Integral Research
(ISSN: 3048-5991) Coden: IRABCA

Research Article
(Peer-reviewed, Open Access & Indexed Multidisciplinary Journal)
Journal home page: https://integralresearch.in/
Vol. 03, No. 02, February. 2026

Ecological Distribution and Vector Potential of Anopheles Mosquitoes in Faridpur Tehsil of Bareilly District, Uttar Pradesh, India

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Malaria still hits hard in many tropical and subtropical areas, and parts of India aren't spared. The disease spreads when a female Anopheles mosquito, carrying the parasite, bites someone. So, if we want to control malaria, we need to know which mosquito species are around and how good they are at spreading the parasite. In this study, I looked at the diversity and possible vector status of Anopheles mosquitoes in Faridpur Tehsil, Bareilly district, Uttar Pradesh. I collected mosquitoes all year from different spots—inside homes, cattle sheds, mixed shelters, and outdoor resting places. After catching them, I used standard morphological keys to figure out which species I had. Then I dissected the females to check their midguts and salivary glands for malaria parasites. I found ten different Anopheles species in the area. The most common were *Anopheles culicifacies*, *Anopheles fluviatilis*, *Anopheles stephensi*, *Anopheles annularis*, and Anopheles maculatus. When I looked closer, I found malaria parasites in Anopheles fluviatilis, which points to its role as a malaria vector here. Even though the infection rate was low, this species matters in the local transmission of the disease. These results make one thing clear: we can't let up on mosquito surveillance and integrated vector control if we want to cut down malaria risk in the rural parts of Bareilly district..

Keywords: Malaria transmission, Anopheles mosquitoes, vector incrimination, Faridpur Tehsil, Bareilly district,

Introduction

Malaria still hits hard across the world, especially in places where public health resources are stretched thin. Even with all the progress in medicine and mosquito control, this disease continues to weigh heavily on developing countries. In India, malaria shows up in all kinds of landscapes—thick forests, riverbanks, farmland, and even crowded city neighborhoods. The culprits are protozoan parasites from the genus Plasmodium, passed to humans by the bite of an infected female Anopheles mosquito. Not every Anopheles mosquito spreads malaria, but a handful of species in India do most of the damage: *Anopheles culicifacies*, *Anopheles stephensi*, *Anopheles fluviatilis*, *Anopheles minimus*, and *Anopheles dirus*. Where these mosquitoes thrive depends on the environment—rainfall, temperature, humidity, and especially the availability of good breeding spots.

India has about 58 species of Anopheles mosquitoes. Out of all these, six stand out as the main players in spreading malaria: *Anopheles culicifacies*, *Anopheles stephensi*, *Anopheles fluviatilis*, *Anopheles dirus*, *Anopheles sundaicus*, and *Anopheles minimus.* A few others—like *Anopheles annularis*, *Anopheles philippinensis*, *Anopheles jeyporiensis*, and *Anopheles varuna*—don't usually get the spotlight but can still pass on malaria when the environment suits them (Tyagi, 1992). Looking back, several entomologists have surveyed mosquito populations in the Rohilkhand region, which covers Bareilly, Rampur, Pilibhit, Moradabad, Budaun, and Shahjahanpur. Names like Ansari, Prasad, Sharma, and the S&T Project pop up in the literature from the 1980s and 1990s. Even earlier, Puri (1936) reported Anopheles fluviatilis in Moradabad. But after Ansari et al. (1984), there's barely any research on mosquito fauna in Bareilly. Since figuring out which mosquitoes actually transmit malaria is crucial for understanding the disease and checking how well control programs work—especially in regions where many Anopheles species live side by side—I decided to organize a thorough survey. The goal: to

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identify and incriminate the malaria vectors present in the Bareilly region.

Materials and Methods

Study Area

This study took place in Faridpur Tehsil, in the Bareilly district of Uttar Pradesh, India. The climate here is subtropical—hot summers, a decent monsoon season, and winters that don't get too harsh. Agriculture shapes daily life. Fields stretch out in every direction, broken up by irrigation canals, ponds, and clusters of villages. All these features create ideal spots for mosquitoes to breed and rest.

Collection of Mosquitoes

Collected adult mosquitoes from all sorts of habitats around the area. Main sites included people's homes, cattle sheds, places where people and animals live together, and outdoor spots like thick vegetation or shaded structures. Early mornings were best, since mosquitoes tend to rest indoors or in cool, sheltered places then. I used standard collection methods to catch them while they were resting.

Identification of Mosquito Species

After collecting them, brought the mosquito specimens back to the lab for identification. I used a stereoscopic microscope and focused on features like wing spots, the structure of their palpi, and specific body markings. For accuracy, I relied on standard taxonomic keys and trusted entomological references throughout the identification process.

Dissection and Detection of Infection

Next, dissected female Anopheles mosquitoes to check for malaria parasites.

The process focused on two organs: the midgut (to look for oocysts) and the salivary glands (for sporozoites). Finding oocysts in the midgut signals early infection; spotting sporozoites in the salivary glands means the mosquito can actually transmit malaria to humans. I followed established procedures for malaria vector incrimination at every step.

Results

Researchers surveyed mosquitoes in Faridpur Tehsil and found ten different Anopheles species buzzing around. This means the area has a pretty mixed mosquito crowd. Out of all the mosquitoes they caught, a handful stood out as the most common: Anopheles culicifacies, Anopheles fluviatilis, Anopheles stephensi, Anopheles maculatus,Anopheles annularis. They also spotted Anopheles aconitus, Anopheles subpictus, and Anopheles splendidus, but these showed up less often.

The team dissected female mosquitoes from several species to check for malaria parasites. Only Anopheles fluviatilis carried the parasite, and they found it in both the midgut and salivary glands. That's important—it means this species isn't just picking up the parasite, but could actually spread malaria in Faridpur. Even though not many mosquitoes turned out to be infected, finding any infected ones at all matters. It points straight to Anopheles fluviatilis as a player in local malaria transmission.

Received 06 February 2026; Accepted 21 February 2026. Available online: 28 February 2026. Published by SAFE. (Society for Academic Facilitation and Extension) This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License

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Table 1: Species Composition of Anopheles Mosquitoes Collected from Different Habitats in Faridpur Tehsil, Bareilly District

S. No.	Species of *Anopheles*	Human Dwellings	Cattle Sheds	Mixed Dwellings	Outdoor Resting Sites	Total Collected
1	*Anopheles culicifacies*	62	84	48	36	230
2	*Anopheles fluviatilis*	41	36	27	22	126
3	*Anopheles stephensi*	38	29	21	16	104
4	*Anopheles annularis*	26	31	19	14	90
5	*Anopheles maculatus*	22	18	16	13	69
6	*Anopheles aconitus*	14	16	11	10	51
7	*Anopheles subpictus*	18	12	9	7	46
8	*Anopheles splendidus*	11	9	7	6	33
9	*Anopheles barbirostris*	9	7	6	5	27
10	*Anopheles vagus*	8	6	5	4	23

Table 2: Dissection Results of Female *Anopheles* Mosquitoes for Detection of Malaria Parasites

S. No.	Species	Number Dissected	Midgut Infection (Oocysts)	Salivary Gland Infection (Sporozoites)	Infection Rate (%)
1	*Anopheles culicifacies*	80	0	0	0
2	*Anopheles fluviatilis*	62	3	2	3.22
3	*Anopheles stephensi*	48	0	0	0
4	*Anopheles annularis*	39	0	0	0
5	*Anopheles maculatus*	28	0	0	0
6	Other species combined	52	0	0	0

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Table 3: Relative Abundance (%) of *Anopheles* Species in Faridpur Tehsil

S. No.	Species	Total Collected	Relative Abundance (%)
1	*Anopheles culicifacies*	230	28.79
2	*Anopheles fluviatilis*	126	15.77
3	*Anopheles stephensi*	104	13.01
4	*Anopheles annularis*	90	11.26
5	*Anopheles maculatus*	69	8.63
6	*Anopheles aconitus*	51	6.38
7	*Anopheles subpictus*	46	5.75
8	*Anopheles splendidus*	33	4.13
9	*Anopheles barbirostris*	27	3.38
10	*Anopheles vagus*	23	2.88

The tabulated data reveal that *Anopheles culicifacies* was the most abundant mosquito species in the study area, accounting for approximately 28.79% of the total mosquito population. This was followed by *Anopheles fluviatilis* and *Anopheles stephensi***.** The presence of these species indicates favorable ecological conditions for mosquito breeding in Faridpur Tehsil. Dissection of female mosquitoes demonstrated that only *Anopheles fluviatilis* showed evidence of malaria parasite infection in both the midgut and salivary glands. The infection rate recorded for this species was 3.22%, suggesting its potential role in malaria transmission in the region.

Discussion

Our findings show that Faridpur Tehsil in Bareilly district offers a perfect mix of conditions for different Anopheles mosquito species to thrive. You see it everywhere—fields stretching out, irrigation canals weaving through the land, patches of stagnant water, cattle shelters tucked between farms. Each of these spots turns into a breeding ground or a resting place for mosquitoes. *Anopheles culicifacies* and Anopheles fluviatilis dominate the scene here, echoing what earlier researchers found across northern India. These species play a major role as malaria vectors in the region. We also found malaria parasites in Anopheles fluviatilis, which underlines just how important this species is for local malaria transmission.

This study uncovered a striking diversity of Anopheles mosquito species in Faridpur Tehsil, Bareilly district. Clearly, the region's mix of climate and ecology—fields, irrigation canals, stagnant puddles, cattle sheds—creates ideal breeding grounds for malaria vectors. Other parts of India see the same story: where there's water and agriculture, mosquitoes thrive (Das et al., 1990; Kulkarni, 1990).Out of all the species we found, Anopheles culicifacies, Anopheles fluviatilis, and Anopheles stephensi dominated. These are well-known players in India's malaria

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transmission. Past research has pointed to them as the main culprits across a variety of ecological zones (Tyagi, 1992; Bruce-Chwatt, 1991). The fact that Anopheles culicifacies showed up in such high numbers in our survey fits perfectly with earlier reports labeling it a major malaria vector in rural regions (Nagpal and Sharma, 1980).

We detected malaria parasites in some Anopheles fluviatilis specimens, underscoring its role as a vector here in Bareilly. This isn't new—studies from northern India have already identified Anopheles fluviatilis as an efficient malaria carrier, especially in rural and forested areas (Mahesh and Jauhari, 2001). Finding infected mosquitoes in our samples points to their active role in keeping local malaria transmission going.Mosquito numbers didn't stay the same all year. They peaked during the monsoon, with much lower counts in winter. This pattern tracks with the abundance of temporary breeding sites—rain-filled pools, irrigation channels, stagnant water—during the wet season. Studies from all over India have seen the same seasonal trends (Das et al., 1990; Gunasekaran et al., 1987).

The range of mosquito species we recorded lines up with what earlier surveys found in the Rohilkhand region. Past work in Bareilly and nearby districts also reported several Anopheles species capable of spreading malaria (Ansari et al., 1984; Sharma et al., 1985; Prasad and Sharma, 1990). But since those studies, we haven't had much up-to-date information on the current mosquito population in Bareilly.We identified and classified mosquitoes using standard taxonomic keys and entomological references (Christophers, 1933; Knight and Stone, 1977; Wattal and Kalra, 1961). Getting species identification right matters—a lot. It's essential for understanding which mosquitoes are driving malaria outbreaks and for designing control measures that actually work.Proving which species spread malaria—vector incrimination—remains a cornerstone of malaria research and control. With several Anopheles species present, transmission dynamics here are probably complex. Regular monitoring of both mosquito populations and their infection rates is vital if we want to keep malaria in check and head off future outbreaks (WHO, 1976; Sharma, 1996).

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