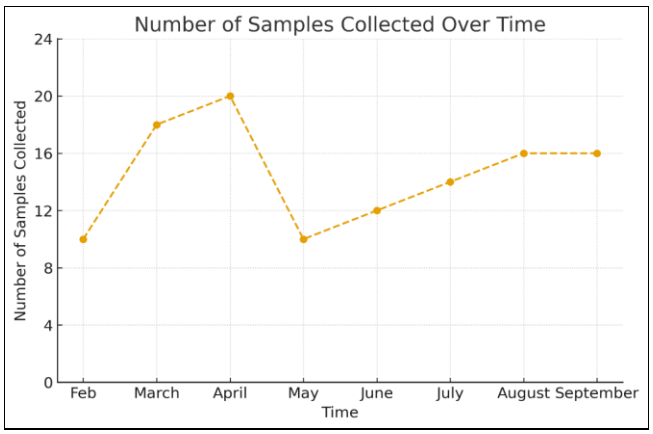
Results and Dicussions

Table - Monthly weather conditions (temperature, number of cloudy/sunny/precipitation days) and mosquito collections (*Anopheles culicifacies* and *Anopheles stephensi*).

Months	February	March	April	May	June	July	August	September
Day (temp)	70°F	85°F	98°F	104°F	103°F	92°F	87°F	86°F
Night (temp)	51°F	61°F	75°F	83°F	89°F	84°F	80°F	79°F
Cloudy (days)	7	7	9	5	9	7	2	7
Sunny (days)	22	24	21	26	18	9	3	10
Precipitation (days)	0	0	0	0	3	15	26	13
Collection: *Anopheles culicifacies*	10	20	20	14	14	16	18	12
Collection: *Anopheles stephensi*	8	18	20	10	12	14	16	14



Anopheles culicifacies



Anopheles stephensi

The monthly mean indoor density of female *Anopheles culicifacies* and *Anopheles stephensi* from February 2024 to September 2024 presented. The species had been active through the period with found different peaks of activity. 10 mosquitoes of *Anopheles culicifacies* of 70°F in day, 51° F at night, 7 days cloudy, 22 days sunny and zero precipitation in the month of February 2024, whereas only 8 samples of *Anopheles stephensi* were collected.

20 mosquitoes of *Anopheles culicifacies* were collected at the average temperature of 85°F in day, 61°F at night, 7 days cloudy, 24 days sunny and zero precipitation in the month of March 2024, whereas 18 samples of *Anopheles stephensi* were collected. 20 mosquitoes of *Anopheles culicifacies* were collected at the average temperature 98°F in day, 75°F at night, 9 days cloudy, 21 days sunny and zero precipitation in the month of April 2024, whereas 20 samples of *Anopheles stephensi* were collected.

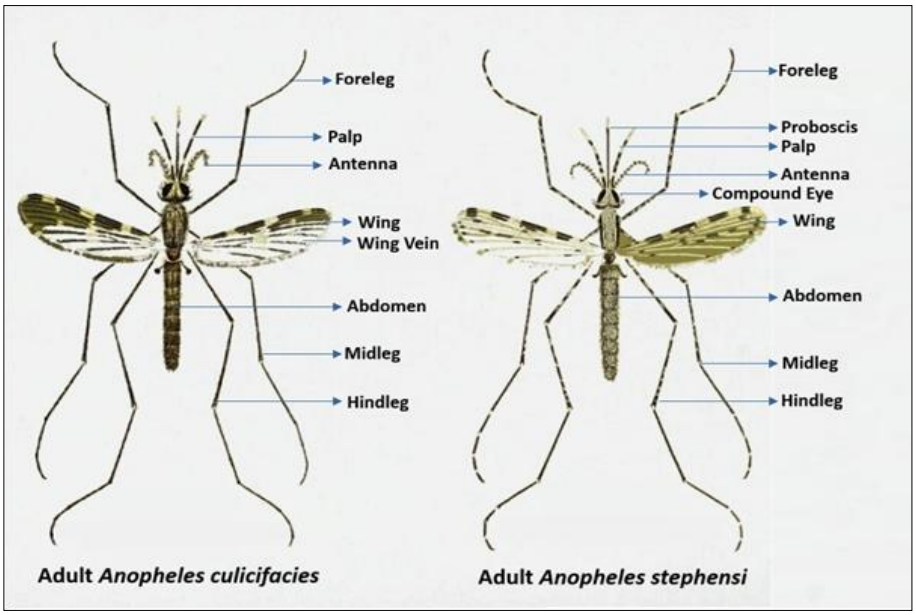
14 mosquitoes of *Anopheles culicifacies* were collected at the average temperature 104°F in day, 83°F at night, 5 days cloudy, 26 days sunny and zero precipitation in the month of May 2024, whereas only 10 samples of *Anopheles stephensi* were collected.

14 mosquitoes of *Anopheles culicifacies* were collected at the average temperature 103°F in day, 89°F at night, 9 days cloudy, 18 days sunny and 3 days precipitation in the month of June 2024, whereas 12 samples of *Anopheles stephensi* were collected.

16 mosquitoes of *Anopheles culicifacies* were collected at the average temperature of 92°F in day, 84°F at night, 7 days cloudy, 9 days sunny and 15 days precipitation in the month of July 2024, whereas 14 samples of *Anopheles stephensi* were collected.

18 mosquitoes of *Anopheles culicifacies* were collected at the average temperature of 87°F in day, 80°F at night, 2 days cloudy, 3 days sunny and 26 days precipitation in the month of August 2024, whereas 16 samples of *Anopheles stephensi* were collected.

12 mosquitoes of *Anopheles culicifacies* were collected at the average temperature of 86°F in day, 79°F at night, 7 days cloudy, 10 days sunny and 13 days precipitation in the month of September 2024, whereas 14 samples of *Anopheles stephensi* were collected.



Conclusion

This study assessed fauna and ecology of *Anopheles* at Agra district, Uttar Pradesh. That analysis was carried out by taking two villages of Agra. At these places, collection of two species: one is *Anopheles culicifacies* and second *Anopheles stephensi* at different temperature ranges. In present investigation, it was found that highest peak in month of March-April, in September lower numbers and

other months average numbers are found. Collection of *Anopheles culicifacies* are more than *Anopheles stephensi*. According to study, the Agra district is dangerous for humans and highly contaminated by mosquitoes.

Zaim *et al*. (1992) [2] studied on the ecology of *Anopheles pulcherrimus* in the Baluchistan, Iran. This species was active throughout the year with 2 peaks of activity, April-May and August-September. Vatandoost *et al*. (2007) studied on the ecology of *Anopheles dthali* Patton in Bandar Abbas district. This species is active throughout the year in mountainous area with two peaks of activity, whereas in coastal areas it has one peak. Banafshi *et al*. (2013) [2] investigated a total of 2096 third and fourth instar larvae of mosquitoes were collected, four genera and 11 species of mosquitoes were identified. Soltani *et al*. (2017) [6] studied total of 689 adults and1313 larvae of *Culicidae* were collected of which 3 genera and 6 species of *Culicidae* were recognised.

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