Ecology of Mosquito Larvae in Varied Ecosystems near Ratchamongkol Beach, Trang

Piyapat Pethin, Surayut Dongjan and Kalyakon Tongsongsom
Chulabhorn Science High School, Trang
196 Moo 4, Trang-Sikao Rd., Bangrak, Amphoe Muang, Trang, 92000
Email: piyapatpet2295@gmail.com

Abstract
The diversity and quantity of mosquito larvae in four distinct areas near Ratchamongkol Beach, Trang, Thailand as a function of environmental factors was studied. The four selected areas were beach forest, swamp forest, mangrove forest, and forest near the residential area. The study aimed to examine the relationship between water quality in the breeding sites and the types and quantities of mosquito larvae present. Ovitraps, designed to attract mosquitoes to lay eggs, were installed at each site, with 20 traps per site. Mosquito larvae and water quality data, including measurements of water surface temperature, water temperature, pH, and electrical conductivity, were collected on a weekly basis for seven weeks. The study identified two types of mosquito larvae, namely *Aedes albopictus* and *Culex sitiens*, with the highest quantity of *Aedes albopictus* larvae found in the residential forest area and the highest quantity of *Culex sitiens* larvae found in the mangrove forest area. Water quality analysis revealed no significant differences in average water temperature, surface temperature, pH, and electrical conductivity among the four areas and between ovitraps with and without mosquito larvae, except for the mangrove forest area, where there were differences in electrical conductivity between ovitraps with and without mosquito larvae.

Keywords: *mosquito larvae, ovitrap, dengue fever, mosquito ecology*

I. INTRODUCTION

Thailand has been reporting dengue fever outbreaks for over 60 years, with the disease spreading throughout the country, including Trang Province, which experiences outbreaks every year. From 2015 to 2019, the number of dengue fever cases ranged from 1,860 to 9,961 cases per year. Sikao district in Trang consistently had a high number of cases and ranked among the top in the province every year. In 2019, it was the district with the highest number of dengue fever cases (Ministry of Public Health, 2019). Additionally, there are other diseases present, such as malaria, elephantiasis, and encephalitis, transmitted largely by *Aedes* mosquitoes, *Culex* mosquitoes, and *Anopheles* mosquitoes (Dumrongphan, 2017). A major factor in the spread of these diseases is Thailand being a tropical country, which contributes to the spread of diseases due to the abundance of mosquito populations.

Ratchamongkol Beach in Trang Province is a significant educational and tourist destination, attracting a large number of visitors each year. The beach area is characterized by diverse ecosystems, beautiful sandy beaches, and a connection to the local way of life. It is located in Mai Fat, Sikao District, which is at a high risk of dengue fever outbreaks (Ministry of Public Health, 2019). The index of mosquito ovitrap positivity in the area exceeds 10%, which is higher than the standard set by the World Health Organization (WHO, 2009), indicating a high risk of dengue fever occurrence.

Some mosquito species tend to reside close to humans, while others prefer forested areas, swamps, or areas with tall grass (Centers for Disease Control and Prevention, 2016). Due to this, we aim to investigate whether there is a difference in dengue fever risk among different areas of Ratchamongkol Beach, including beach area, beachside forest, intertidal mangrove forest, and forest near the residential area. These areas are frequented by people, increasing their vulnerability to dengue fever. The study aims to explore the prevalence and diversity of mosquito species in these different areas.

II. METHODS

Site Selection

This research was conducted at Ratchamongkol Beach, Mai Fat, Sikao District, Trang, located at coordinates 7.5282° N, 99.3079° E. The study area was divided into four study zones: beachside forest, swamp forest, mangrove forest, and the forest near the residential area, as shown in Figures 1 and 2.

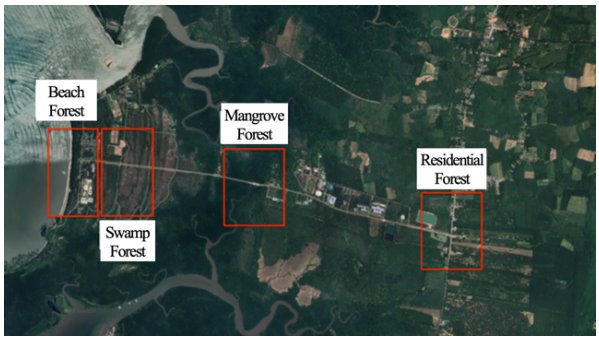

Figure 1. Map of the study area at Ratchamongkol Beach, Sikao, Trang, showing the four study areas.

Ovitrap Installation

An ovitrap, shown in Figure 3, is a black plastic cup-shaped device capable of holding water with an open top to allow mosquitoes to fly in and lay eggs. Ovitraps were installed on prominent trees in each study area at a height of approximately 1 meter above the ground. The ovitraps were placed in shaded areas. Each study zone, measuring 500 square meters, was equipped with 20 ovitraps, spaced approximately 2-4 meters apart, for a total of 80 containers installed in the four study zones. Each ovitrap was filled with 300 milliliters of distilled water.

Collection and Classification of Mosquito Larvae

Data collection was carried out once a week for a period of 7 weeks at Ratchamongkol Beach. Mosquito larvae samples were collected from each ovitrap and the data recorded using the Mosquito Habitat Mapper. The mosquito larvae collected from each container were counted. The preserved mosquito larvae were classified into different mosquito species using the Mosquito Larvae Globe Protocol Identification (Globe, 2018).

Each week the water quality was assessed based on the following parameters: 1) pH value, 2) electrical conductivity, 3) water surface temperature measured using an infrared thermometer, and 4) water temperature measured using a multiparameter pen-like device for all containers.

Figure 3. The mosquito ovitraps used in the study.

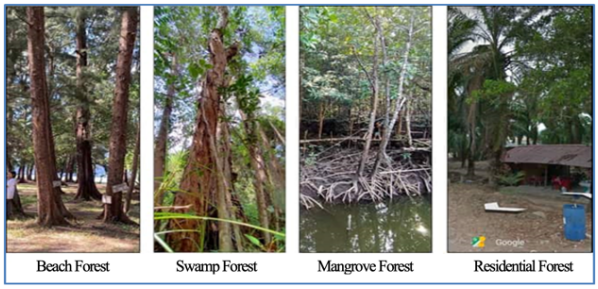

Figure 2. Study areas at the beach forest, swamp forest, mangrove forest, and residential forest habitats.

Statistical Analysis

Statistical analysis was performed on the number of mosquito larvae in each study zone. The data were analyzed using a t-test to compare the number and species of mosquito larvae found in each study zone and the water quality parameters.

III. RESULTS AND DISCUSSION

Mosquito larvae Species and Numbers

From the study, it was found that there are three types of mosquito larvae, namely, yellow-fever mosquito (*Aedes aegypti*), tiger mosquito (*Aedes albopictus*), and house mosquito (*Culex sitiens*) larvae. The *A. aegypti* and *A. albopictus* mosquito larvae were found in greatest proportions in the mangrove forest (89% *A. aegypti* larvae, 43% *A. albopictus* larvae), while the most *C. sitiens* larvae were found mostly in the residential forest area (60%), as shown in Figure 4.

Based on the research findings, the mangrove forest and the residential forest areas were identified as high-risk areas for mosquito-borne diseases, including Aedes, which transmits dengue fever, and Culex, which transmits encephalitis. Therefore, both diseases should be closely monitored in these areas.

Mosquito Larvae Species	Numbers and Percentages of Mosquito Larvae				Total
	Beach Forest	Swamp Forest	Mangrove Forest	Residential Forest	
A. aedes	0 (0%)	0 (0%)	**8 (89%)**	1 (11%)	9 (100%)
A. albopictus	185 (12%)	140 (9%)	**673 (43%)**	555 (36%)	**1553 (100%)**
C. sitiens	52 (18%)	29 (11%)	29 (11%)	**165 (60%)**	275 (100%)
Total	256 (13%)	192 (10%)	729 (38%)	**767 (39%)**	1944 (100%)

Figure 4. Types and quantities of mosquito larvae found in the mosquito larvae traps in each study area.

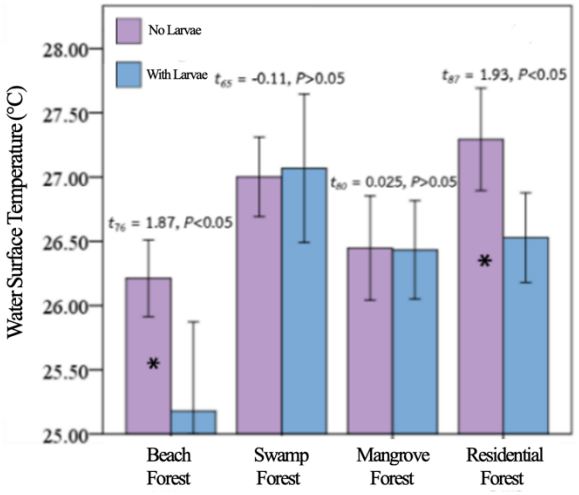

Figure 5. Water surface temperature values of the water in ovitraps with and without mosquito larvae.

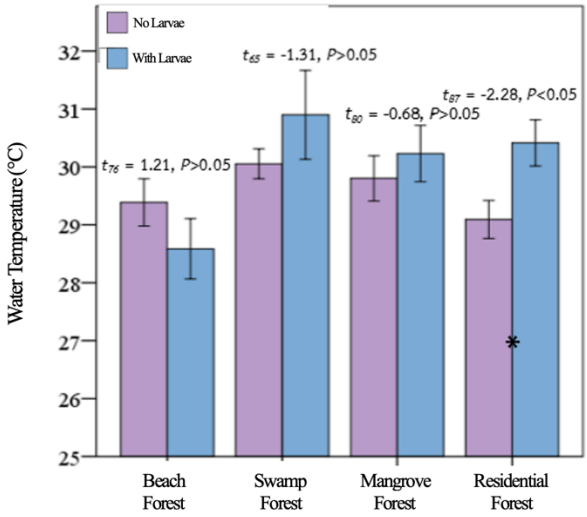

Figure 6. Water temperature values of the water in ovitraps with and without mosquito larvae.

Water quality in the ovitraps in each of the study areas

The water surface temperature in the ovitraps was lower in the beach forest area than the other areas, likely due to wind, as shown in Figure 5. However, there were no significant differences in values between temperature of the water itself in the four areas (Figure 6). The water surface temperature in ovitraps without larvae was higher than those with larvae for the beach forest area and the residential forest area. The temperature of the water itself also showed significant difference between ovitraps with and without larvae for both the residential forest and the beach forest. Interestingly, the ovitraps with larvae had higher water temperatures in the residential forest, but lower in the beach forest area. The temperature range in the containers with mosquito larvae was consistent with the research conducted by Dalpadado et al, which found that the suitable temperature for mosquito egg-laying ranged from 25.3 to 39.8 degrees Celsius (Dalpadado, 2565).

The analysis of the pH values showed that ovitraps with mosquito larvae had higher pH values compared to the traps without mosquito larvae for the beach forest and residential forest areas, as shown in Figure 7. In the mangrove forest area, the traps with mosquito larvae had lower pH values compared to the traps without mosquito larvae. However, there was no significant difference in pH values between ovitraps with and without larvae in the swamp forest area. The overall pH values of the ovitraps with larvae is consistent with the research findings of Prompram and Kaew, which found that the pH values of water with mosquito larvae ranged from 7.45 to 10.64 (Prompram, 2016).

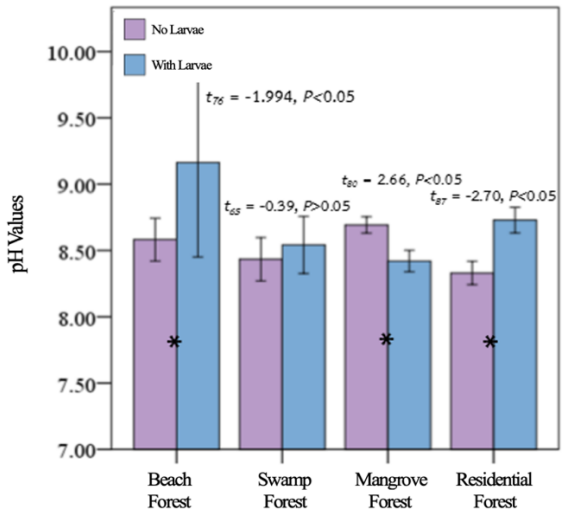

Figure 7. pH values of the water in ovitraps with and without mosquito larvae.

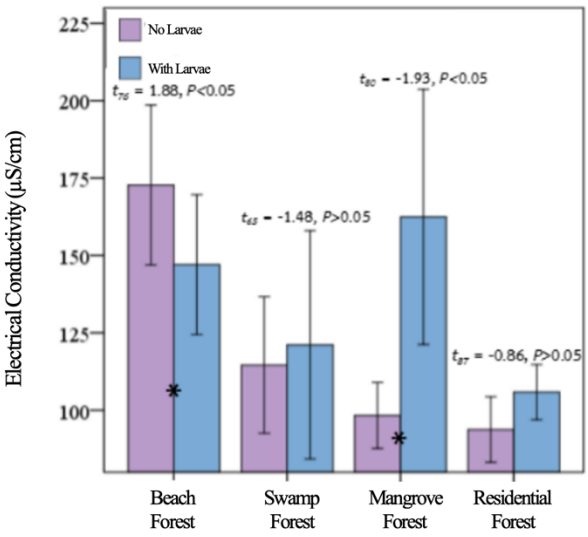

Figure 8. Conductivity values of the water in ovitraps with and without mosquito larvae.

Mosquitos Larvae Species		Mangrove Forest				Residential Forest			
		Water Surface Temp. (°C)	Water Temperature (°C)	pH value	Electrical Conductivity (µs/cm)	Water Surface Temp. (°C)	Water Temperature (°C)	pH value	Electrical Conductivity (µs/cm)
A. aegypti	Correlation Coefficient	0.115	0.045	-0.131	0.110	0.145	-0.017	-0.114	-0.027
	Sig. (2-tailed)	0.303	0.691	0.239	0.324	0.174	0.877	0.287	0.802
	N	82	82	82	82	89	89	89	89
A. albopictus	Correlation Coefficient	0.077	0.048	-0.301**	0.193	-0.214*	0.272*	0.243*	0.303**
	Sig. (2-tailed)	0.492	0.669	0.006	0.082	0.045	0.010	0.022	0.004
	N	82	82	82	82	89	89	89	89
C. sitiens	Correlation Coefficient	-0.055	0.314	0.172	0.180	-0.026	0.179	0.218*	0.167
	Sig. (2-tailed)	0.625	0.048	0.123	0.105	0.812	0.093	0.041	0.117
	N	82	82	82	82	89	89	89	89

*$P<0.05$, **$P<0.005$ **Numbers of larvae in the beach and swamp forests showed no significant correlations with water quality.

Figure 9. Relationship between the quantity of mosquito larvae of each species and water quality parameters.

Water conductivity, Figure 8, showed significant differences between ovitraps with and without larvae only in the beach forest and mangrove forest area. The traps without mosquito larvae had higher conductivity values in in beach forest, but lower values in the mangrove forest. In the swamp forest and residential forest areas there was no significant difference. This relationship is likely related to differences in the number of mosquito larvae and the dissolved organic matter in water, such as leaves, in the different areas. Another possible factor is that the beach forest and mangrove forest areas are closer to saltwater sources compared to the other two study areas.

Analyzing correlations between the mosquito larvae types and water quality, shown in Figure 9, it was found that the number of *A. albopictus* larvae in the mangrove forest had a significant negative correlation with pH values, while in the residential forest it had a negative correlation with water surface temperature and a positive correlation with pH values, conductivity, and electrical conductivity. As for the *C. sitiens* larvae in the residential forest area, it had a positive correlation with pH values.

Regarding the proportion of mosquito larvae in ovitraps, shown in Figure 10, the highest proportion of *A. albopictus* larvae was found in the mangrove forest, accounting for 95% of the population, while the highest proportion of *C. sitiens* larvae was found in the swamp forest area, accounting for 32% of the population. The index values of ovitraps were higher than the standard criteria, exceeding 10%, in all areas. This indicates that all study areas are at risk of dengue fever transmission (WHO, 2009), with the highest risk observed in the mangrove forest, accounting for 86%. These findings provide preliminary data for monitoring and developing dengue fever surveillance systems in alignment with breeding sites, mosquito behavior, and community lifestyles. It is recommended to regularly establish and implement dengue fever surveillance, prevention, and control plans in relevant organizations.

Study Area	Total Ovitraps	Total Ovitraps w/ larvae	Ovitraps w/ *A. aegypti*	Ovitraps w/ *A. albopictus*	Ovitraps w/ *C. sitiens*	Ovitraps w/ *A. aegypti* & *A. albopictus*	Ovitraps w/ *A. aegypti* & *C. sitiens*	Ovitraps w/ *A. albopictus* & *C. sitiens*	Ovitraps w/ all species	Ovitrap Index	% w/ *A. aegypti*	% w/ *A. albopictus*	% w/ *C. sitiens*
Beach Forest	140	29	0	18	1	0	0	6	0	62.06	0.00	0.83	0.24
Swamp Forest	140	22	0	13	4	0	0	3	0	29.09	0.00	0.73	0.32
Mangrove Forest	140	42	0	35	1	1	0	4	0	85.71	0.02	0.95	0.12
Residential Forest	140	56	0	39	4	1	0	8	0	71.42	0.02	0.82	0.21

Figure 10. Ovitrap index values in mosquito larvae traps in the four study areas.

IV. CONCLUSION

It was found that *A. albopictus* larvae were found in largest numbers in ovitraps in the mangrove and residential forest areas. *A. albopictus* and *C. sitiens* larvae were found in all four study areas, with *A. albopictus* larvae being the most abundant, followed by *C. sitiens* and only small numbers of *A. aegypti* larvae found. It was also shown that all four areas had ovitrap index values higher than the standard threshold (> 10%) (WHO, 2009), indicating a higher risk of dengue fever in these areas.

V. REFERENCES

Centers for Disease Control and Prevention. (2023). Where Mosquitoes Live. www.cdc.gov/mosquitoes/about/where-mosquitoes-live.html

Dalpadado, R., Amarasinghe, D., & Gunathilaka, N. (2022). Water quality characteristics of breeding habitats in relation to the density of *Aedes aegypti* and *Aedes albopictus* in domestic settings in Gampaha district of Sri Lanka. Acta Tropica, 229, 106339. https://doi.org/10.1016/j.actatropica.2022.106339

Damrongpanthawong, T. (2017). Important Medical Mosquitoes of Thailand (2nd Edition). Naresuan University Publishing House.

Globe/worldwide Education. Mosquito Larvae Globe Protocol Identification. www.globe.gov/documents/11865/0dcf909a-b4b3-4793-969a-5f88c48fbf26

Ministry of Public Health. (2019). Situation of Dengue Fever in Trang Province. Retrieved from http://www.rh12.moph.go.th/wpcontent/uploads/2019/Ovitrap.

Ministry of Public Health. (2019). Dengue Fever Incidence Rate per Hundred Thousand Population, Health District 12, Trang Province, 2019. Retrieved from https://trg.hdc.moph.go.th

Supawan, P. P., & Churi, J. (2016). Ecological Study of Mosquitoes in Kuen Kreng Forest Area, Keng Subdistrict, Chauat District, Nakhon Si Thammarat Province. Retrieved from http://dspace.nstru.ac.th: 8080/dspace/bitstream/123456789/2197/3/Fulltext.pdf

World Health Organization. (2009). Dengue: Guidelines for Diagnosis, Treatment, Prevention and Control. World Health Organization, pp. 1-160.

Acknowledgements

We would like to express our gratitude to Dr. Anantani Chumsri from Rajamangala University of Technology Srivijaya, Trang Campus, for providing support and guidance throughout the research process. We also extend our thanks to the management and teachers of Chulabhorn Science High School, Trang, for their support in conducting this research. We are thankful to the Science and Technology Promotion Institute (STPI) for supporting environmental research activities. Last but not least, we would like to thank the community health workers and local residents for their excellent cooperation and valuable contributions in data collection for this study.