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DISTRIBUTION AND ABUNDANCE OF *AEDES AEGYPTI* AND *AEDES ALBOPICTUS* MOSQUITEIS IN TEHSIL KABAL, SWAT

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Abstract

The background Aedes mosquitoes are the main vectors of arboviral diseases like dengue, chikungunya and yellow fever that are the major cause of ill health among the population. The purpose of this paper was to determine the composition, distribution, abundance, and ecological diversity of Aedes aegypti and Aedes albopictus in Tehsil Kabal, District Swat, Pakistan, to be used in evidence-based control of the vectors. The survey was an entomological survey and carried out in 14 villages: Ningolai, Kabal, Bara Bandai, Kuza Bandai, Kanju, Hazara, Bar Abakhail, Kuz Abakhail, Kala Kalay, Deowlai, Shah Dahari, Dardiyal, Qalagay and Totano Bandai in 3 to 8 in 2024. The breeding sites of the mosquitoes were collected by use of standard dippers of capacity 350 ml and the mechanical aspirators to capture the larvae, pupa and adults of the mosquitoes. The specimens were determined to their standard taxonomic keys. Analysis of the data was done based on relative abundance, frequency of distribution, Margalef richness index (Dmg), Shannon-Weiner diversity index (H) and Simpson dominance index (D).7311 Aedes mosquitos were obtained comprising of 5398 Ae. aegypti (73.85) and 1913 Ae. albopictus (26.15). The most common in all the sites was Aedes aegypti which had a relative abundance of 73.85 (Dominant species) and frequency of distribution of 100 percent (Constant species). The highest number of Ae. aegypti was recorded in Dardiyal (n=800; RA within site = 88.89) and Kanju (n=700; RA within site = 87.50) and these were suspected to be disease transmission hot spots. Aedes albopictus (n=150; RA within site=25.00) was the highest with Bara Bandai (n=150). The total Margalef index of richness was low (Dmg = 0.11) and it means that, there were two target species. The low diversity of the species was confirmed using the Shannon-Weiner index of diversity (H' = 0.58) and the dominance index of Simpson (D = 0.60) was used to demonstrate that two randomly chosen mosquitoes had the greatest chance of being of the same species (60 percent possibilities) and this *indicated that Ae. aegypti was largely dominant ecologically. The Ae. aegypti (H 0.40, D 0.78) has been found to be the dominant in Hazara, Kuz Abakhail, Deowlai, Dardiyal and Kanju. Aedes aegypti is a very efficient agent in the outbreak of dengue and it is therefore likely that the massive disease outbreak will be witnessed in the Tehsil especially in the hot spots' villages of Dardiyal and Kanju. Another causative factor to the threat of human health is also the fact that all the sites have Ae. albopictus. These results indicate the necessity to resort to location-specific, specific and evidence-based interventions as far as the problem of vectors control is involved. The further monitoring of entomology, community involvement in the eradication of the sources and species-specific control strategies are pertinent, so as to reduce the likelihood of dengue epidemic phenomenon occurring in the area in the future.*

INTRODUCTION

Culicidae (Diptera) belongs to the insects' family of mosquitoes, and consists of two large subfamilies: the anophelinae and culicinae, consisting of approximately 3,500 species (1). Culicinae subfamily is the most abundant with about 3,060 species in 109 genera (2), and anophelinae three genera and 481 species (3). Among them, the representatives of the genus Aedes, in particular, the subgenus Stegomyia, have the greatest medical importance in the role of primary vectors of the dengue, chikungunya, yellow fever, and Zika virus species (4-6). The Aedes aegypti is considered one of the most significant disease vectors in the world due to its great adaptability to the city environment and its competency in the transmission of pathogens (7, 8). The Aedes mosquitoes can easily be distinguished according to their typical black and white body and leg pattern. They are the most active in the morning and evening and are day biters (9). They have a holometabolous life cycle and it can be subdivided into egg, larva, pupa, and adult. This is a process that is highly sensitive to the environmental factors including temperature and humidity therefore the time that is involved during this cycle (10). The females are usually anautogenous and require the blood to be fed on to produce their eggs as well as they are also capable of laying up to 100- 200 eggs once during gonotrophic cycle. They are laid on wet surfaces above the waterline in both natural (e.g., tree holes) and artificial (e.g. tires, flower pots) containers so that they can survive several months of drought (11). The wrigglers, as they are commonly referred to, are a water-dwelling organism, which breathes through the surface of the water using siphon (12).

The past several decades have witnessed a gigantic increase in the number of the diseases being transmitted by Ae. aegypti everywhere in the world. The disease dengue that was only endemic in nine countries in 1969 has been spread to over 100 countries exposing nearly half the world population to the risk (13). Dengue is a disease, which has the greatest impact in Asia (less than 70 percent) compared to other parts of the world (14). Dengue is a systemic disease, which has been recurrent in Pakistan and the outbreaks of the disease are normally highest in the months of September and October during the post-monsoon seasons (15, 16). The primary way of preventing the disease is direct control of vectors as it is hard to diagnose it in its early stage and has no specific antiviral alternatives (17, 18). This is achieved by destroying the mosquitoes through the management of the environment besides other chemical or biological control measures. International trade and traveling assists in the distribution of the mosquitoes to other geographical locations (19). The prevalence rate of dengue in the world is thus described to have multiplied by three times over the last fifty years (20). Defense against being bitten by mosquitoes, which is mostly done by using repellents, is a very significant defense measure incorporated. Even though synthetic repellents are highly efficient (e.g. DEET: N, N-diethyl-meta-toluamide), the need to eliminate side effects and environmental toxicity has precipitated the use of natural and plant-based repellents (e.g. oil of lemon eucalyptus (PMD) and other essential oils) (21-25). Since dengue is increasingly becoming a menace in Pakistan, the dissemination and density of dengue vectors within the area should be familiar in order to come up with efficient and specific control efforts. The study was therefore conducted to determine the species composition, relative abundance and distribution patterns of Aedes aegypti and Aedes albopictus in Tehsil Kabal, Swat, to provide the required information to plan the public health and in controlling the Aedes mosquitoes.

METHODS

Study Area

This study was conducted in Tehsil Kabal, District Swat, Khyber Pakhtunkhwa, Pakistan. Tehsil Kabal is located at 34°47′N 72°17′E at an altitude of 845 meters (2,772 ft), approximately 10 kilometers south of the district headquarters, Mingora. The survey was carried out in Ningolai, Kabal, Bara Bandai, Kuza Bandai, Kanju, Hazara, Bar Abakhail, Kuz Abakhail, Kala Kalay, Deowlai, Shah Dahari, Dardiyal, Qalagay, and Totano Bandai.

Mosquito Collection

Systematic mosquito collections were conducted from March to August 2024. Each village was sampled four times per month. Immature stages were collected from a variety of potential breeding sites using standard 350 ml dippers and pipettes. Habitats surveyed included discarded containers (tires, buckets, tins), flowerpots and vases, construction sites, rainwater pools, tree holes, and leaf axils. Adult mosquitoes were collected both indoors and outdoors using mouth aspirators and mechanical sweep nets. Collections were focused on resting sites such as dark corners of rooms, under furniture, vegetation, and other shaded areas. All collected specimens (larvae, pupae, and adults) were carefully transferred to labeled, net-covered plastic jars and transported to the laboratory for processing. In the laboratory, adult mosquitoes were immobilized using chloroform-soaked cotton wool in an airtight jar. They were then removed, counted, and preserved in labeled glass vials containing silica gel desiccant. Larval and pupal samples were preserved in 70% ethanol. All specimens were identified to species level using a dissecting microscope and standard taxonomic keys, specifically "The Fauna of British India, including Ceylon and Burma. Diptera. Family Culicidae" (26, 27).

Data Analysis

Relative Abundance:

The relative abundance of each species was calculated using the formula: (Number of individuals of a species / Total number of individuals) × 100 (28). Species were categorized based on their abundance: Dominant (>10%), Subdominant (3-10%), and Satellite (<3%) (29).

Species Distribution:

The distribution frequency (C) of a species across the study sites was calculated as: (Number of sites where species present / Total number of sites) × 100 (29). Species were classified as: Constant (80–100%), Frequent (60–80%), Moderate (40–60%), or Infrequent (20–40%).

Species Richness:

Margalef's richness index (Dmg) was used to estimate species richness: $Dmg = (S - 1) / \ln N$, where S = total number of species and N = total number of individuals (30).

Species Diversity:

Shannon-Weiner Diversity Index (H'):

This index was used to measure species diversity, accounting for both richness and evenness. It was calculated as: $H' = -\Sigma\, p_i \ln p_i$, where p_i = the proportion of individuals belonging to the i-th species (n_i/N) (30).

Simpson's Diversity Index (D):

This index measures the probability that two individuals randomly selected from a sample will belong to the same species, thus reflecting species dominance and rarity. It was calculated as: $D = \Sigma\, n(n-1) / N(N-1)$, where n = number of individuals of a species and N = total number of individuals. The value of D ranges from 0 to 1, with higher values indicating lower diversity (higher dominance by one species) (31).

RESULTS

Total of 7,311 *Aedes* mosquitoes were collected from the fourteen villages in Tehsil Kabal between

March and August 2024. Of these, 5,398 (73.85%) were identified as *Aedes aegypti* and 1,913 (26.15%) as *Aedes albopictus*. The distribution and counts of both species across the study area are presented in Table 1 and Table 2. *Aedes aegypti* was the dominant species, found in all surveyed villages. The highest populations of *Ae. aegypti* were recorded in Dardiyal (n=800) and Kanju (n=700), marking these as areas with the highest vector density. *Aedes albopictus* was also widespread but in lower numbers, with its highest concentration observed in Bara Bandai (n=150). A more balanced population of the two species was noted in Shah Dahari and Bar Abakhail.

Table 1: ***Site-Specific Abundance and Relative Abundance of Aedes Species in Tehsil Kabal (March-August 2024)***

Area	*Ae. aegypti* (n)	*Ae. albopictus* (n)	N_site)	*Ae. aegypti* RA (%) within site	*Ae. albopictus* RA (%) within site	Site-Specific Shannon (H')	Site-Specific Simpson (D)
Ningolai	368	100	468	78.63	21.37	0.52	0.66
Kabal	300	50	350	85.71	14.29	0.41	0.76
Bara Bandai	450	150	600	75.00	25.00	0.56	0.63
Kuza Bandai	400	100	500	80.00	20.00	0.50	0.68
Kanju	700	100	800	87.50	12.50	0.38	0.78
Hazara	450	50	500	90.00	10.00	0.33	0.82
Bar Abakhail	350	50	400	87.50	12.50	0.38	0.78
Kuz Abakhail	500	50	550	90.91	9.09	0.31	0.84
Kala Kalay	550	100	650	84.62	15.38	0.44	0.74
Deowlai	500	50	550	90.91	9.09	0.31	0.84
Shah Dahari	120	33	153	78.43	21.57	0.52	0.66
Dardiyal	800	100	900	88.89	11.11	0.35	0.80
Qalagay	180	30	210	85.71	14.29	0.41	0.76
Totano Bandai	300	50	350	85.71	14.29	0.41	0.76
Total	5,398	1,913	7,311				

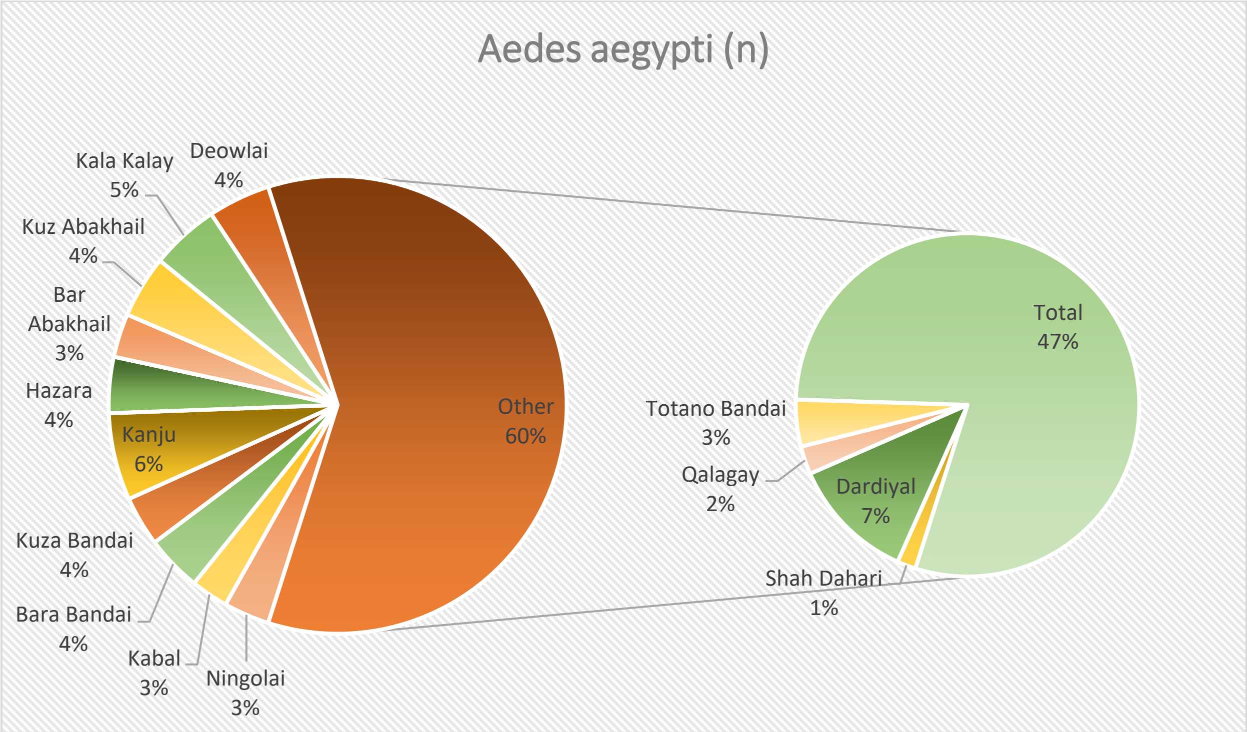

Figure Percentage distribution of *Aedes aegypti* field populations collected from different localities

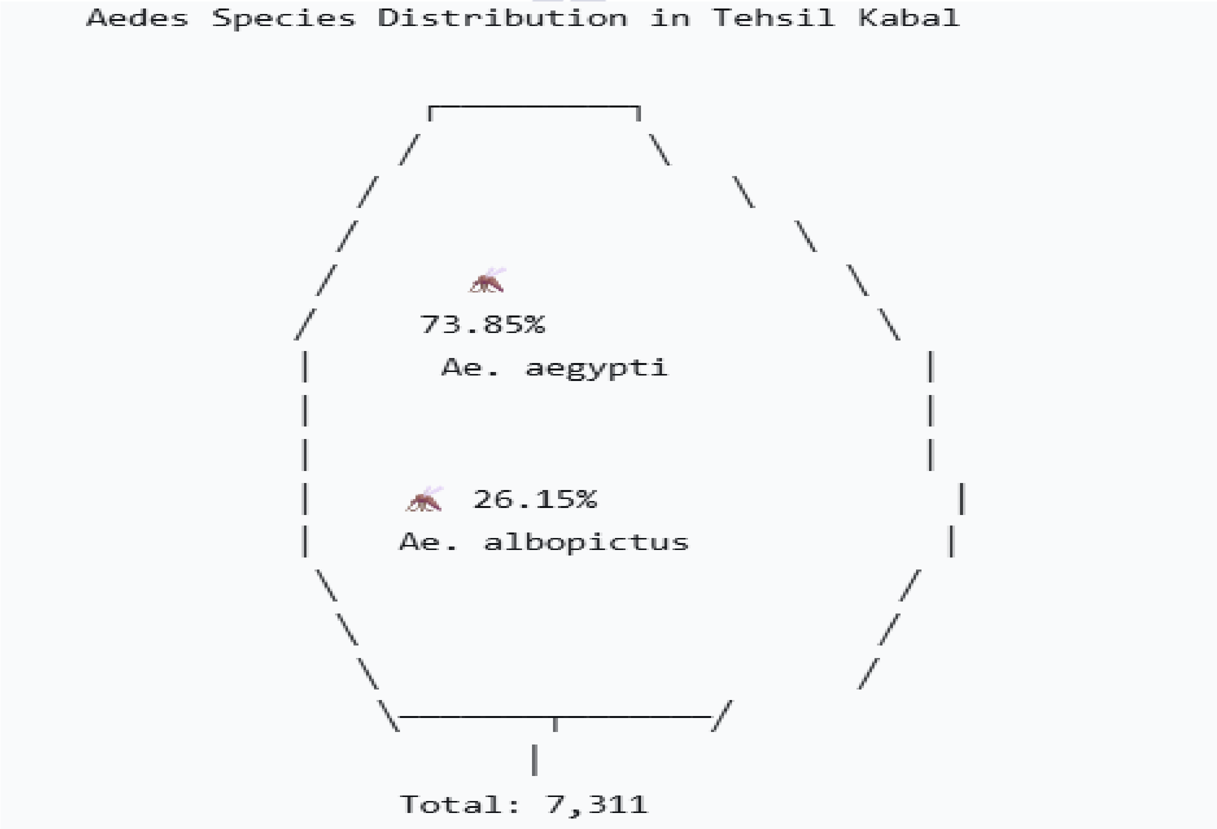

Figure Species composition of* Aedes *mosquitoes in Tehsil Kabal, showing the relative abundance of* Ae. aegypti *and* Ae. albopictus *(n = 7,311).

Table 2: *Overall Population Statistics and Ecological Indices for Tehsil Kabal*

Metric	*Aedes aegypti*	*Aedes albopictus*	Combined/Index Value
Total Number (n)	5,398	1,913	7,311 (N)
Overall Relative Abundance (%)	73.85	26.15	100%
Species Classification (by RA)	Dominant	Dominant	-
Distribution (Sites Present)	14	14	14 (Total Sites)
Distribution Frequency (C %)	100%	100%	-
Species Classification (by C)	Constant	Constant	-
Species Richness (Margalef Index - Dmg)	-	-	0.11
Species Diversity (Shannon Index - H')	-	-	0.58
Species Dominance (Simpson Index - D)	-	-	0.60

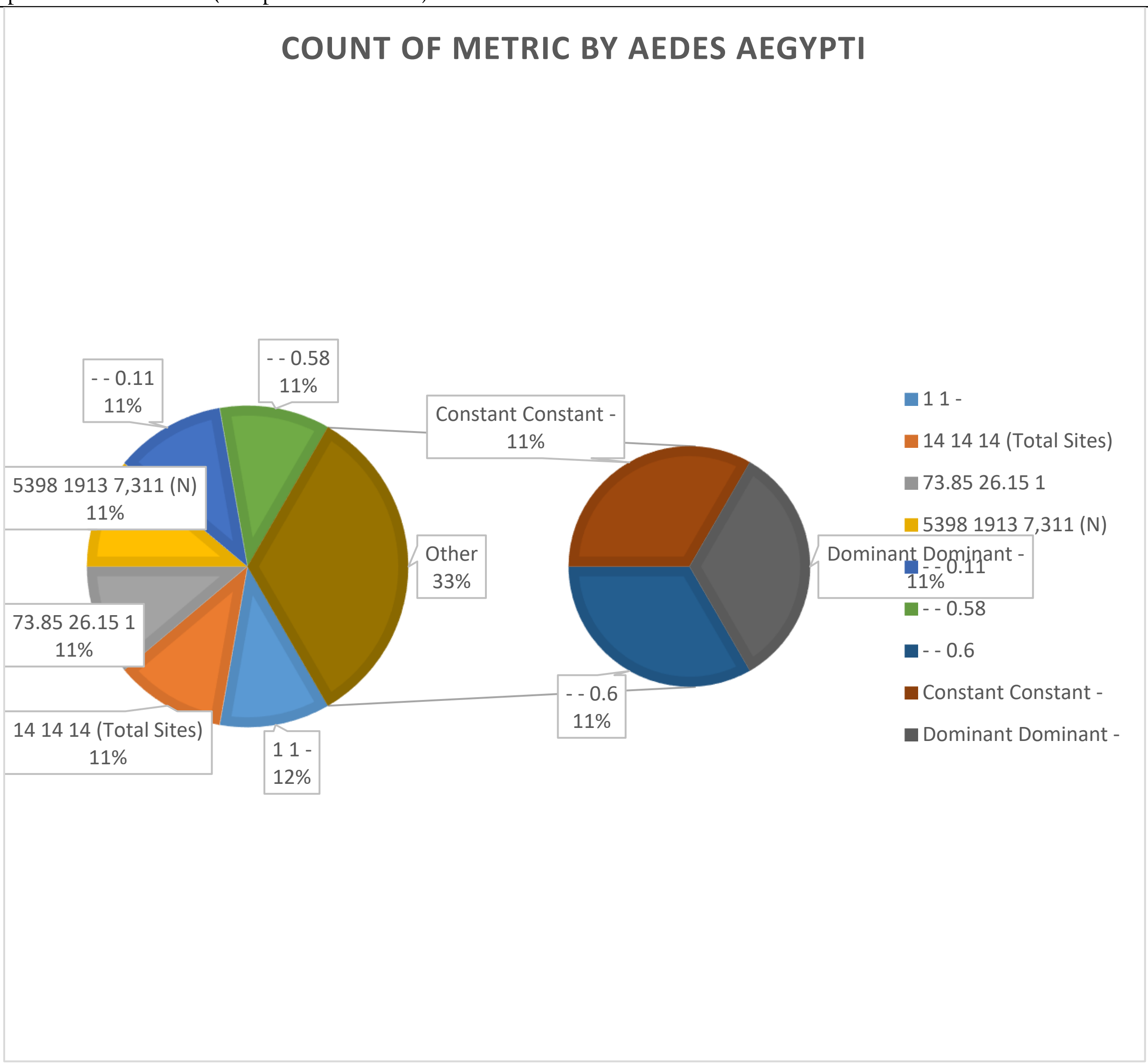

Figure Collection sites and proportional distribution of* Aedes aegypti *field populations in Islamabad Capital Territory, Pakistan (n = 47% of total collections).

Ecological Indices

Relative Abundance: Overall, *Ae. aegypti* (73.85%) was classified as the **Dominant** species, while *Ae. albopictus* (26.15%) was also a **Dominant** species but with a significantly lower share.

Distribution Frequency: *Ae. aegypti* was found in 14 out of 14 sites (100%), classifying it as a **Constant** species. *Ae. albopictus* was also found in all 14 sites (100%), making it a **Constant** species as well.

Species Richness (Margalef Index): The overall Margalef index for the study area was Dmg = (2-1) / ln (7311) = 1 / 8.90 = **0.11**. This low value indicates low species richness, as expected when only two target species are considered.

Shannon-Weiner Diversity Index (H'): The overall diversity index for the entire collection was calculated as H' = **0.58**. This relatively low value reflects the strong dominance of *Ae. aegypti* over *Ae. albopictus* in the community.

Simpson's Diversity Index (D): The overall Simpson index was calculated as D = **0.60**. This moderate-to-high value confirms the low diversity and high dominance of a single species (*Ae. aegypti*) in the sampled areas.

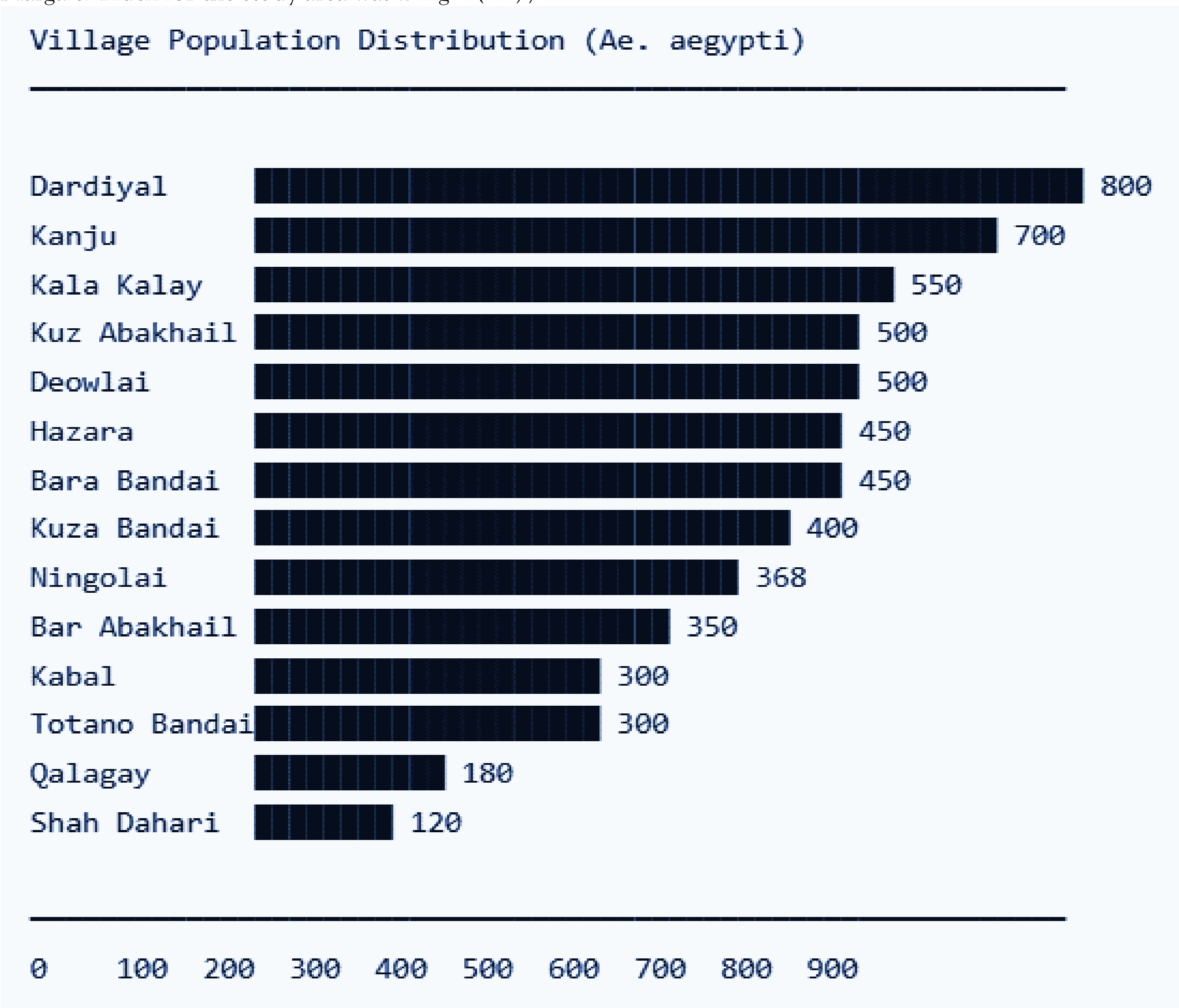

Figure Distribution of* Aedes aegypti *collection counts across villages in Tehsil Kabal, Pakistan.

Table 3: *Dominance and Diversity Patterns*

Pattern	Areas/Villages Identified
High *Ae. aegypti* Dominance (H' < 0.40, D > 0.78)	Hazara, Kuz Abakhail, Deowlai, Dardiyal, Kanju
Moderate *Ae. aegypti* Dominance (H' 0.40 - 0.56)	Bara Bandai, Ningolai, Shah Dahari, Kala Kalay, Kabal, Qalagay, Totano Bandai
Potential Hotspots (Highest Absolute Numbers)	Dardiyal (900), Kanju (800), Kala Kalay (650), Bara Bandai (600)

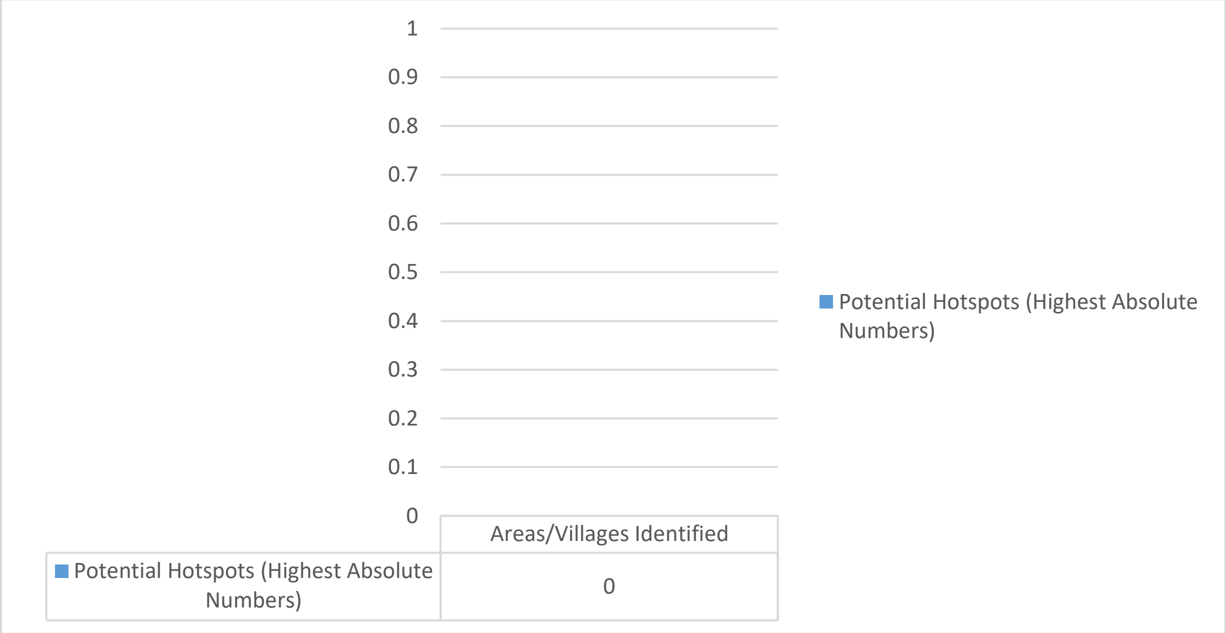

***Figure Distribution of* Aedes aegypti *collection counts across villages in Tehsil Kabal, Pakistan. Species composition pie chart (73.85%* Ae. aegypti*, 26.15%* Ae. albopictus*) – Species composition of* Aedes *mosquitoes in Tehsil Kabal, showing the relative abundance of* Ae. aegypti *and* Ae. albopictus *(n = 7,311)*.**

DISCUSSION

The article presents the primary baseline information about the prevalence and distribution of the dengue vectors in Swat Tehsil Kabal. The results have indeed made the Aedes aegypti the most common and prominent species of vectors, the propensity of which is acceptable considering the fact that it is a highly urbanized and anthropophilic mosquito (4, 7). The high number of cases in all 14 of the surveyed villages is an indication of an overall threat of the dengue virus spread in the tehsil. It means that it possesses an ecological superiority system as the relative abundance (73.85) and constant distribution (100) of Ae. aegypti are both equal in terms of low Shannon (0.58) and high Simpson (0.60) indexes of diversity. The data that Dardiyal and Kanju were identified as possible hotspots where Ae. aegypt population was found to be 800 and 700 respectively is a crucial information to the public health authorities. They are high probability sites that likely have high artificial containers with high and good environmental conditions that favor high population of mosquitoes and therefore should be given first priority to be received by interventions of immediate and intensive mosquito control. It also has the presence of Ae. albopictus but they are not very abundant. It may also be retained as a secondarily agent within the more pastoral and peridomestic setting and may even contribute to persistence of virus during inter-epidemic time as it was assigned the position of a secondary agent (5). Regions, where the Ae. albopictus population is comparatively higher such as Bara Bandai, might need slightly different control measure that includes peri-domestic habitat with some naturally occurring breeding location too. The findings show that a standardized approach to the control of vectors is not effective. This is due to the lopsidedness of vectors that require stratified and focused response. With heavy burdens such as in Dardiyal and Kanju, excessive depletion of source (removal of artificial containers), breeding sites of the larvae and the use of special indoor-residential spraying or space spraying (during an outbreak), should be done. Community mobilization, health education and frequent surveillance are the main dangers which must be considered in Low-density areas and populations cannot be left to reach their critical values. The results of the study are in line with the national trend on the increase in the risk of dengue in Pakistan (15, 16) and also to the necessity of active and evidence-based control of the vectors. It underscores the fact that Ae. aegypti is abundant in the environment and therefore, it can be concluded that human practice and poor sanitation (e.g. discarded tires, water storage habits) is one of the major factors that contributes to the breeding development of the mosquitoes. Consequently, sustainable control program should take into consideration the inclusion of a strong participation by the community, and environmental control in conjunction with the utilization of chemicals to control.

CONCLUSION

Most widespread and most prevalent species of the mosquito vectors in Tehsil Kabal, Swat and Aedes albopictus among other species are carried on a regular basis. These villages like Dardiyal and Kanju have large populations of vectors and this points to the fact that the potential of dengue epidemic is great and it has been increasing. These are the key aspects that the local health department can employ when formulating and adopting the specific measures to manage the vectors in the area. The entomological surveillance should also continue, there must be community involvement in the control of the sources to ensure that there is immediate response that will control the actions so that the threat can be kept at bay in the region.

Author Contributions

FK conceptualized the study, led the investigation and data collection efforts, and supervised field activities as the corresponding author; **MQK** contributed to methodology development, provided technical supervision, and assisted with manuscript review; **SM** &**ZU** conducted laboratory assays, performed species identification, and assisted with data collection; **SB** curated the data, performed formal statistical analysis, and calculated ecological indices; **SJ** prepared the original draft, created visualizations, and conducted literature review; and **AH** contributed to manuscript review and editing, validation of results, and resource management.

Conflict of Interest None

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