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# Mosquito diversity and their larval habitats from the northern part of West Bengal

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**Abstract**

Mosquitoes are the members of the Culicidae family under the order Diptera. In recent years, West Bengal has been fighting a number of mosquito borne diseases. North Bengal refers to the districts of Darjeeling, Jalpaiguri, Cooch-Bihar, Malda, Uttar Dinajpur, Dakshin Dinajpur, Alipuduar and Kalimpong. This review compiles an up-to-date list of all mosquito species reportedly found in the Northern part of West Bengal providing information on their larval habitat and it will also serve as a reference for future research. A total of 50 different mosquito species belonging to 8 different genera have been recorded in this area. The majority of the recorded species are belonging from the genus *Anopheles*. In the other hand genus *Toxorhynchites* and *Orthopodomyia* are accounted for the least number of species. Immature mosquitoes were reported from various lentic aquatic habitats. The cemented tanks had the greatest number of species, followed by the temporary pools, ground pool and tree holes.

**Keywords:** Mosquito diversity, North Bengal, larval habitat, mosquito-borne diseases, mosquito vectors

**1. Introduction**

Mosquitoes are a large group of insects found throughout the world's temperate and tropical regions, as well as beyond the Arctic Circle. They are members of the Culicidae family under the order Diptera<sup>[1]</sup>. Mosquitoes are cosmopolitan as they can adapt to new environments and exploit them<sup>[2]</sup>. They breed in virtually all types of lentic aquatic habitats<sup>[3]</sup>. Mosquitoes are essential medical and veterinary insects because they spread arboviruses, protozoa, helminthes and other infections that harm human health<sup>[4]</sup>. They transmit a variety of vector-borne diseases such as Dengue, Malaria, Filariasis, Chikungunya and Japanese Encephalitis (JE), to name some<sup>[5]</sup>.

India is one of the world's 12 mega diverse countries, with a vast biological diversity. After Brazil, Indonesia, Malaysia and Thailand, India is ranked fifth in terms of mosquito biodiversity<sup>[6]</sup>. West Bengal, which stretches from the Himalayas in the North to the Bay of Bengal in the South, is India's eastern bottleneck. It is located between 85°50'E and 89°50' E longitude, and 21°25'N and 27°13' N latitude<sup>[7]</sup>. The state covers an area of 88,752 square kilometers in total<sup>[8]</sup>. Northern part of West Bengal or North Bengal refers to the districts of Darjeeling, Jalpaiguri, Cooch-Bihar, Malda, Uttar Dinajpur, Dakshin Dinajpur, Alipuduar and Kalimpong, which are all located to the North of Ganga. These sites have a temperature that ranges between 26-35°C in summer (occasionally crosses 35°C) and 15-25°C in winter, with an annual rainfall of 123mm to 292mm<sup>[9]</sup>.

In recent years, West Bengal has been fighting a number of mosquito borne diseases. Directorate of Health Service (DHS), Govt. of West Bengal reported several cases of malaria, dengue, acute encephalitis syndrome etc in 2016<sup>[10]</sup>. The NVBDCP (National Vector Borne Disease Control Programme) reported 224 confirmed Dengue fever cases (From January to September, 2021)<sup>[11]</sup>, 8215 confirmed Malaria cases (from January to August, 2021)<sup>[12]</sup> and 20 confirmed Chikungunya cases (From January to September, 2021)<sup>[13]</sup> from West Bengal. According to NVBDCP, 24-Parganas North, 24-Parganas South, Bankura, Bardwan, Birbhum, Cooch-Bihar, Malda, Medinipur East, Medinipur West, Murshidabad, Nadia and Purulia districts of West Bengal are considered as Endemic Districts for Lymphatic Filariasis<sup>[14]</sup>. Among them, Malda and Cooch-Bihar falls under the Northern part of West Bengal.

Landscape changes have an impact on mosquito diversity and disease transmission i.e., vectors and their associated disease that were earlier exclusively found in forests are now found near to human environment as a result of human activities<sup>[15]</sup>. Mosquito management necessitates a thorough understanding of species diversity and composition, sheltering locations, habitats and breeding sites, as well as biting preferences over time and period. Because understanding of faunal diversity and vector control is often a key component of disease control, it's crucial to correctly identify and comprehend the bionomics of the species involved in transmission.

Previous authors have compiled lists of mosquito species found in Northern part of West Bengal, but a complete updated list of all mosquito species found in the state is still missing. Species documentation is an essential component of biodiversity research, as it aids in the protection of genetic resources as well as pest and vector control. The exact number of mosquito species found in this region must be estimated. As a result, the goal of this review is to compile an up-to-date list of all mosquito species reportedly found in the Northern part of West Bengal, information on their larval habitat, as well as need for future research.

## 2. Materials and methods

Data were gathered from two online resource databases, namely Google scholar and Science direct, as well as published materials since 1970. Additional articles were found by searching the references list of the collected articles. The terms, 'Mosquito', 'Diversity', 'Northern part of West Bengal' were used as keywords to find articles. As a result the current research is a compilation of scientific studies conducted between 1970 and September, 2021. A limited number of articles were found regarding the diversity of mosquito from the Northern part of West Bengal. For the preparation of this article, 20 papers related to the topic were retrieved and 4 papers with diversity of mosquitoes from Northern part of West Bengal were selected and analyzed (Fig. 1).

## 3. Results and Discussion

A total of 50 different mosquito species belonging to 8 different genera have been recorded in this area, so far. As per our knowledge the first survey for the mosquito diversity of this region was done in 1966<sup>[16]</sup>. A team from the Armed Forces Medical College in Pune studied a stretch of eastern Himalayan foothills for the sylvan mosquito fauna from July to December 1966. The 200- Kilometer Bengdubi – Bagdogra- Siliguri – Bagrakot- Binaguri- Hashimara region in the eastern Himalayan foothills was surveyed. (Lat. 26°30'N - 27°0'N; Long. - 88°15'E - 89°30'E). A total of 674 specimens were recorded, out of which 18 species belonged to Culicine family and 19 to Anopheline family. Another survey was conducted in the Siliguri – Naxalbari block of Darjeeling district in 1993-94 to investigate the occurrence and distribution of Anopheline mosquitoes<sup>[17]</sup>. They reported 13 species under Anopheline family from this region, namely, *Anopheles vagus*, *An.culicifacies*, *An.annularis*, *An.barbistrostris*, *An.subpictus*, *An.maculatus*, *An.tessellatus*, *An.jamesii*, *An.aconitus*, *An.hyrceanus* group, *An.karwari*, *An.fluviatilis* and *An. jeyporiensis* with the first five species accounting for the majority of the species (92%).

Seasonal variation in mosquito diversity was also recorded by few researchers. In 2006, mosquito larval variety was

documented from different localities of Darjeeling town<sup>[3]</sup>. Six mosquito species under four genera *Armigeres*, *Aedes*, *Culex* and *Toxorhynchites* were found to have significant temporal change in their relative and absolute numbers. They reported the mosquito species diversity index (H') from this region maintained between 0.87 and 1.53. They also reported that the evenness components varied greatly, ranging from 54.03 to 95.03% in this region. In the same year, mosquitoes were surveyed from Nagrakata, Binnaguri, Ballaguri and Totopara in the central dooars<sup>[18]</sup>. In this study, 16 mosquito species were found in human habitation. They reported that *T.splendens* was more abundant in the wet season than in the winter and summer. Anopheles species accounted for 55.17% of total indoor resting samples, with densities ranging from 3.79% to 12.24% of the overall mosquito population. The total *Culex* spp. density in the mosquito collection was 20.32%. The populations of *Aedes* spp. and *Mansonia* spp. were 7.55% and 4.98%, respectively.

Table 1 shows the genus composition of mosquitoes at various sample sites in North Bengal, together with their larval environment. Mosquito taxonomy is an important component in vector control. In case of Anopheline mosquitoes, vector control in a region is influenced by the number and complexity of primary and secondary vectors, necessitating a study of the entire anopheline fauna in order to integrate the various information about the vector system and formulate an appropriate and effective control strategy. Furthermore, certain unknown arboviruses capable of transmitting to humans may thrive in our forest ecosystem's sylvatic cycles. These data demonstrate the significance of mosquito fauna research<sup>[19]</sup>.

Since the 1970s, limited research in some parts of North Bengal have discovered numerous new species. With the rise of mosquito-borne diseases and changing ecology, a reevaluation of the Indian Culicidae fauna is required. On a large scale, comprehensive surveys incorporating DNA-based approaches such as mosquito DNA barcoding<sup>[20]</sup> are required. Mosquito species recorded from Northern part of West Bengal

1. *Culex bitaeniorhynchus*<sup>[3, 16]</sup>
2. *Culex mimeticus*<sup>[16]</sup>
3. *Culex fatigans*<sup>[16]</sup>
4. *Culex gelidus*<sup>[16]</sup>
5. *Culex mimulus*<sup>[16]</sup>
6. *Culex epidesmus*<sup>[16]</sup>
7. *Culex whitmorei*<sup>[16]</sup>
8. *Culex fuscocephalus*<sup>[16]</sup>
9. *Culex vishnui*<sup>[16, 18]</sup>
10. *Culex quinquefasciatus*<sup>[3, 18]</sup>
11. *Armigeres abturbans*<sup>[16]</sup>
12. *Armigeres subalbatus*<sup>[3, 18]</sup>
13. *Armigeres theobaldi*<sup>[3]</sup>
14. *Uranotaenia luteola*<sup>[16]</sup>
15. *Uranotaenia maculipleura*<sup>[16]</sup>
16. *Orthopodomyia anopheloides*<sup>[16]</sup>
17. *Aedes albopictus*<sup>[16, 18]</sup>
18. *Aedes walbus*<sup>[3, 16]</sup>
19. *Aedes aegypti*<sup>[18]</sup>
20. *Mansonia indiana*<sup>[16, 18]</sup>
21. *Mansonia uniformis*<sup>[16]</sup>
22. *Mansonia crassipes*<sup>[16]</sup>
23. *Mansonia annulifera*<sup>[18]</sup>
24. *Toxorhynchites splendens*<sup>[3, 18]</sup>

25. *Anopheles aconitus* <sup>[16, 17]</sup>
26. *Anopheles aitkenii* <sup>[16]</sup>
27. *Anopheles barbirostris* <sup>[16-18]</sup>
28. *Anopheles hyrcanus* <sup>[16, 17, 18]</sup>
29. *Anopheles kochi* <sup>[16]</sup>
30. *Anopheles gigas* <sup>[16]</sup>
31. *Anopheles jamesii* <sup>[16, 17]</sup>
32. *Anopheles annandalei* <sup>[16]</sup>
33. *Anopheles culiciformis* <sup>[16]</sup>
34. *Anopheles culicifacies* <sup>[17, 18]</sup>
35. *Anopheles sintoni* <sup>[16]</sup>
36. *Anopheles karwari* <sup>[16, 17]</sup>
37. *Anopheles lindesayi* <sup>[16]</sup>
38. *Anopheles leucosphyrus* <sup>[16]</sup>
39. *Anopheles splendidus* <sup>[16]</sup>
40. *Anopheles tessellates* <sup>[16, 17]</sup>
41. *Anopheles maculatus* <sup>[16, 17, 18]</sup>
42. *Anopheles vagus* <sup>[16, 17, 18]</sup>
43. *Anopheles majidi* <sup>[16]</sup>
44. *Anopheles philippinensis* <sup>[16]</sup>
45. *Anopheles annularis* <sup>[17]</sup>
46. *Anopheles subpictus* <sup>[17]</sup>

47. *Anopheles fluviatilis* <sup>[17, 18]</sup>
48. *Anopheles jeyporiensis* <sup>[17]</sup>
49. *Anopheles minimus* <sup>[18]</sup>
50. *Anopheles varuna* <sup>[18]</sup>

The majority of the recorded species are belonging to the genus *Anopheles*. In the other hand genus *Toxorhynchites* and *Orthopodomyia* are accounted for the least number of species. (Fig. 2) Immature mosquitoes were reported from various lentic aquatic habitats. The cemented tanks had the greatest number of species, followed by the temporary pools, ground pool and tree holes. According to this review, the Northern part of West Bengal provides suitable habitat for mosquitoes to grow and develop. These habitats are seasonal in nature and only persist for a few months each year.

In comparison to other aquatic bodies, cemented temporary pools have the most resources in terms of dissolved organic matters, vegetation and algae <sup>[3]</sup>. This may allow coexistence among most species from various guilds.

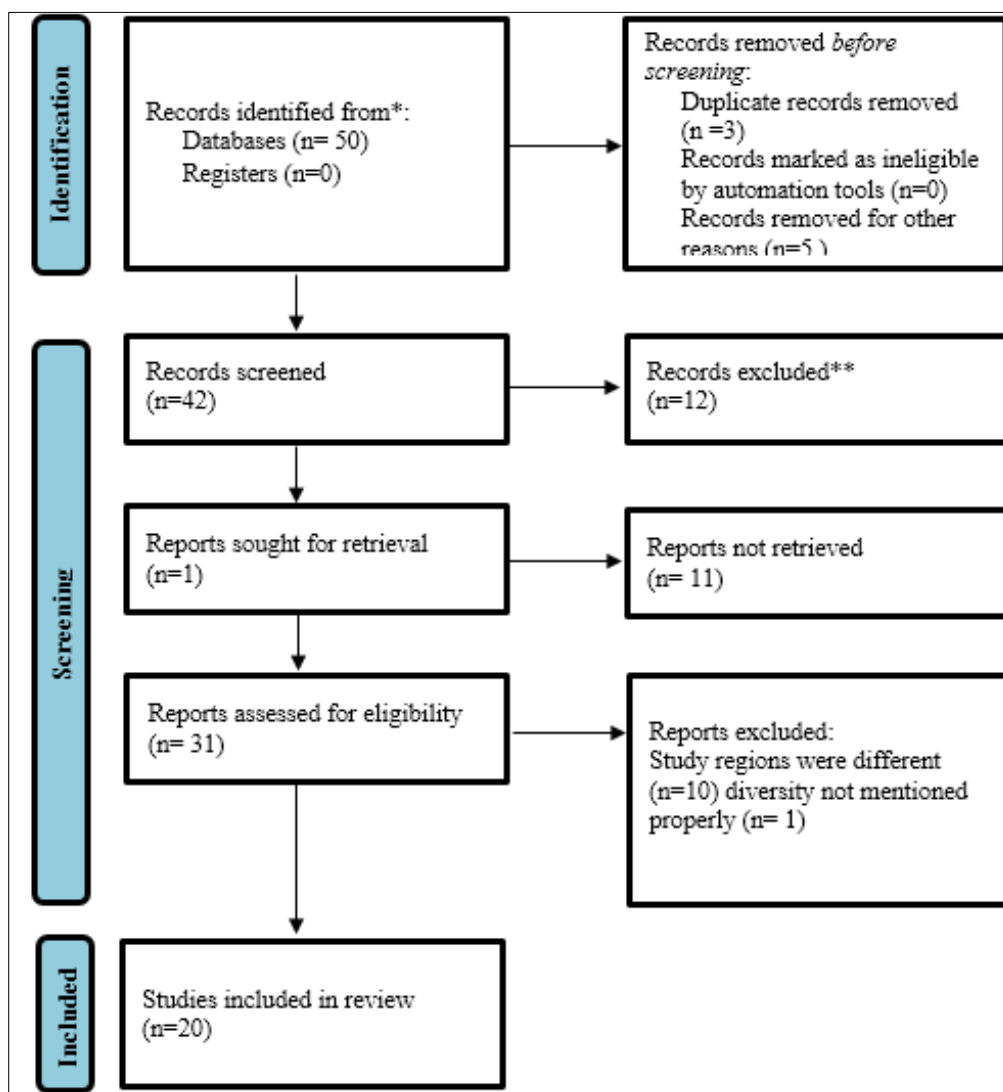
### 3.1 Tables and Figures

**Table 1:** Reported larval diversity of mosquitoes according to their habitat in North Bengal <sup>[3, 16, 17, 18]</sup>

Genus name	Reported larval diversity of mosquitoes according to their habitat in Northern part of West Bengal*																	
	TP	CT	HT	TD	SD	MD	PF	WP	SwP	GP	SP	TH	BS	StP	LA	RP	IC	LK
1. <i>Culex sp</i>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
2. <i>Armigeres sp</i>	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
3. <i>Uranotaenia sp</i>	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
4. <i>Orthopodomyia sp</i>	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗
5. <i>Aedes sp</i>	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✗	✗
6. <i>Mansonia sp</i>	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✓
7. <i>Toxorhynchites sp</i>	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗
8. <i>Anopheles sp</i>	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓

\* TP: Temporary pools, CT: Cemented tanks, HT: Household tanks, TD: Temporary ditches, SD: Sewage drains, MD:MD: Muddy drains, PF: Paddy fields, WP: Weeded pond, SwP: Scanty weeded pond, GP: Ground pool, SP: Seepage pool, TH: Tree holes, BS: Bamboo stumps, StP: Stream pools, LA: Leaf axil, RP: Rock pool, IC: Irrigation canal, LK: – Lake.

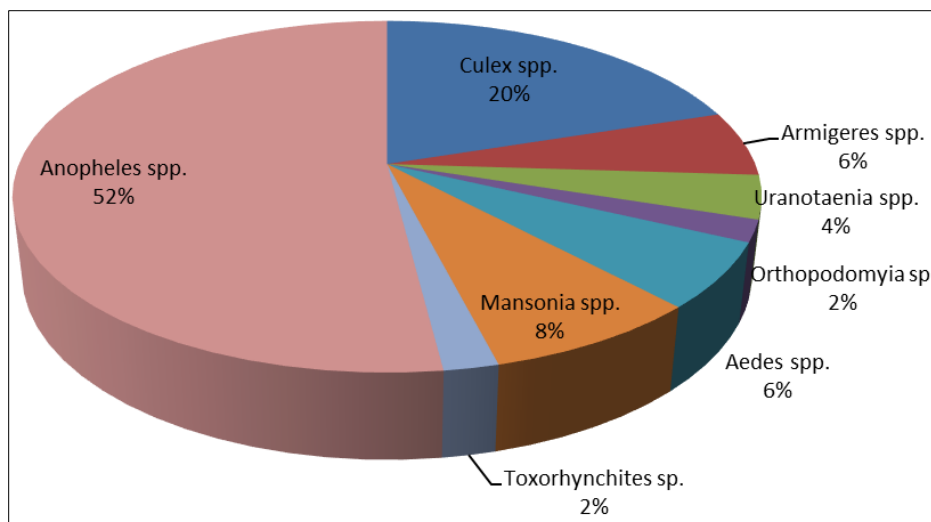
‘✓’ indicates species recorded & ‘✗’ indicates species not recorded.



\*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

\*\*If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Fig 1: PRISMA 2020 flow diagram for new systematic reviews [21].



Out of total 8 reported genera *Anopheles* (52%) was the most abundant genus where as *Toxorhynchites* (2%) and *Orthopodomyia* (2%) were least abundant genus.

Fig 2: Mosquito faunal diversity and abundance reported from the northern part of West Bengal.

#### 4. Conclusions

The species listed in this review is the most comprehensive and latest format compiled since, 1970. It provides a brief overview about the species richness and distribution of mosquito species, which includes major disease vectors as well as potential secondary vectors. This updated list will help to study the species bionomics. It will aid organizations to effectively control primary vectors as well as secondary vectors in their respective habitats, which would otherwise lead to reemergence of diseases like malaria, dengue etc. through secondary vectors. This is evident from the fact that the vector capacitance of the secondary vectors increases in absence of primary vectors. According to our review, mosquito larva can thrive in a variety of areas other than drains. As a result, vector management measures can also be applied to those prospective locations. Because only few studies on this topic has been undertaken in few districts of North Bengal, mosquito diversity may differ in other areas of this region. The current data provide a preliminary assessment of mosquito diversity and mosquito larval habitats in this region. But there are several other districts, such as Malda, Uttar Dinajpur, Dakshin Dinajpur, Alipurduar, Kalimpong and Cooch Behar, from northern part of West Bengal which are endemic to mosquito borne diseases and there are no records on mosquito biodiversity studies from these districts. Furthermore, due to human population explosion, previously unexploited areas are now being occupied, for different anthropogenic activities, increasing the chances of human vector interaction. Therefore, in order to avoid any unprecedented occurrence of disease morbidity and mortality, a comprehensive survey on the mosquito species richness, habitat distribution and population dynamics from this area is needed.

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