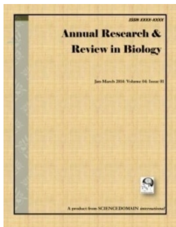

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Larval Mosquito Diversity and Distribution in Rice Field Agro-Ecosystems in Sariaya, Quezon Province, Philippines

Glenn Sia Su[1*], Janine Bobadilla[1], Katherine Claire De Leon[1], Maria Lilibeth Sia Su[2] and Elena Ragragio[1]

[1]Biology Department, College of Arts and Sciences, University of the Philippines Manila, Philippines.
[2]College of Medicine, University of the Philippines Manila, Philippines.

Authors' contributions

This work was carried out in collaboration between all authors. Author GSS designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors JB and KCDL managed the analyses of the study. Authors MLSS and ER managed the literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: This study assessed the larval mosquito diversity and distribution in rice field agro-ecosystems in Quezon Province, Philippines.
Study Design: Cross-sectional study.
Place and Duration of Study: Sariaya, Quezon Province, Philippines between November 2011 and January 2012.
Methodology: Grab water samples were obtained in the constructed agricultural wetlands and were assessed for physicochemical parameters (pH, temperature, and total dissolved solids). Mosquito larvae surveys were conducted in the rice field agro-ecosystems using the standard dipping method, and fourth instar larvae were examined to genus level morphologically using standard keys.
Results: A total of 2,106 mosquito larvae were collected from the rice field agro-ecosystems. Of these total, four genera were obtained, namely, *Culex sp., Anopheles sp., Stegomyia sp.,* and *Toxorhynchites sp.* The monitored rice field agro-ecosystem had a high breeding index but low to medium mosquito diversity. No significant differences on

**Corresponding author: Email: glss76@yahoo.com;*

the breeding and diversity index exist across the study sites examined (P =0.36).
Conclusion: Continuous monitoring of the occurrence of mosquito larvae is necessary as it plays an important role in the transmission of mosquito-related diseases.

Keywords: Mosquito; diversity; agro-ecosystem; distribution.

1. INTRODUCTION

Agricultural ecosystems or agro-ecosystems are systems of agricultural production geared towards attaining food security for the need of the general public. Agro-ecosystems, nowadays, have become popular man-dominated ecosystems, especially in countering the problems of poverty and hunger. Over the years, agricultural modernization, provision of agricultural inputs, and agrarian reforms have, been made to alleviate the socioeconomic conditions of farmers. One of those developments includes the construction of rice fields that are continuously irrigated with canals. These developments have been made to continually assist the farmers, especially those who cultivate rice in their fields.

Rice is a commonly cultivated crop in the Philippines. Rice cultivation has been cultivated in the Philippines for so many years, and it is the staple food of Filipinos. In the cultivation of rice in agro-ecosystems, the flooding of rice with water has been the usual practice, since this ensures provision of nutrients and helps in the control of weeds [1,2]. However, this practice is also associated with problems, since the flooded areas serve as breeding grounds for mosquitoes, which may later be responsible for the transmission of numerous diseases. A study [3] has shown that rice field agro-ecosystems provide important habitats for insects associated with vector-borne disease transmission. Mosquitoes [4] generally benefit from flooded rice fields as they gain refuge, resting and breeding grounds for their growth and survival. However, a study [5] has shown that the occurrence of these mosquitoes varies from place to place, since this is dependent on the biological and physicochemical conditions present in their breeding habitats.

The problem nowadays is that mosquitoes continue to thrive and proliferate in the environment. The existence and distribution of the mosquitoes in flooded rice fields affects the quality of life of individuals, who may be inflicted by consequent morbidities and mortalities arising from the diseases borne by these vectors. In the Philippines, there is limited information pertaining to the occurrence and distribution of mosquitoes in agro-ecosystems, particularly in rice field agro-ecosystems. This study is aimed at assessing the larval mosquito diversity and distribution in rice field agro-ecosystems. Most studies [6-9] have focused on studying the occurrence of mosquitoes in urban areas of the Philippines. A number of studies [10] have studied the occurrence of mosquitoes in ponds and in water bodies in the rural areas. There are limited studies on the occurrence of mosquitoes in rice field agro-ecosystems. The present increase in the distribution of mosquitoes in both urban and rural areas is of important interest, especially because this enables us to understand the heterogeneity of mosquito distribution and its diversity in the environment.

2. MATERIALS AND METHODS

Sariaya, Quezon, is an agricultural land occupying 77 hectares of rice fields. It is situated 13º58′1.2″N and 121º31′58.8″E in the Quezon Province (Fig. 1). The mosquito larval surveillance was conducted in three sampling points. The sampling points were arbitrarily identified based on the heterogeneity of the landscape. The first sampling point is situated in the middle portion of the rice field agro-ecosystem. The second sampling point is situated in the rice field near a forest ecosystem. The third sampling point is situated in the rice field near households. A 10m by 10m plot was assessed for the larval mosquito inhabiting the sampling points. The mosquito surveillance was conducted during the wet season particularly in the month of November 2011.

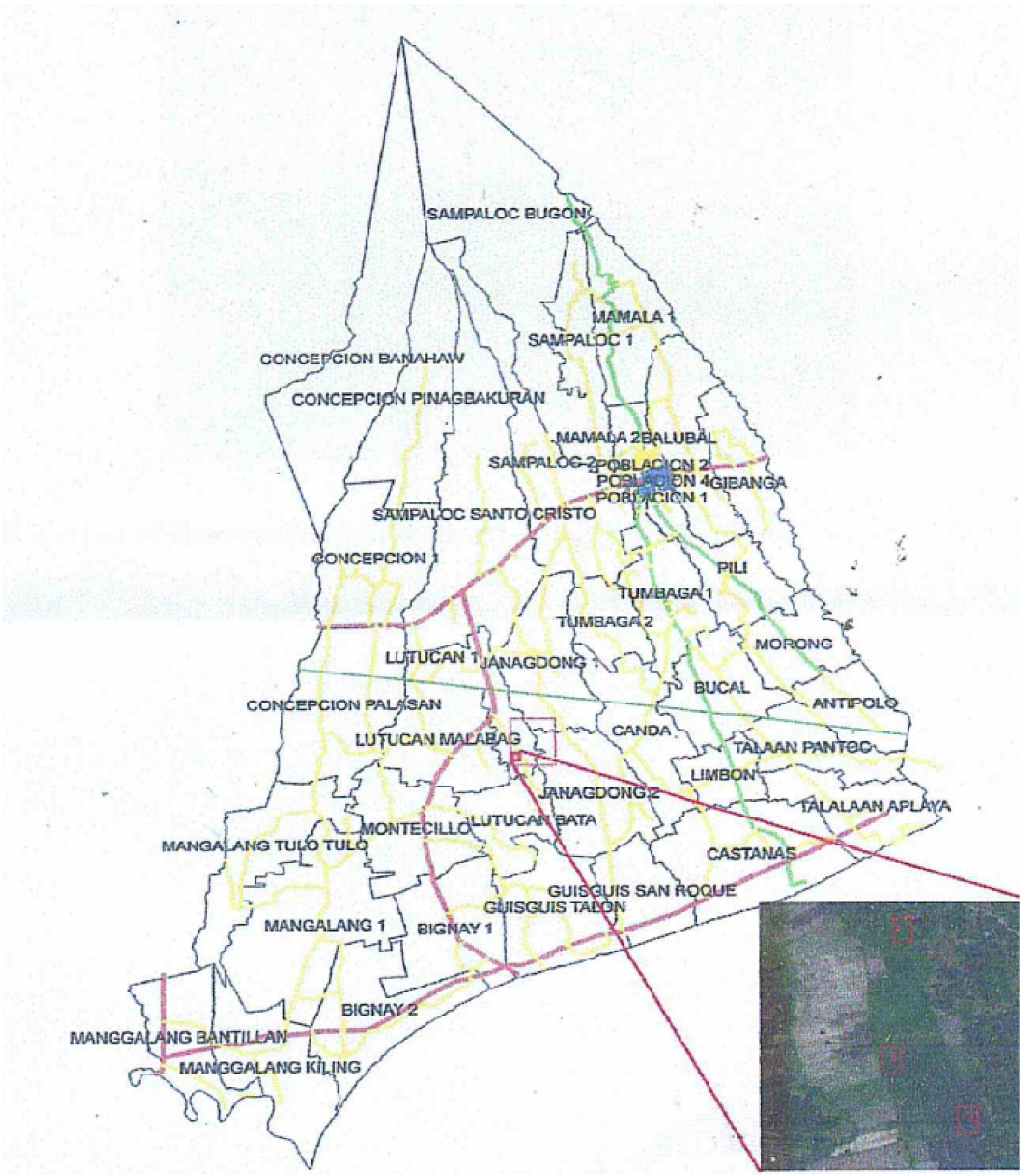

Fig. 1. Study site in Sariaya, Quezon Province, Philippines

Grab water samples were done in the sampling areas where the physicochemical parameters, particularly pH, temperature, and water depth, were determined in situ. The pH was determined using a pH paper (Merck, Germany), the temperature through a thermometer and the water depth through a meter stick. The total dissolved solids were determined through gravimetric methods in the laboratory.

Mosquito larvae were collected using the standard dipping method [11]. The field-collected fourth instar larvae in the study sites were examined morphologically, whereas those larvae that were not in their fourth instar stages were reared until they have reached their fourth instar stages before being examined morphologically to genus level. Mosquito larvae were placed in hot water and preserved in 10% formalin solution. They were identified using standard keys [12,13].

The breeding index for each sampling point in the study site was determined using the formula as indicated by Belkin [14]: BI = TLP/ND $\times$ BP, where BI = breeding index, TLP = total number of larvae and pupae taken, ND = number of dips, and BP = number of breeding places/sampling stations. The diversity of the mosquito larvae at each sampling point was assessed based on the Shannon–Wiener Diversity Index. The frequency of occurrence of each taxon was determined by obtaining the total number of collections of the particular taxon obtained divided by the total number of samples examined. The significant differences on the mosquito larvae diversity in the different sampling points were determined using the Kruskal–Wallis test. Significant level was set at P=0.05.

3. RESULTS AND DISCUSSION

Table 1 shows the mean values of the physicochemical parameters on the water quality of the rice field agro-ecosystem. The results show that water quality of the rice field agro-ecosystem is conducive for the breeding of mosquitoes in the area [6]. A total of 2,106 mosquito larvae were obtained from all the sampling points in the study site. The mosquito larvae obtained were found to belong to four genera, namely *Anopheles, Stegomyia, Culex*, and *Toxorhynchites*. Fig. 2 shows the mosquito larvae obtained in the study site and their morphological characterization. The most and least common mosquito larvae obtained were the *Culex* and the *Stegomyia*, respectively.

Table 1. Values of physicochemical parameters assessed on water quality of rice field agro-ecosystem in Sariaya, Quezon Province

Physicochemical parameters	Mean±SEM
Depth (ft)	1.50±0.29
Temperature (ºC)	31.00±5.00
pH	6.50±0.00
Total dissolved solids (ppm)	453.33±186.67

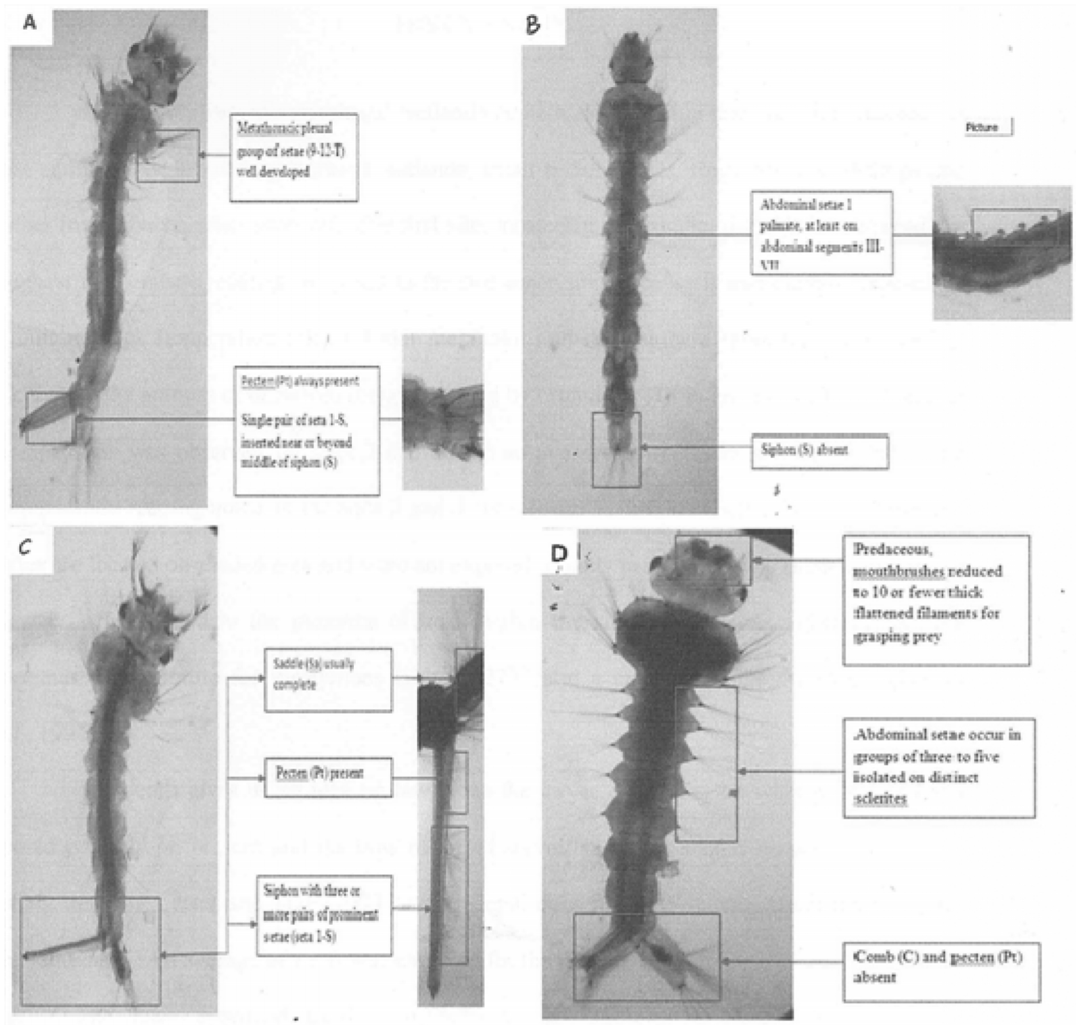

Fig. 2. Mosquito larvae and the morphological differences observed within the rice field agro-ecosystem of Sariaya, Quezon (A) *Stegomyia sp.;* (B) *Anopheles sp.;* (C) *Culex sp.;* (D) *Toxorhynchites sp.*

Table 2 shows the Shannon–Wiener Diversity Index, the breeding index, and the frequency of occurrence of the mosquito larvae in the rice field agro-ecosystem of Quezon Province. The highest breeding index was observed in the third sampling point, whereas the least breeding index was observed in the second sampling point. Although the highest breeding index was found in the third sampling point, it had the lowest Shannon–Wiener Diversity Index as compared to those observed in the two sampling points. The *Anopheles* and the *Culex* species were found to predominantly inhabit the rice field agro-ecosystem. *Culex* mosquito was the predominant mosquito in the sampling points assessed. The *Toxorhynchites* were likewise observed in all sampling points, except that they were few in number compared to the other two species of mosquitoes. The *Stegomyia* larva was only present in the second sampling point. Results of the study showed that the breeding index and Shannon–Wiener index in the sampling points examined were not significantly different (P=0.36). The indices obtained across the sampling points were found to be the same.

Table 2. Breeding and diversity index and the frequency of larval mosquito occurrences assessed in the rice agro-ecosystem of Sariaya, Quezon

Study site	Breeding index	Shannon–Wiener diversity index	Frequency of larval mosquito occurrence (%)			
			***Anopheles* sp.**	***Stegomyia* sp.**	***Culex* sp.**	***Toxorhynchites* sp.**
1	9.16	0.47	13.33	0.00	86.66	1.77
2	6.87	0.43	9.65	0.46	88.06	1.84
3	13.94	0.17	3.91	0.00	96.01	0.08

This was a cross-sectional study, and its scope was limited to determining the diversity and distribution of the larval mosquitoes inhabiting a rice field agro-ecosystem. This study was also limited to determining physicochemical parameters (depth, temperature, pH, and total dissolved solids) that may affect the water quality and the breeding habitats of mosquitoes. It was observed that the sampling points were conducive to the breeding and growth of mosquitoes larvae. It was also detected that the sampling point was a homogeneous breeding habitat for mosquitoes. Site 3 had the most number of *Culex* mosquito larvae collected among the study sites examined. Our results corroborate results of similar studies [15,16], which indicated that, in a rice field, the most common mosquito larvae that can be observed are those of the *Culex* mosquitoes. We also observed that the highest breeding index of mosquito larvae was evident in site 3, but that it had the lowest diversity index of 0.17. Site 1 instead showed the highest diversity index of 0.47. The occurrences of the mosquito larvae in the study sites indicate that mosquito species oviposition may depend on the presence of resources and the predators that exist in these areas [17]. It was observed that most of the mosquito larvae existed in areas where there was vegetation present. A study [17] has indicated that occurrence of mosquitoes in a particular habitat is dependent on the complexity of the ecosystem, creating also complex scenarios that prevent gradual attacks by other organisms including other mosquito species. The occurrence of other organisms in the rice field like fish, tadpoles, and aquatic insects noted at the time of collection may have influenced the population of the mosquito species thriving in the habitat. This is also supported by a study [18] where they found that the presence of other organisms in the rice fields might have influenced the diversity and distribution of the mosquito species within the habitat. Despite the variability in the breeding and the diversity index observed in the different study sites, no significant differences were observed (P=0.36).

4. CONCLUSION

In conclusion, this study highlights the diversity and distribution of mosquito larvae associated with an irrigated rice field agro-ecosystem in the Philippines. The occurrence of these mosquito larvae in the study sites suggests that the larvae can adapt to a variety of aquatic habitats. The study likewise demonstrates that, even though the breeding index of the mosquitoes is high, the diversity index may not be high. Despite the variability in the breeding, diversity, and distribution of the mosquito larvae across the different study sites, the occurrences of the mosquito larvae remain the same. Results of this study, which presents the diversity of mosquitoes in rice field agro-ecosystems may help in developing future vector control measures, considering that these mosquitoes have the potential to transmit vector-borne diseases. Further mosquito surveillance of rice field agro-ecosystems are needed to continuously monitor the occurrence of the mosquito vectors, especially those that have the potential to bring about threats to human health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Keiser J, Utzinger J, Singer BH. The potential of intermittent irrigation for increasing rice yields, lowering water consumption, reducing methane emissions, and controlling malaria in African rice fields. J Am Mosq Control Assoc. 2002;18:329-40.
2. Ijumba JN, Lindsay SW. Impact of irrigation on malaria in Africa: Paddies paradox. Med Vet Entomol. 2001;15:1-11.
3. Edirisinghe JP, Bambaradeniya CNB. Rice fields: An ecosystem rich in biodiversity. J Natl Sci Found Sri. 2006;34(2):57-9.
4. Okogun GRA, Nwoke BEB, Okere AN, Anosike JC, Esekhegbe AC. Epidemiological implications of preferences of breeding sites of mosquito species in Midwestern Nigeria. Ann Agric Environ Med. 2003;10:217-22.
5. Kengluecha A, Singhasivanon P, Tiensuwan M, Jones J, Sithiprasasna R. Water quality and breeding habitats of anopheline mosquito in northwestern Thailand. Southeast Asian J Trop Med Public Health. 2006;36(1):46-53.
6. Sia Su G, Beronilla K, Yao B. Water quality and *Aedes* larval mosquito abundance in Caloocan City, Philippines. Dengue Bull. 2012;36:175-81.
7. Schapira A, Garcia C, Asor M, Riquentino I, Bahillo L, Palattao M et al. Baseline and key container survey for *Aedes aegypti* and *Aedes albopictus* in Albay Province, Philippines. Dengue Bull. 2012;36:182-96.
8. Mahilum MM, Ludwig M, Madon MB, Becker N. Evaluation of the present dengue situation and control strategies against *Aedes aegypti* in Cebu City, Philippines. J Vector Ecol. 2005;30(2):277-83.
9. Bangs MJ, Focks DA. Abridged pupa identification key to the common container-breeding mosquitoes in urban Southeast Asia. J Am Mosq Control Assoc. 2006;22(3):565-72.
10. Santiago ATA, Claveria FG. Larval mosquito fauna (Family *Culicidae*) of Sta. Ignacia, Tarlac, Philippines. J Protozool Res. 2008;18(1):17-25.
11. O'Malley C. Guidelines for larval surveillance. Proc. 76th Annual Meeting New Jersey Mosquito Control Assoc., Inc. 1989;45-55.
12. Pratt HD. Mosquitoes: Pictorial key to U.S. genera of larvae. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. 1993;138.
13. Delfinado MD, Viado GB, Coronel LT. A checklist of Philippine mosquitoes with a larval key to genera (*Diptera*, *Culicidae*). Philipp J Sci. 1962;91(4):433-57.
14. Belkin JN. Simple larval and adult mosquito indexes for routine mosquito control operations. Mosquito News. 1954;14:127-31.
15. Amala S, Rajendrabhoopathy S, Arunachalam N, Aunradha V. A study on diversity of mosquitoes in Rajathanikottai Village, Dindigul District, Tamil Nadu, India. Ann Biol Res. 2011;2(6):496-99.
16. Kanojia PC, Shetty PS, Geevarghese G. A long term study on vector abundance and seasonal prevalence in relation to the occurrence of Japanese encephalitis in Gorakhpur District, Uttar Pradesh. Indian J Med Res. 2003;117:104-10.

17. Aditya G, Pramanik MK, Saha GK. Larval habitats and species composition of mosquitoes in Darjeeling Himalayas, India. J Vect Borne Dis. 2006;43:7-15.
18. Pramanik MK, Raut SK. *Toxorhynchites splendens,* a potential biological control agent of the pest and vector mosquitoes occurring in boro rice-fields in West Bengal, India. Environ Ecol. 2005;23(3):698-704.

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