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MOSQUITOES (DIPTERA: CULICIDAE) FAUNA OF DISTRICT TANK, KHYBER PAKHTUNKHWA: THEIR DIVERSITY AND HABITAT PREFERENCE

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ABSTRACT

Mosquitoes are blood suckers that bite mammals, birds, reptiles, amphibians, and fish to transmit diseases like filariasis, malaria, and dengue fever. Various factors, including climate, water sources, vegetation, land use, and human activities, contribute to the diversity of mosquitoes in an area. This study aimed to assess mosquito diversity and their habitat preference in the Tank district, Khyber Pakhtunkhwa. The study was conducted from November 2024 to May 2025, resulting in a wide-ranging and representative sample. A total of 10 study sites with seven different habitats were selected for mosquito sampling, including marshy areas, sewage, crops, agriculture, animal sheds, ponds, and barren land. Sampling was done using sweep nets and inhalation mosquito lamps (IML). Furthermore, the sampling was preserved in a 95% ethanol solution. The collected samples were identified with the help of taxonomic keys, examined using a stereo-zoom microscope. A total of 13 species were identified. Out of the thirteen recorded species, seven were included in the Anophelinae and Culicinae, two were from the tribe Aedini, and four were from the Culicini. The most prevalent species identified was Culex quinquefasciatus, while Aedes albopictus, a primary vector for dengue fever, was the least common. A high and diversified population was recorded in cropland. These results highlight the diverse mosquito populations within the region and underscore the need for ongoing surveillance and vector control efforts to mitigate the health risks posed by these species. Appropriate monitoring steps should be taken to prevent the further growth of the mosquito population; otherwise, it may lead to the spread of diseases such as malaria and Dengue fever.

Keywords: *Mosquito fauna, District Tank, Marshy Areas, Sewage, Crops, Agriculture, Animal Sheds, Ponds, Barren Land.*

Introduction

Mosquitoes are small, flying insects belonging to the family Culicidae, known for transmitting infectious diseases such as malaria, dengue, and yellow fever, which affect millions of people (Lundquist *et al.* 2012). Dengue fever, primarily spread by *Aedes aegypti* mosquitoes, is the leading cause of human disease and mortality globally,

particularly in Pakistan, a subtropical nation known for its breeding grounds (Fatima *et al.* 2016)

Over 3500 species (135 subgenera) of mosquitoes have been recorded worldwide. The three subfamilies are Anophelinae, Culicinae, and Toxorhynchites (Din and Khan, 2015; Brant *et al.* 2011). Mosquito species have varying habitat preferences (Mehmood *et al.* 2022). They breed in various habitats like freshwater, stagnant water, and sewage. They are spatially and temporally distributed based on species, climatic conditions, and environment (Khan *et al.* 2015). Aedes species are more prevalent in higher-latitude areas (Gadahi *et al.* 2012). Some species breed in various locations, including permanent lakes, pools, ponds, ditches, artificial receptacles, transient locations, and high ammonia concentrations. Their larvae and pupae develop in freshwater environments and are crucial components of the food chain (Attaullah *et al.* 2021).

In Pakistan, 134 species of mosquitoes were reported, including 23 Anopheles, 63 Culicines, three Culiseta, two Mansonia, and one each of Tripteroides, Uranotaenia, Coquilletidia, Ficalbia, and Armigere (Rasheed and Zaidi, 2023). The country is a hotspot for diseases spread by mosquitoes, yet little is known about the variety of mosquitoes in the country (Ashfaq *et al.* 2014). Malaria is a protozoan infection of red blood cells and ranks as the most significant parasitic disease affecting humans. Of the 172 known *Plasmodium* species, the vast majority are typically capable of infecting birds, reptiles, and nonhuman mammals (Tolle, 2009). The dengue virus may have been endemic in Pakistan, but no outbreaks were reported until 1994. Sero-epidemiological studies in the 1960s and 1980s found healthy populations in Rawalpindi, Peshawar, Punjab, and Karachi (Manzoor *et al.* 2020).

Various comprehensive studies on the diversity and habitat preference of mosquitoes across Pakistan have been conducted, reflecting the collaborative efforts of the scientific community in understanding the mosquito species in the country. For instance, Usman *et al.* (2017) recorded five mosquito species from Amin Khel District, Karak Khyber Pakhtunkhwa, Pakistan. Khan *et al.* (2015) explored nine species belonging to four genera: *Culex*, *Culiseta*, *Aedes*, and *Anopheles*, in which *Culex–quinquefasciatus* was the dominant species (84 numbers, 30.21%) and *Aedes shortii* was the minor species (9 numbers, 3.24%). Gul *et al.* (2022) reported six species in four genera from Mardan District, Khyber Pakhtunkhwa. *Culex pipiens* (89.80%) were the most abundant species. Saira *et al.* (2019) recorded eight species comprising three genera: *Aedes*, *Culex*, and *Anopheles*.

Keeping in view the importance of mosquitoes as medical pests. Therefore, the proposed research was conducted for the first time in different geographical localities of the district of Tank. The purpose of this research work was to conduct an evaluation of the Mosquito Fauna in the District of Tank, Khyber Pakhtunkhwa.

Materials and Methods

Study Area

The study was conducted in the rural and urban areas of District Tank (32.209537 N, 70.3837 E) (Fig 1). It is situated northwest of Dera Ismail Khan. The annual rainfall ranges between 250 and 300 mm. It has a total area of 1,679 km^2, where wheat and rice are frequently grown (Marwat *et al.* 2012). High temperatures are recorded in June and July (35-45 °C). December to February are the coldest months, when the average temperature ranges from 5 to 8 °C. The highest temperature occurred in June, when the average reached approximately 44 °C (Shehzad et al., 2023). The study area features open-running and standing water bodies and is rich in biodiversity, encompassing a diverse array of fauna and flora. Additionally, the study area has many sewages, ditches, and marshy areas, which are the finest places to find mosquito fauna.

Data collection

A total of 10 study sites with different habitats were sampled for species collection. Sampling was conducted for 2-3 hours, from 6:00 am to 9:00 am and 5:00 pm to 8:00 pm, regularly, four days a week. Samples were collected from seven habitats, including marshy areas, sewage, crops, agriculture, animal sheds, ponds, and barren land. Adult

mosquitoes were collected both indoors and outdoors. In the collection, an Inhalation mosquito lamp and sweep net (Figure 1) were used (Yovogan *et al.* 2023) at six different sites from November 2024 to May 2025, confirming a comprehensive and representative sample.

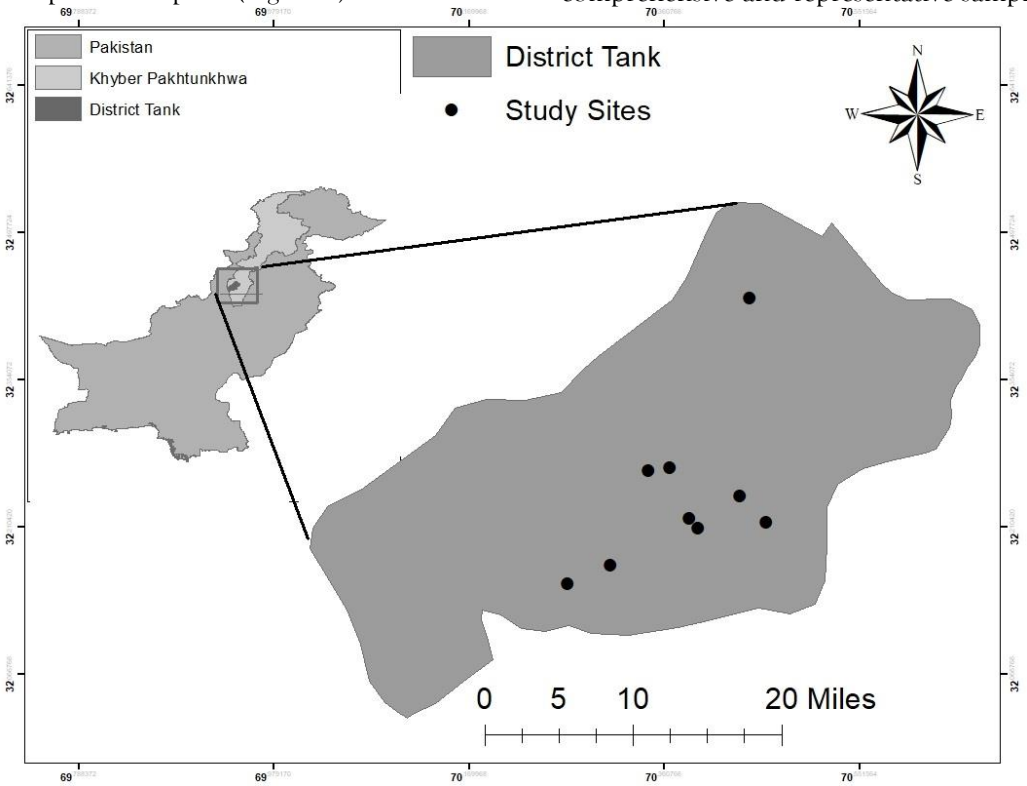

Figure 1: Map of the study Area

The specimens were preserved in 95% ethanol solution and viewed under a stereo zoom microscope to identify a wet-preserved mosquito. Physical characteristics like antennae, palps, and proboscis were examined, along with scale patterns on the thorax, wings, legs, and abdomen. The mosquito species was correctly identified. Images of the specimens were subsequently compared with specific taxonomic keys to facilitate their identification and classification (Clark-Gil and Darsie, 1983; Blanford, 1898; Rueda, 2004). Identification work was carried out at the Laboratory of the Kohat University of Science and Technology (KUST). The GPS (Offline maps, travel guides, and navigation) was used to determine the geographical coordinates of specimens.

Results and Discussion

Thirteen mosquito species from three genera and two subfamilies were identified, with higher populations in residential areas, sewage systems, and animal shelters. Table 1 shows that 264 samples belong to *Anopheles, Culex,* and *Aedes*. In which 143 males (57.37%) and 121 females (42.63%) were collected from seven habitats: marshy areas, sewage, crops, agriculture, animal sheds, ponds, and barren land of the District Tank. Out of 264 samples recorded, 163 (61.74%) of *Anopheles spp.* were collected from all habitats of the district tank except barren land. High abundance was found in cropland and sewage, while low abundance was found in a marshy area. A total of 94 (35.61%) *Culex spp.* were collected from all habitats of the study area. High abundances were found in cropland, while low abundance was found in ponds. Furthermore, 7 (2.65%) of *Aedes spp. Aedes spp*. were collected from only two habitats, including cropland and barren land within the study area.

Table 1: Diversity of mosquito species recorded from different habitat types in the district of Tank.

Species	Cropland	Barren Land	Sewage	Horticulture	Pond	Animal Shed	Marshy area
Anopheles sergenti	+	-	+	+	-	-	+
Anopheles pulcherrimus	+	-	+	+	+	+	+
Anopheles superpictus	-	-	-	+	-	-	-
Anopheles stephensi	+	-	+	+	+	-	+
Anopheles claviger	-	-	-	-	+	-	+
Anopheles plumbeus	-	+	-	+	-	-	+
Anopheles multicolor	+	-	+	+	+	-	+
Culex pipiens	-	-	+	-	-	+	+
Culex theileri	-	-	+	-	+	-	+
Culex mimeticus	+	-	-	+	+	-	-
Culex quinquefasciatus	+	-	+	-	+	+	+
Aedes albopictus	+	-	-	-	-	-	-
Aedes aegypti	+	+	-	+	-	-	-

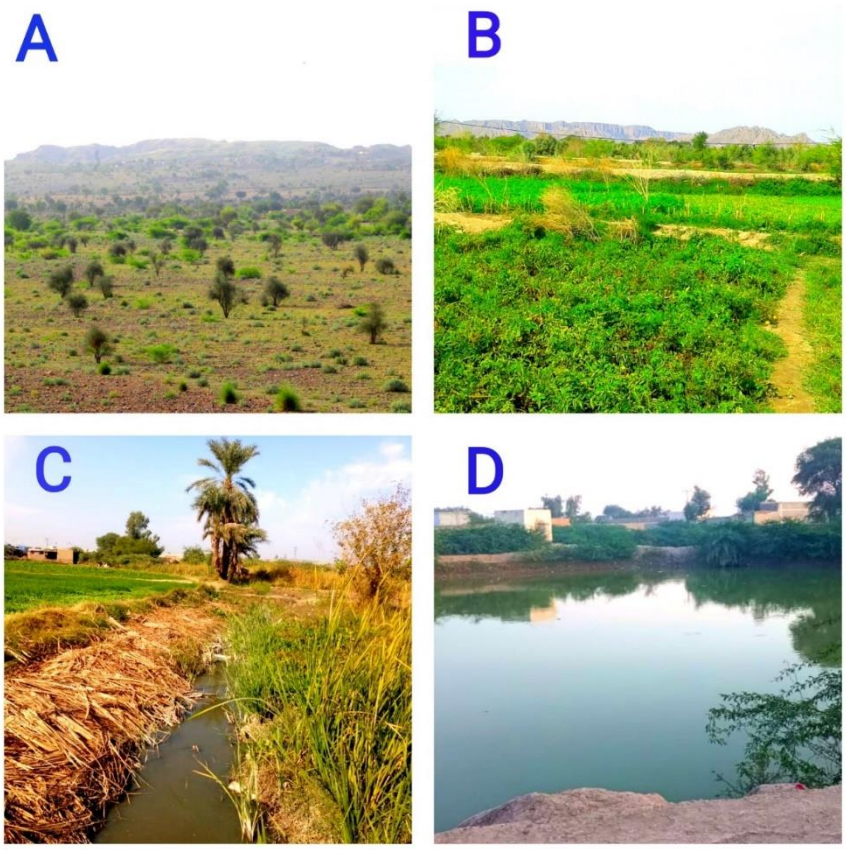

Figure 2: Representative habitats sampled in District Tank: A) Barren land, B) Cropland, C) Sewage channel, D) Pond.

Culex quinquefasciatus was collected and observed from the cropland, sewages, marshes, ponds, and animal sheds. It is abundantly present in the study area, including Lahore and District Dir Upper. (Sarwar *et al.* 2018, Khan *et al.* 2015). Asha and

Aneesh, (2014) reported this species from stagnant drains in India.

Aedes aegypti was collected from the cropland and horticulture, *Anopheles stephensi* was present in all habitats in the study area. It is mainly found in fresh environments where no sewage water is present. Previously, *Aedes aegypti* was dominant in the urban regions and threatened the outbreak of dengue fever in the metropolitan areas. While *Anopheles stephensi* was identified from urban and rural areas of the study area, breeding in diverse habitats including plastic containers, water tanks, and polythene sheets shows its adaptation to proliferate in these areas (Radhakrishnan, 2019), also documented from Punjab, Pakistan (Khan *et al.* 2018)

Additionally, our data support the assertion that *Aedes aegypti* can sustain flight within a temperature range of 15 °C to 32 °C, with limited activity at the temperature extremes of 10 °C and 35 °C (Scolari *et al.* 2019). The ability of *Aedes* species to thrive and maintain higher population densities during the rainy season has significant implications for disease transmission, particularly of dengue and chikungunya, which are transmitted by these species.

Our findings partially agree with those of Liu et al. (2016), suggesting that *Aedes* species adapt to climatic variations and exploit environmental changes to their advantage, thereby increasing disease risk during wet seasons. *Aedes albopictus* was collected from cropland in the study area. Previously, it was most abundant in parks. At the same time, the lowest was recorded in the pre-scrapyard (Mehmood *et al.* 2022), also documented in eastern Punjab, Pakistan (Mohsin *et al.* 2016). The diversity of the mosquito fauna in South Asia is well-documented, with 134 species reported from Pakistan (Rasheed and Zaidi, 2023). This high diversity is attributed to various ecological factors, including diverse habitats and climatic conditions that are beneficial for mosquito breeding. Our findings align with the established understanding that mosquitoes' environmental and biological characteristics are essential for effective disease management and outbreak detection (Ali *et al.* 2015).

Anopheles pulcherrimus was collected from all habitats in the study area. But it was present in the highest abundance in sewage and marshy areas. Previously, it was observed from Peshawar, KP, Pakistan (Lubna *et al.* 2023), that the predominance of *Culex* and *Anopheles* species in agricultural and aquatic habitats corresponds with the observations made by. They highlighted these genera's ecological role in local environments. The abundance of these mosquitoes in croplands and water bodies highlights their adaptability and suggests that agricultural practices may have a significant impact on their populations.

Anopheles multicolor is constantly distributed throughout the study area. This aligns with the previous report by Malakand and Dir Lower, Pakistan (Attaullah et al., 2021). Based on the present research, it can be concluded that this area of the District has a diverse range of mosquito fauna. Proper control steps should be taken to stop the further growth of the mosquito population; otherwise, it may lead to the spread of diseases like Malaria. A study was conducted to determine the mosquito biodiversity of Masti Khel District, Karak, Khyber Pakhtunkhwa, Pakistan. During the survey, eight species of mosquitoes were recorded (Usman *et al.* 2017). Another study was conducted in District Jhelum (Punjab, Pakistan) to determine mosquitoes' distribution, abundance, and diversity. 21 mosquito species belonging to *Culex* (9), *Anopheles* (6), *Lutzia* (2), *Aedes* (2), and *Armigeres* (2), comprising 365 specimens in different habitats. *Anopheles maculatus* was collected from two habitats, including animal sheds and streams. High abundance was found in animal sheds, while low abundance was found in streams (Mehmood *et al.* 2022)

Cropland had the largest abundance of *Anopheles*, *Aedes*, and *Culex*. It was previously noted in Pakistan's District of Sialkot (Suneela *et al.* 2023). In Punjab and Khyber Pakhtunkhwa, 21 mosquito species were the subject of another study. These included seven species of *Anopheles* (*An. subpictus*, *An. peditaeniatus*, *An. stephensi*, *An. splendidus*, *An. pulcherrimus*, *An. annularis*, and *An. culicifacies*), six species of *Culex* (*Cx. quinquefasciatus*, *Cx. theileri*, *Cx. tritaeniorhynchus*, *Cx. bitaeniorhynchus*, *Cx. mimeticus*, and *Culex (Stegomyia)*, and four species

of *Aedes* (*Stegomyia*) (*Aedes aegypti*, *Aedes* (*Stegomyia*), and seven species of *Culex* (*Ashfaq et al. 2014*).

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Author Contribution
Najeeb Ullah conducted the field survey, preserved, identified, and prepared the research article. Dr. Anwar Iqbal Khan and Muhammad Shehzad supervised the research work and provided all the facilities. Muhammad Shehzad drafted and finalized the manuscript. Muhammad Rizwan and Abdul Majid provide technical support.

Conflict of interest
The authors have declared no conflict of interest.

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