Water Temperature and pH Affecting Mosquito Larval Occurance at the Pasak Jolasid Dam, Saraburi Province, Thailand

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Abstract

This research investigates how water temperature and pH affect the number and diversity of mosquito larvae at the Supattra Resort and Pasak Jolasid Dam in Thailand. We collected all mosquito larvae and measured water temperature and pH using the GLOBE Program. The study advocates for alternative, environmentally friendly mosquito control measures and proposes community-based interventions for disease prevention. Collaborative efforts with STEM professionals and advanced data analysis techniques enhance the study's interdisciplinary nature.
Keywords: GLOBE Observer: MHM App, Water Temperature, Water pH, Mosquito, Thailand

1. Introduction

Mosquitoes are a significant public health concern, as they serve as vectors for numerous infectious diseases, including malaria, dengue fever, and lymphatic filariasis. Understanding the factors influencing mosquito larval occurrence is crucial for effective vector control strategies. Abiotic factors, such as water temperature, pH, and dissolved organic and inorganic matter, influence mosquito larvae development (Amarasinghe & Ranasinghe, 2019). Improving our understanding of these factors is critical for disease control, as they can directly impact the survival and proliferation of mosquito populations (Pfaehler et al., 2006). Previous studies have demonstrated that pH and salinity can significantly affect the abundance and distribution of mosquito larvae (Multini et al., 2021).

Dengue is a significant public health concern in Thailand (Thisyakorn et al., 2022). Over 70% of the population in Southeast Asia and the Western Pacific Regions are at risk of dengue infection, and Thailand is experiencing cyclical epidemics (Ouédraogo et al. (2022). Dengue cases in Thailand typically peak during the rainy season (Thisyakorn et al., 2022). Temperature, rainfall, and humidity influence the transmission cycle of the dengue virus (Thisyakorn et al., 2022). In Thailand, 2019 saw a relatively high number of dengue cases, with 116,647 patients and 129 deaths, and in 2020, there was a decrease in cases, with 67,538 dengue fever cases and 49 deaths reported.

Thailand contributes significantly to the global dengue burden (Gupta & Reddy, 2013). Thailand reports many dengue infections, second only to India (Avramov et al., 2024). In this study, we investigated (1) whether water temperature and pH affect the diversity of mosquito larvae and their abundance at Pasak Jolasid Dam, Saraburi Province, Central Thailand. To test this, we conducted our mosquito larval survey at Supattra Resort in all outdoor containers, measured water temperature and pH, and counted mosquito larvae. We identified up to species level: *Aedes* (*Ae. albopictus*, *Ae. aegypti*), *Culex* spp., *Armigeres* spp., and *Toxorhynchites* spp.

2. Materials and methods

2.1 Study site

In November 2024, a survey of mosquito larvae was conducted at Supattra Resort, near Pasak Jolasid Dam in Saraburi Province, the central region of Thailand (14.86242° N, 101.06671° E). Saraburi Province has three seasons: summer (mid-February to mid-May), rainy (mid-May to mid-October), and winter (mid-October to mid-February).

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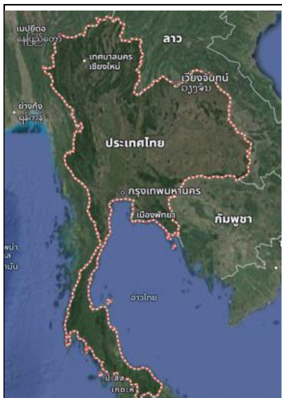
<td>
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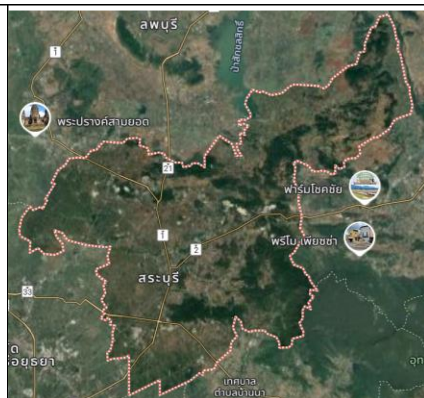
<td>
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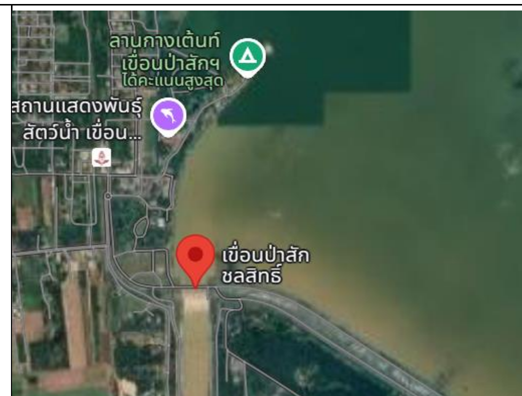
<td>
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<tr>
<td>Map of Thailand
(a)</td>
<td>Map of Saraburi
(b)</td>
<td>Map of Supattra Resort
(c)</td>
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Figure 1. Map of Thailand. (a) Map of Phetchaburi and (b) Map of study sites at Pa Sak Jolasit Dam. Saraburi Province

2.2 Sampling of mosquito larvae.

Figure 2. GLOBE Observer: MHM App

2.2.1 Surveyed 30 houses, then collected samples of larvae and larval predators for classification.

2.2.2 Inspect every container, both with and without water. Measure the water's pH and temperature in the container.

2.2.3 Measure the amount of water in the container and check whether it has a lid.

2.2.4 Scoop up and put living things, including mosquito larvae and predators, into plastic bags.

2.2.5 Use the MHM app to find the latitude and longitude coordinates of the area where mosquito larvae were found and save the information into the GO MHM app (Figure 2).

2.2.6 The captured organisms were returned to be classified as species and recorded.

2.3 Data collection

In this study, we conducted a mosquito larval survey at Supattra Resort and Pasak Jolasid Dam in all outdoor containers, measured water temperature and pH, and counted mosquito larvae.

We systematically documented and categorized all potential habitat types at each location, conducting thorough inspections for the presence or absence of mosquito larvae. We measured water pH, temperature, and conductivity using a handheld multi-parameter meter. We used the GLOBE observer: MHM app to find the latitude and longitude coordinates where mosquito larvae were found.

2.4 Entomological studies

A comprehensive survey of mosquito larvae was conducted in all water containers in Supattra Resort and near Pasak Jolasid Dam. For smaller containers, the contents were directly emptied through them, while larger containers were sampled using a net. The net was swirled in a motion, covering all edges, ensuring a thorough sampling from the top to the bottom (Indriyani et al. (2024). All viable mosquito larvae were collected in plastic bags, transported to the laboratory, and preserved. The species level was identified using Rattanarithikul and Panthusiri’s keys. Notably, the first and second instars and pupae were excluded from the study due to the challenges of identifying immature mosquitoes at these stages. The study involved a total of 50 container categories. Plastic water containers were further divided into two groups: large plastic containers designed for water storage (>100 L) and plastic bottles (i.e., 0.5–2.0 L water bottles). Earthen jars were also classified into two categories: small earthen jars with a volume of ≤100 L and large earthen jars exceeding 100 L in volume.

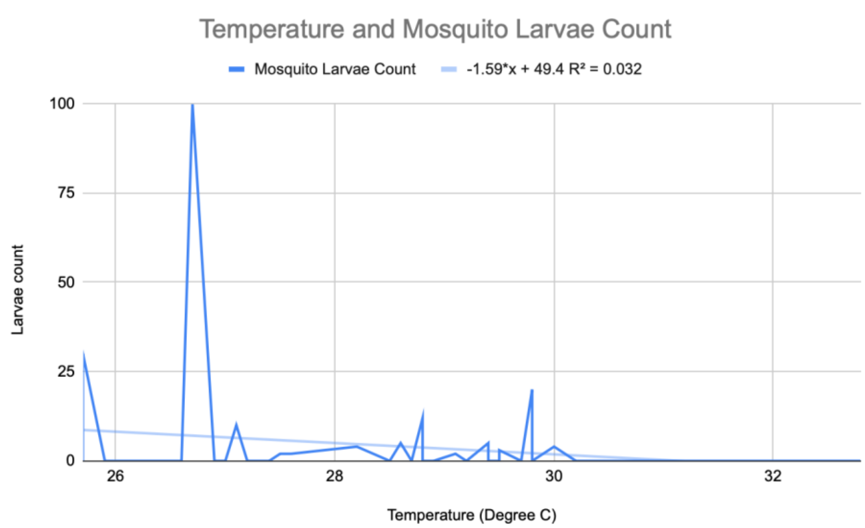
2.5 Statistical analysis

The Komogorov-Smirnov test assessed the Normality of all variables, and Levene's test examined the equality of variances. Descriptive statistics were employed to analyze the data. A linear regression test and Chi-square were utilized to investigate the quantities of the quantities of mosquito larvae in different water pH and temperature. A simple linear regression and Chi-square test were employed to assess the relationship between water parameters and the number of mosquitoes. All significant tests were conducted with a two-tailed approach.

3. Results

a)

Collected Data



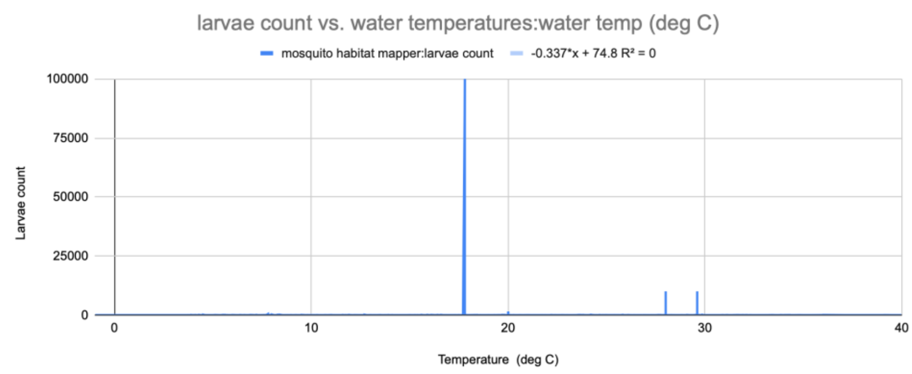
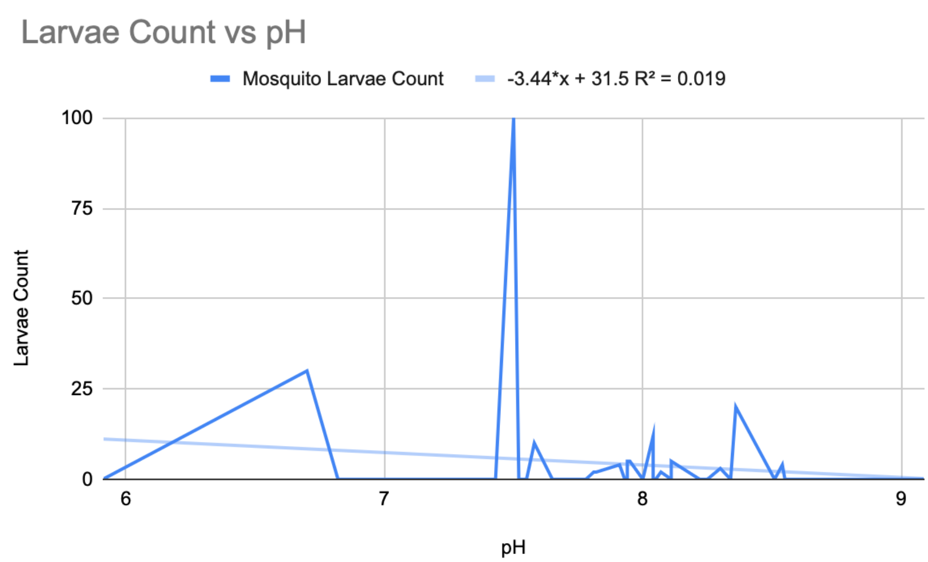
b) GLOBE data	

Figure 3(i). Water Temperature and mosquito larvae. (a) collected water temperature (°C)., and (b) GLOBE water temperature (°C).

a) Collected Data	

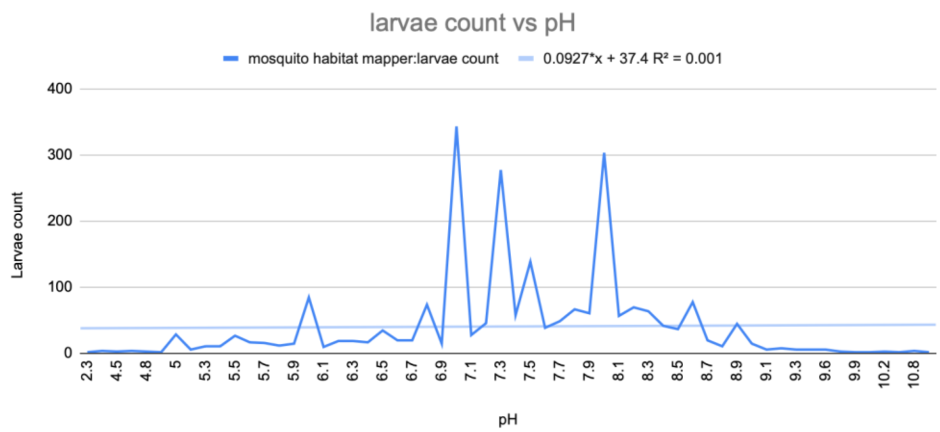
b) GLOBE data	

Figure 3(ii). Water parameters and mosquito larvae. (a) collected water pH, and (b) GLOBE water pH

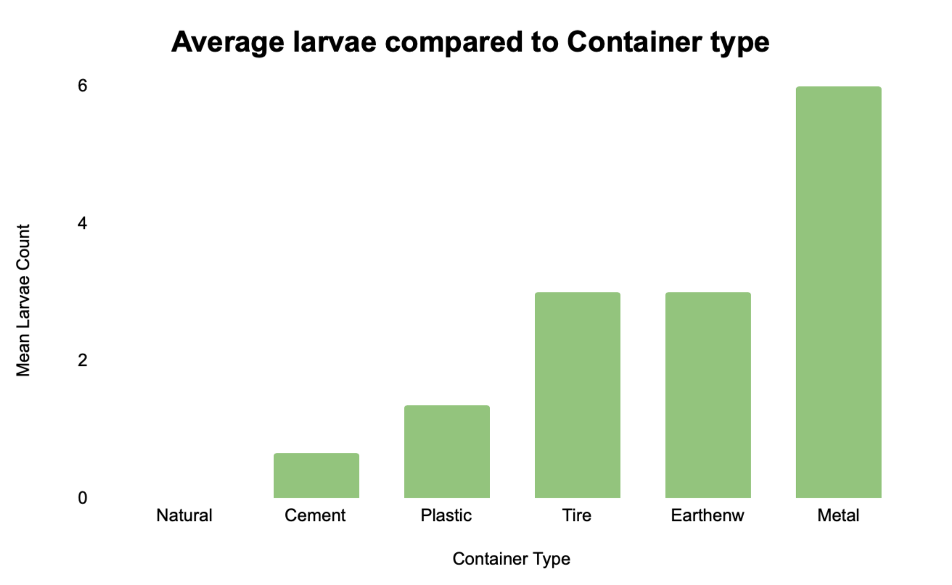
Water Temperature

Water temperature affects the growth and development of mosquito larvae. The optimal water temperature for developing *Aedes* sp mosquito larvae ranges from 25– 30°C (Suryaningtyas et al., 2017). There is a statistically significant relationship between water temperature in water reservoirs and the presence of mosquito larvae, as indicated by a p-value of 0.005. However, the R^2 value of 0.019 suggests that water temperature explains only 1.9% of the variation in the presence of mosquito larvae, indicating a weak relationship. This finding contrasts with research conducted by Ummul (2023) in Makassar City, in Pasak Jolasid Dam, and the Supattra Resort, which concluded that there is no relationship between water temperature and the presence of mosquito larvae, reporting a p-value of 0.619. The Global data shows the same pattern as the collected data, with a p-value of 0.052 (Figure 3(i).

Water pH

Water pH is essential for the survival and growth of *Aedes* mosquito larvae. *Aedes* mosquito larvae cannot survive or will die at pH levels ≤ 3 and ≥ 12 (Suryaningtyas, Margaretha, and Desy Asyati, 2017). The alkaline pH level inhibits the growth of adult mosquito larvae by affecting the cytochrome oxidase enzyme. The dissolved oxygen level is higher at low and lower at high pH. *Aedes sp.* larvae optimally live at pH 7 to 8 (Listiono, Rimbawati, and Apriani, 2021). Based on the chi-square statistical test results, there is no significant relationship between water pH and the presence of larvae, as indicated by a p-value of 0.691 ($p > 0.05$) (Figure 3(ii)).

a)
Collected Data



b)
GLOBE data

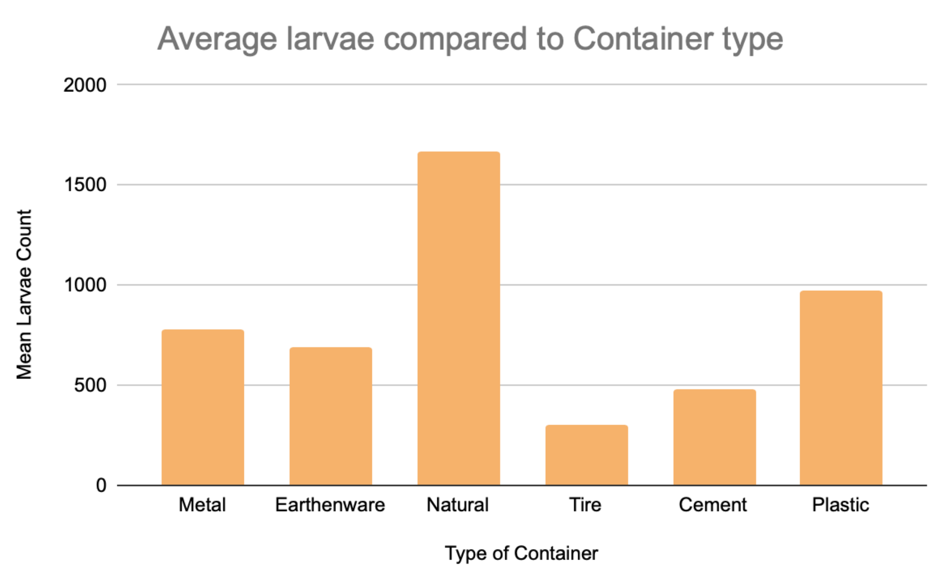
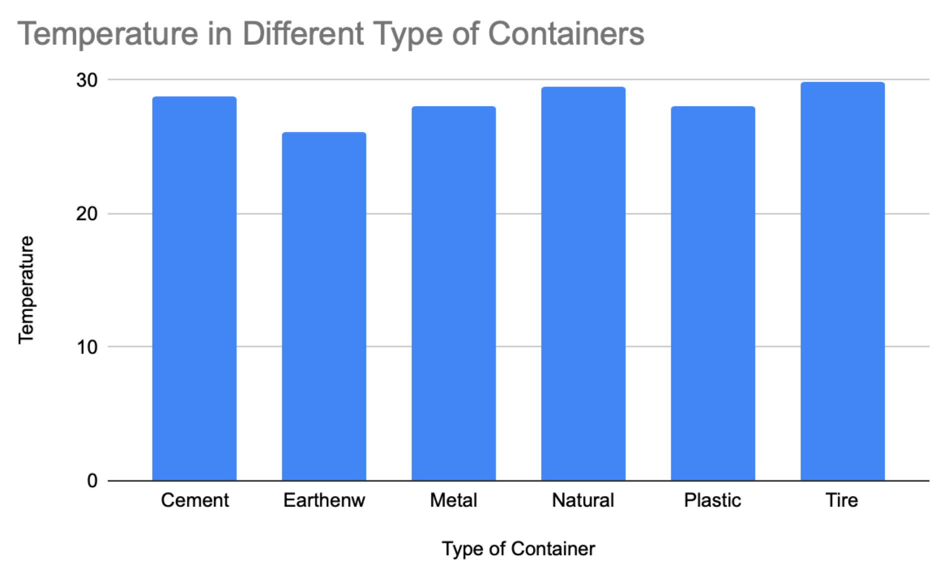
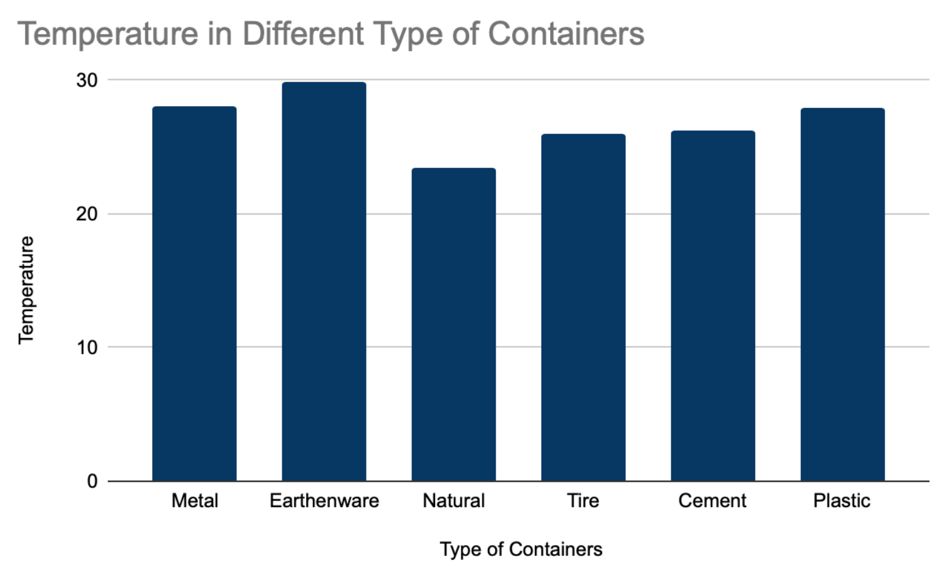


Figure 3(iii). Type of water containers and mosquito larvae. (a) collected water containers, and (b) GLOBE water containers

In the **collected data (Figure 3(iii) (a),** The results show that **Plastic** has the highest sample count with 26, followed by **Cement** (9), **Tire** (6), **Natural** (4), **Earthenware** (3), and **Metal** (2). This distribution indicates that **Plastic** is the most represented material, while **Metal** has the fewest samples, suggesting a more limited dataset for specific materials. The varying sample sizes may influence the reliability of the results, with larger sample groups like **Plastic** and **Cement** providing more consistent data. In comparison,e smaller groups like **Metal** and

Earthenware may be less robust for analysis. In **Globe data (b),** the results show that **cement** has the highest value at 780, followed by **earthenware** (437) and **metal** (340). **NNatural comes**next with 270, while **Plastic** (150) and **Tire** (90) have lower values. This indicates that **Cement** is the most prominent material, with **Tires** having the most miniature representation in the dataset. The distribution suggests a significant variation in the prominence of these materials,

a) Collected Data	
b) Globe data	

with **Cement** and **Earthenware** standing out, while **Tire** and **Plastic** are less represented.

Figure 4. Water Temperature over Different containers

In the collected data (Figure 4a,b), The results indicate that the mean values for the different materials vary, with **Tire** showing the highest mean of 29.85, followed closely by **Natural** at 29.525. These two materials perform significantly better than the others in terms of measured attributes. **Cement** (28.8111) and **Plastic** (28.0913) have relatively similar, above-average means, while **Metal**(28.0000) is slightly below the overall average of 28.4255. However, **Earthenware** has the lowest mean of 26.1333, suggesting it performs much worse than the other materials. The overall average mean across all materials is 28.4255, reflecting the general performance trend where most materials fall within a similar range, with **Tire** and **Natural** as the highest performers. In Globe data (b), The results show that **Earthenware** has the highest mean value of 29.85, indicating it performs the best among the materials tested. **Metal** follows with a mean of 28.0913, showing relatively high performance, though slightly lower than **Earthenware**. **Plastic** comes next with a mean of 27.9, indicating good performance. At the same time, **cement** (26.2) and **tire** (25.97) show moderate performance levels, with values lower than **those of metal** and **earthenware** but still within a similar range. The material with the lowest mean is **Natural**, with a value of 23.4, suggesting it performs the worst in this dataset. E**arthenware** and **metal** stand out as the highest performers, while **natural** material has the least favorable results.

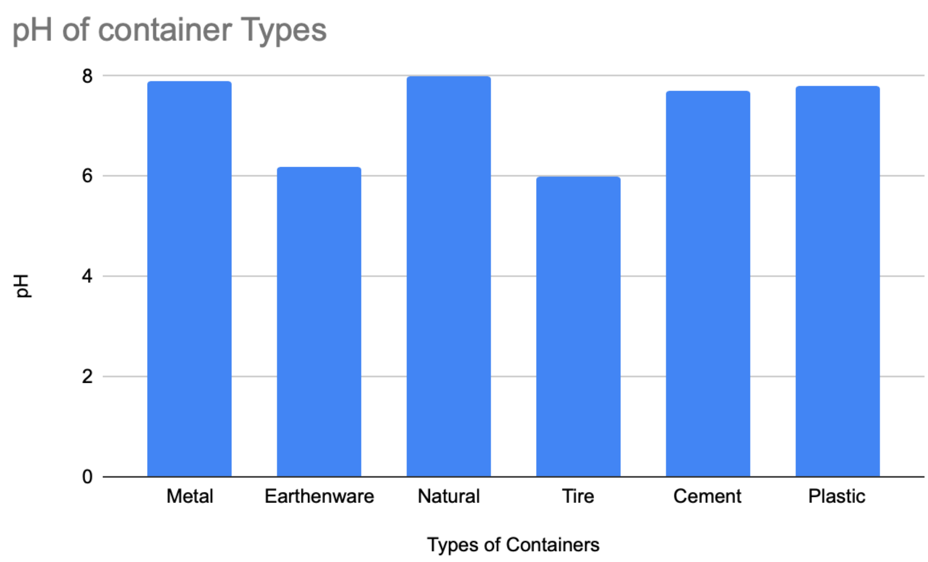
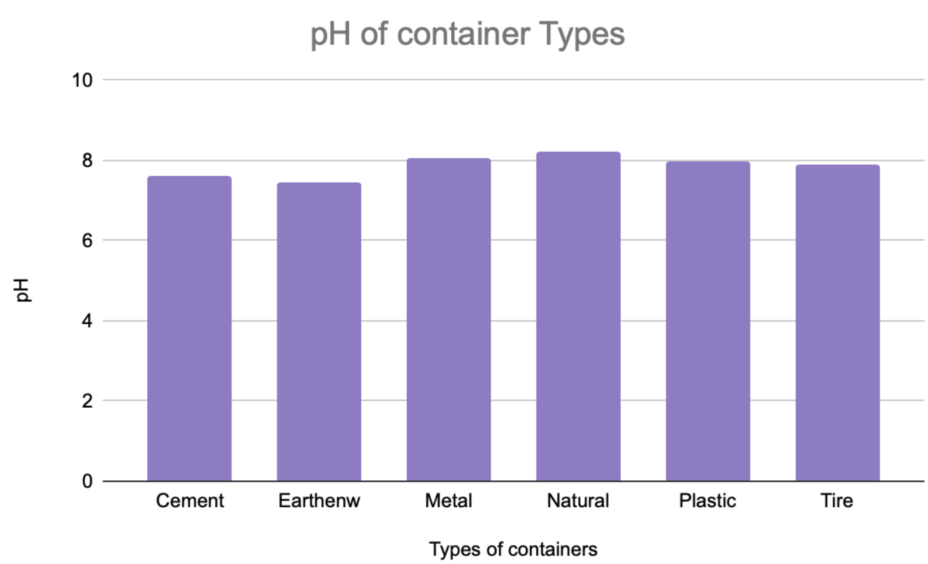
a) Collected Data	
b) Globe data	

Figure 5. Types of containers and pH

The **collected data (Figure 5a,b)** The pH values for the materials vary, with **Natural** exhibiting the highest mean pH of 8.2375, indicating it is the most alkaline material. **Metal** follows closely with a mean pH of 8.075. The overall mean pH across all materials is 7.8997, suggesting that most materials are mildly alkaline. **Plastic** (7.9867) and **Tire** (7.89) show pH values slightly below the total average but still near neutral. **Cement** (7.6122) and **Earthenware** (7.46) have lower pH values, with **Earthenware** being the least alkaline material in the dataset. The variation in pH values suggests that most materials are mildly alkaline, with **Earthenware** standing out for its lower pH. In the **Globe data (b),** The results reveal that **Natural** material has the highest mean value of 8, indicating it performs the best among the materials tested. **Metal** follows closely with a mean of 7.9, demonstrating strong performance. **Cement** (7.7) and **Plastic**(7.8) also show relatively high performance, though slightly lower than **Metal** and **Natural**. On the other hand, **Earthenware** and **Tire** have the lowest mean values of 6.2 and 6, respectively, suggesting that they perform less effectively compared to the different materials. Overall, the materials show a range of performances, with **Natural** standing out as the top performer and **Earthenware** and **Tire** being the least favorable.

4. Discussion

Water temperature and pH are critical factors shaping mosquito larvae distribution and abundance in aquatic habitats (Pfaehler et al., 2018). Previous studies have shown that higher temperatures accelerate larval metabolism and development, leading to shorter life cycles (Pfaehler et al., 2018).

Water Temperature and Larval Development

Extreme temperatures can be detrimental, reducing larval survival rates. In the Pa Sak Jolasid Dam context, seasonal temperature variations likely dictate larval density, with higher occurrences observed during warmer months. This aligns with research indicating that tropical mosquito species thrive between 28°C and 32°C (Ratnasari et al., 2023). These findings suggest that targeted larvicidal interventions should coincide with periods of elevated water temperatures to maximize effectiveness.

Water temperature is crucial to mosquito larvae development, survival, and reproduction. Water temperatures between 20 °C and 30°C provide optimal conditions for their development and growth. At low temperatures, mosquito larvae have delayed development. Temperatures below 10°C could slow mosquito larval development, reducing the number of adult mosquitoes emerging(Suryaningtyas, Margaretha, & Asyati, 2017). Very low temperatures can increase mosquito larvae mortality rates.

Warmer temperatures have been reported to accelerate mosquito larval development, faster maturation, and increased adult emergence. However, extremely high temperatures above 35°C reduce their survival rates (Ummul, 2023). Temperature also affects food availability and mosquito predator activities (e.g., fish and water striders). For effective mosquito control, we could target mosquito control efforts by manipulating water temperature, e.g., reducing water temperature by shading to slow down mosquito development.

Water pH and Larval Survival

The pH of water also directly affects the availability of nutrients and the survival of aquatic organisms, including mosquito larvae (Putra & Suharyo, 2019). The study's findings indicate that larvae were most abundant within a slightly acidic to neutral pH range (6.5–7.5), supporting prior evidence that many mosquito species prefer neutral pH environments for egg hatching and larval survival. At more extreme pH levels, larval occurrence diminishes, potentially due to the toxicity of the environment or reduced microbial food sources. Managing pH levels through ecological or chemical interventions could, therefore, serve as a strategy to control mosquito populations.

Water pH can influence mosquito larval survival, development, and adult size. Mosquito larvae generally thrive in water with a neutral pH, around 6.5 to 7.5, the pH of most natural bodies of water, such as ponds, lakes, and streams. The acidic pH (below 6.5) has been reported to reduce mosquito larval survival. Mosquito larvae may experience respiration, digestion, and development difficulties at low pH levels. In highly acidic water, mosquito larvae may suffer from direct toxicity and increased susceptibility to fungal infections. In high pH levels, mosquito larvae have been reported to develop slower and reduce hatching success.

Containers and Larvae Growth

The collected data shows that Plastic is the most frequent material, while Metal is the least represented. Larger sample sizes, like Plastic and Cement, offer more reliable data, whereas smaller groups, such as Metal and Earthenware, may lead to less robust conclusions. This suggests that sample size can influence the reliability of findings on larvae growth in different containers.

In contrast, the Globe data shows cement and earthenware as the most prominent materials, with plastic and tires less represented. This implies that Cement and Earthenware may provide more favorable conditions for larvae growth, while Plastic and Tire might be less conducive. The variation in material representation highlights the need for further research to understand better how different containers affect larvae survival and development.

I would like to claim IVSS badges

1. **I make an impact**

The document explicitly outlines the link between a community concern and the research inquiries, establishing connections between local and global repercussions. The students must depict how their research has positively influenced their community by providing recommendations or implementing actions derived from their findings. Exploring the ecology of mosquito larvae offers insights that can be utilized to safeguard the community against disease transmission via animal vectors, achieved by modifying or minimizing the use of specific container materials.

2. **I am a STEM professional.**

The report distinctly outlines the collaboration with a STEM professional, which bolstered the research methods, enhanced precision, and facilitated more advanced analyses and interpretations of the results. The data underwent analysis through independent-samples t-tests to compare the quantities of mosquito larvae in various container types.

3. **I am a data scientist.**

The report thoroughly examines both the students' proprietary data and additional data sources. Students critically evaluate the limitations of these data, draw inferences about historical, current, or future events, and leverage the data to address questions or resolve issues within the depicted system. This may involve incorporating data from other educational institutions or utilizing information from external databases. The latitude and longitude of the locations where mosquito larvae were observed were recorded using the GLOBE Observer: MHM App.

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Appendix:

Temperature vs Larvae Counts

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	208.456[a]	231	.854
Likelihood Ratio	92.139	231	1.000
Linear-by-Linear Association	.048	1	.826
N of Valid Cases	50		

pH vs Larvae Counts

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	281.434[a]	294	.691
Likelihood Ratio	107.048	294	1.000
Linear-by-Linear Association	.159	1	.690
N of Valid Cases	50		