MOSQUITO LARVAL DISTRIBUTION AND ABUNDANCE AT THE OPEN UNIVERSITY OF SRI LANKA (OUSL), NAWALA: POTENTIAL THREATS TO VECTOR BORNE DISEASE TRANSMISSION

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Mosquitoes are vectors of human diseases like malaria, filariasis and dengue. Their ability to transmit diseases is heavily influenced by environmental factors and the intensity of their larval production. This study was done to assess the mosquito larval distribution and abundance in four distinct sites selected within the OUSL premises, Nawala, each with a diverse set of microhabitats. Sampling was triplicate between December 2022 and January 2023 from all potential larval breeding sites. Depending on the mosquito larvae's microhabitat, sampling was done using dipping and pipetting techniques. The collected larvae were then counted and identified using standard taxonomic keys (Amerasinghe, 1995). Data were analyzed using SPSS version 26, with species diversity calculated using Shannon (H') indices. The relationship between abundance and microhabitat features was examined using Principal Component Analysis (PCA). A total of 118 mosquito larvae were collected from all four sites. Four genera were recorded namely, *Aedes*, *Culex*, *Armigeres* and *Toxorhynchites* with the highest numbers recorded of *Aedes* and *Culex* sp. Shannon (H') index showed the highest diversity of mosquitos in site 2, followed by site 4, site 1 and site 3. Site 1 was dominated by *Aedes* sp while sites 2 and 4 were dominated by *Culex* sp. During the survey, *Aedes*-positive container indices were found to be 35.29%, 39.29% and 34.29%, respectively. PCA analysis revealed that there was *Aedes* dominance in sites 1 and 2, while *Culex* and *Armigeres* dominance was there in site 4. A lower abundance of larvae was recorded in site 3 possibly due to the presence of *Toxorhynchites*, carnivorous larvae. This study established a correlation between microhabitat characteristics and the presence of mosquito species within the OUSL premises in Nawala, suggesting an increased potential for transmitting different vector-borne diseases due to the greater availability of vector immature stages, emphasizing the necessity of prioritizing vector control measures, particularly source reduction to mitigate mosquito breeding. Further analysis focusing on *Toxorhynchites* larvae as a biological vector control would be productive.

Keywords: larval densities, larval ecology, larval habitat, mosquito-borne diseases, vector

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INTRODUCTION

Mosquitoes have a worldwide distribution occurring in tropical, sub-tropical and temperate regions and inhabit both aquatic and terrestrial habitats (Giselle *et al*., 2017). They are vectors of important human diseases including malaria, filariasis, yellow fever, dengue fever etc. The vectorial capacity of mosquitoes in disease transmission is largely influenced by the intensity of larval production from breeding habitats (Depinay *et al*., 2004). These preferred breeding sites of different mosquitoes and other environmental factors a major determinants of mosquito distribution and the prevalence of diseases they transmit (El-Badry & Al-Ali, 2010). This study was aimed to assess the diversity and abundance of mosquito larvae across various microhabitats within the Open University of Sri Lanka (OUSL) premises in Nawala, Colombo.

METHODOLOGY

This study was conducted at the Open University of Sri Lanka (OUSL) in Nawala, Colombo, spanning an area of 140,000m² with diverse microhabitats. The OUSL premises are bordered by the Kirulapone Canal to the north and east, with multiple small streams running through the area. OUSL premises contain a range of microhabitats, including natural open spaces with streams and ponds and urbanized areas with construction sites (Figure 1). These diverse environments create ideal breeding grounds for mosquitoes. Four distinct sites were selected within the OUSL, characterized by various water bodies and establishments. Samples were collected three times between December 2022 and February 2023 from all potential larval breeding sites (Table 1).

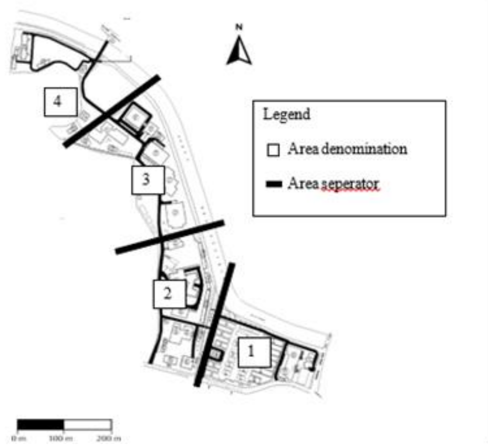

Figure 1 - Study Site
The OUSL premises at Nawala Colombo with the demarcated four sites

Depending on the mosquito larvae's microhabitat, two primary sampling techniques were used such like; Dipping: For larvae in moderately natural settings; and Pipetting: For larvae in smaller, hard-to-reach settings unsuitable for the first two methods. The collected water samples from these methods were placed in a white plastic container to search for mosquito larvae. Samples containing larvae were then transferred to water-filled vials with lids for transport to the laboratory for further identification. The collected mosquito larvae were counted and identified using compound microscope under mid power and with standard Taxonomic keys (Amerasinghe, 1995). Data were analyzed using the SPSS 26 statistical software package. Descriptive statistics were calculated for prevalence and number species available. Species diversity was calculated using Shannon (H') indices. Species abundance was calculated according to the sampling method used. Then the relationship between the abundance and the microhabitat features were analyzed using Principal Component Analysis (PCA).

Table 1 - Boundaries and characteristics of each site

Site	Boundaries				Characteristics of each site
	North	East	South	West	
1	Polluted water canal	Main Road	Main Road	University bridge across polluted water canal	University Laboratories, Student Registration Block, FHS current faculty, students' area, greenhouses, canteen, Demolished Nursing laboratory Facility, garbage disposal area with no proper management
2	Faculty of Health Sciences New building (FHS)	Polluted water canal	University bridge across polluted water canal	Main Road	Under construction buildings, Milk Bar, Examination Halls 1,2 and 3, Butterfly and Herbal Garden, Faculties of Natural Sciences, Engineering and Education, Press, stagnant water canal with polluted water
3	University Main Ground	Polluted water canal	Faculty of Health Sciences New building (FHS) (Under Construction)	Main Road	Library, Administration Block, main vehicle park, green vegetation, playground, canteen
4	University Hostel Premises	Main Road	University Main Ground	Branch of the Polluted water canal	Under construction facilities near the hostel, stagnant sanitary blocks, Examination Halls 4,5 and 6, mini ground

RESULTS AND DISCUSSION

Results

A total of 118 mosquito larvae were collected from all four sites (Figure 2). Four genera were recorded namely, *Aedes*, *Culex*, *Armigeres* and *Toxorhynchites* with the highest numbers recorded of *Aedes* and *Culex* sp.

Species diversity

Shannon (H') index showed the highest diversity of mosquitos in site 2 followed by site 4, site 1 and site 3 (Table 2). Site 1 was dominated by *Aedes* sp, while sites 2 and 4 are dominated by *Culex* sp (Figure 2). Site 3 had the least diversity recording only *Aedes* and *Toxorhynchites* sp. (Figure 2).

Table 2: Descriptive statistics and diversity indices calculated for each site

Site	Total genera recorded	Total number of larvae collected	H'
1	3	41	0.889583
2	3	41	1.021148
3	2	6	0.693147
4	3	30	0.983105

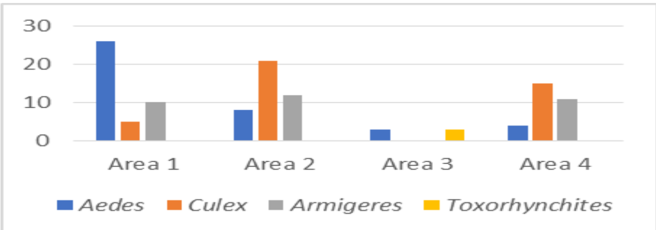

Figure 2: Abundance of each genus of mosquito larvae within each four microhabitats

Larval density

The proportion of *Aedes*-positive containers were measured over the course of three visits. The indices for the three visits were 35.29%, 39.29% and 34.29%. These indices show a high frequency of *Aedes*-positive containers that are present throughout every visit, indicating a high risk of *Aedes* mosquito infestation. For species, other than *Aedes*, per dip density was calculated as shown in Table 3. The immature stages of *Culex*, *Armigeres* and *Toxorhynchites* were found in stagnant waters such as small pits, stream pockets, gully pits, ponds, canals and drains.

PCA analysis

A cumulative percentage variation exceeding 80% was achieved from PC 1 and 2 alone. Hence, to establish the relationship between the species and the microhabitat, only PC 1 and PC 2 were used. According to the analysis, *Aedes* was prominent in site 1 and 2 while *Culex Armigeres* were dominant in site 4 (Figure 3).

Table 3: Density summary of other genera

Site	Average larvae/dip		
	Culex	***Armigeres***	***Toxorhynchites***
1	2	2	0
2	7	3	0
3	0	0	1
4	5	3	0

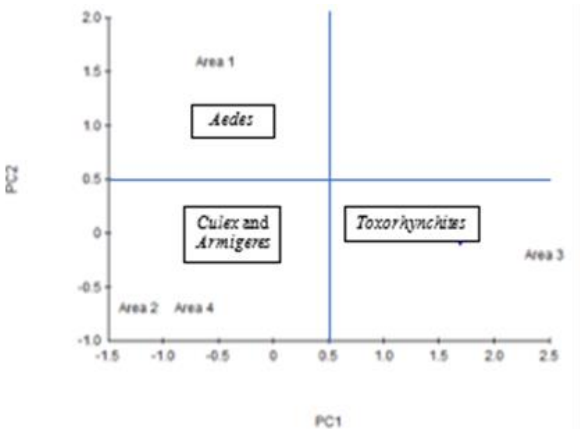

Figure 2: Eigen vector grid plotted with interpreted variables for each micro-habitat

Discussion

A larval survey conducted in four microhabitats on the OUSL premises revealed the presence of four major genera: *Aedes*, *Culex*, *Armigeres*, and *Toxorhynchites*. Among these, *Aedes* and *Culex* were found to be the most prevalent. In site 1, *Aedes* larvae were the most prevalent, with less prominent occurrences of *Culex* and *Armigeres*. Upon moving to neighboring site 2, the predominance shifted from *Aedes* to *Culex*. In site 3, there was a low number of genera and samples, with *Toxorhynchites* being the only recorded species. Lastly, in site 4, both *Culex* and *Armigeres* were predominant.

Sites 2 and 4 were found to have higher values Shannon diversity indices compared to sites 1 and 3. This suggests that there is more even distribution of species within 2 and 4 sites. Conversely, site 1 had a moderately lower value, indicating a slightly less equal distribution of species. Site 3, on the other hand, showed the lowest value for the Shannon diversity index, pointing to an unequal distribution of species within that site. The *Aedes* container index is an internationally accepted method for measuring vector density to understand local prevalence (NDC, 2016). The cumulative container index for *Aedes* across all three survey visits exceeded 30%, highlighting an alarming situation for an educational establishment, as prominent *Aedes* species are directly responsible for transmitting dengue in Sri Lanka (NDC, 2016).

Culex species, the primary vector for bancroftian filariasis in Sri Lanka (Chandrasiri *et al*., 2020), and *Armigeres* species, also capable of transmitting filariasis (Maquart *et al*., 2021), are present. In contrast, *Toxorhynchites*, which are not anthropophilic are not medically significant, could be useful for controlling other vector mosquitoes' larval stages, as they are established predators of mosquito larvae (Donald *et al*., 2020). The presence of *Toxorhynchites* in site 4 might explain the lower density of other genera there as they are carnivorous (Donald *et al*., 2020).

Principal Component Analysis revealed the highest absolute values for the *Culex, Armigeres* and

Toxorhynchites where for the first two genera the negative sector is prominent and for the latter the positive sector is prominent. The remaining *Aedes* could be explained by the PC2 as the absolute value is higher and leaning into positive sector. Hence, according to the Eigen vector grid, it can be determined that site 1 is *Aedes* prone site, 2 and 4 sites are predominantly *Culex* and *Armigeres* sites while site 3 is more likely to be preferred by *Toxorhynchites.* As site 1 contains areas with more student interactions and staff it poses a severe threat of dengue to the associated community.

CONCLUTION/RECOMMENDATIONS

This particular study is limited to three-time larval surveillance within a three months' time period which has still covered a vast area. This study determined the relationship between microhabitat characteristics and existing species within the OUSL premises at Nawala, Colombo which indicated a higher competency to transmit several vector-borne diseases due to the higher availability of vector immature stages. Hence, it is recommended to take priority on vector control actions, especially, the source reduction which the mosquito could breed. Continuous and increased monitoring should be done to maintain the vector free environment to prevent repetitions of outbreaks of vector borne diseases such as dengue. Since this study was conducted over only three months with samples analyzed in three trials, further analysis focusing on *Toxorhynchites* larvae as a biological vector control would be productive.

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