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RESEARCH ARTICLE

BIODIVERSITY OF ADULT FEMALE MOSQUITOES: ACTIVE SURVEILLANCE TO ADDRESS MOSQUITO-BORNE DISEASES IN CIMAHI, INDONESIA

(KEANEKARAGAMAN NYAMUK BETINA DEWASA: PENGAWASAN AKTIF DALAM PENANGGULANGAN PENYAKIT YANG DISEBABKAN NYAMUK DI CIMAHI, INDONESIA)

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ABSTRACT

Mosquito-borne diseases are a global health threat, especially in developing cities such as Cimahi City, West Java, which has shown an increase in cases of dengue fever and filariasis. Limited data on adult mosquito vectors in Cimahi prompted this exploratory descriptive study. A total of 439 female mosquitoes were collected from 15 villages during the dry and rainy seasons using light traps, then identified morphologically. Diversity analysis was conducted using the Shannon-Wiener index (H'), while comparisons between locations were performed using the Kruskal-Wallis test due to non-normal data distribution. The results showed that Culex spp. (54.67%) dominated, followed by Aedes aegypti (32.19%), Armigeres spp. (10.02%), and Aedes albopictus (3.19%). Baros had the highest number of mosquitoes (77), while Central Cimahi had the lowest (11). The majority of villages showed low diversity (H' ≤ 1) and uneven distribution (J < 0.5) with the dominance of certain species. The Kruskal-Wallis test found no significant difference in the number of mosquitoes between villages (p = 0.993).

Keywords: Cimahi City, mosquito diversity, mosquito-borne diseases

ABSTRAK

Penyakit tular nyamuk merupakan ancaman kesehatan global, terutama di perkotaan berkembang seperti Kota Cimahi, Jawa Barat, yang menunjukkan peningkatan kasus demam berdarah dan filariasis. Keterbatasan data mengenai vektor nyamuk dewasa di Cimahi mendorong penelitian deskriptif eksploratif ini. Sebanyak 439 nyamuk betina dikumpulkan dari 15 desa pada musim kemarau dan hujan menggunakan perangkap cahaya, lalu diidentifikasi morfologinya. Analisis keragaman menggunakan indeks Shannon-Wiener (H'), sedangkan perbandingan antar lokasi dengan Kruskal-Wallis (data non-normal). Hasil menunjukkan Culex spp. (54,67%) mendominasi, diikuti Aedes aegypti (32,19%), Armigeres spp. (10,02%), dan Aedes albopictus (3,19%). Baros memiliki jumlah nyamuk tertinggi (77), sementara Cimahi Tengah terendah (11). Mayoritas desa menunjukkan keanekaragaman rendah (H'≤1) dan distribusi tidak merata (J<0,5) dengan dominasi spesies tertentu. Uji Kruskal-Wallis tidak menemukan perbedaan signifikan jumlah nyamuk antar desa (p=0,993).

Kata kunci: keanekaragaman nyamuk, Kota Cimahi, penyakit yang ditularkan nyamuk

INTRODUCTION

Mosquitoes are one of the insects known as vectors of various infectious diseases that have a significant impact on public health. They are blood-sucking dipterans belonging to the Culicidae family, with 3,583 valid species currently described worldwide.[1] Several diseases transmitted by mosquitoes, such as malaria, dengue fever (DHF), chikungunya, filariasis, and Japanese encephalitis, have become global public health problems.[2] According to the World Health Organization (WHO), mosquito-borne diseases account for about 17% of the total burden of all infectious diseases.[3] The intensified movement of humans, animals, and goods on a global scale in combination with climate change creates opportunities for invasive Culicidae vector species to establish.[4]

Active surveillance is crucial for understanding vector diversity and preventing pathogen transmission. Common Asian and African vectors include *Aedes* sp. (dengue, Zika, chikungunya), *Anopheles* sp. (malaria), and *Culex* sp. (Japanese encephalitis, West Nile fever).[5] A theoretical modelling study by Möhlmann et al. suggested that higher vector species richness can increase pathogen transmission.[4] In contrast, a study conducted in 2011 by Chaves et al. suggested that higher diversity in vector communities decreases the risk of amplification and spread of disease.[6] The worldwide emergence of mosquito-borne diseases suggests the need to establish active surveillance programs for common and neglected insect-borne human infectious diseases.

In Indonesia, dengue hemorrhagic fever (DHF) and malaria are major causes of morbidity and mortality, particularly in densely populated areas like Cimahi City, West Java. Cimahi faces a high risk of mosquito-borne diseases, with recent increases in dengue and filariasis cases.[4,5] However, specific information on adult mosquito vector species in Cimahi City is limited. This study addresses that gap by exploring adult mosquito biodiversity to provide data for science-based disease vector control strategies.

METHODS

Study Area

This study analyzed adult mosquito biodiversity in **15 villages across Cimahi City, West Java, Indonesia** (Figure 1). Cimahi City is divided into three districts: Cimahi Selatan (5 villages, 17.41 km², population of 240,990 in 2020), Cimahi Tengah (6 villages, 10.89 km², population of 161,758), and Cimahi Utara (4 villages, 14.13 km², population of 165,652).[7]

Figure 1 Map of the Cimahi area.

Mosquito Collection

Sample collection for adult mosquitoes occurred from July to August 2024 and December 2024 to January 2025 using the Krisbow Inhalant Mosquito Light Trap GM909. This method was selected due its effectiveness in attracting key vectors (*Aedes aegypti*, *Aedes albopictus*, *Culex* spp.). Sampling was conducted over full days, with 24-hour trap deployments at selected sites. Observations focused on female *Ae. aegypti*, *Ae. albopictus*, *Culex* spp., and *Armigeres* spp. Collected specimens were then used for morphological identification and storage.

Species Identification

Mosquito identification was carried out based on morphology, using identification guidelines from "Update of mosquito taxonomic information and photographic identification keys for mosquito genera (Diptera: Culicidae) in Indonesia."[8] The identification process included examining the characteristics of the mosquito's body, such as size, color pattern, wing shape, and antenna structure, as well as utilizing comparisons with images of known species.

Data Analysis

This descriptive exploratory, cross-sectional study analyzed primary data on adult mosquito diversity in Cimahi City. Species diversity and distribution were assessed, including inter-location comparisons. The Shannon-Wiener diversity index (H'), reflecting species richness and evenness, was used to quantify diversity, with higher values indicating greater richness and balanced distribution.[9]

$$H' = -\sum_{i=1}^{s} Pi\ ln\ ln\ Pi$$

Note:
H': Shannon-Wiener diversity index.
Pi: Proportion of individuals of the i-th species to the total individuals (calculated using the formula $Pi = \frac{ni}{N}$).
ni: Number of individuals of the i-th species (the number of individuals of one species).
N: Total number of individuals of all species.
s: Total number of species found.

Differences between sampling locations were examined using the Kruskal-Wallis test. All collected and identified mosquito data were analyzed using SPSS software, with results presented in tables, graphs, or diagrams.[10]

This research was approved by the Padjadjaran University Research Ethics Committee with ethical approval number 71/UN6.KEP/EC/2024.

RESULT AND DISCUSSION

Mosquito-borne diseases pose a significant public health threat in tropical and subtropical regions. Key vectors like *Aedes aegypti* and *Ae. albopictus* spread dengue and Zika, causing severe illness, including high fever, bleeding, and fetal microcephaly.[11] Malaria, transmitted by *Plasmodium spp*. via Anopheles mosquitoes, remains endemic in areas like Papua and Nusa Tenggara Timur.[12] *Culex spp.* transmit Japanese encephalitis, a cause of fatal brain inflammation, while Culex and Aedes mosquitoes spread filariasis (caused by Wuchereria bancrofti), leading to chronic conditions such as elephantiasis.[13] *Armigeres spp*. and *Mansonia spp*. also act as potential vectors of filariasis, especially in rural areas and stagnant waters.[14,15]

Vector mosquitoes are widespread in Indonesia, with Aedes mosquitoes dominating urban areas and Anopheles mosquitoes commonly found in swamps and rivers.[12,16] Controlling these vectors is key to reducing mosquito-borne diseases, using strategies like source reduction, insecticides, and public education.[17] Data-driven approaches, including mosquito biodiversity mapping, help target high-risk areas more effectively. The Indonesian Ministry of Health uses vector mapping to prioritize control efforts and enhance disease prevention.[18]

This study sampled 439 female mosquitoes across Cimahi City during the dry and wet seasons. As detailed in Table 1, species diversity varied significantly across villages. *Ae. aegypti* was most common in Citeureup, Pasirkaliki, Cigugur, Karangmekar, Central Cimahi, Setiamanah, and Utama. Conversely, *Armigeres* spp. dominated Cipageran and Cibeber, and *Culex* spp. were most abundant in Cibabat, Padasuka, Melong, Baros, and Leuwigajah. *Ae. albopictus* appeared in low numbers and was absent in some areas. Specifically, Baros and Leuwigajah recorded the highest *Culex* spp. counts, while Pasirkaliki had the highest number of *Ae. aegypti*, reflecting spatial variations in mosquito populations across the villages.

Table 1 Samples of female mosquitoes found in each village of Cimahi City

No	Villages	*A. ae-gyp-ti*	*A. albo-pic-tus*	*Cu-lex* spp.	*Armige-res* spp.	Total
1	Citeureup	11	7	5	8	31
2	Cipageran	8	3	8	12	31
3	Cibabat	5	1	8	4	18
4	Pasir-kaliki	19	0	1	1	21
5	Cigugur	9	1	2	1	13
6	Karang-mekar	11	2	1	0	14
7	Baros	10	0	67	0	77
8	Cimahi Tengah	7	0	4	0	11
9	Padasuka	6	0	9	0	15
10	Setiama-nah	12	0	14	0	26
11	Melong	9	0	19	0	28
12	Cibeber	3	0	7	18	28
13	Leuwiga-jah	10	0	57	0	67
14	Utama	14	0	15	0	29
15	Cibeu-reum	7	0	23	0	30
Cimahi City		**141**	**14**	**240**	**44**	**439**

Of the 439 mosquito individuals collected from fifteen villages in Cimahi City, *Culex* spp. were the most dominant species, accounting for 240 individuals (55% of the total population). Baros village had the highest number of individuals (77), followed by Leuwigajah (67), while Cimahi Tengah recorded the lowest (11).

Species distribution varied significantly across villages. For instance, *Ae. albopictus* was absent in 10 out of 15 villages. *Armigeres* spp. was primarily found in Cibeber Village, with minimal presence elsewhere. To assess significant differences between study locations, a comparative analysis was conducted as follows:

a. Normality Test

Based on the Shapiro-Wilk normality test, 5 out of 15 villages (Pasirkaliki, Cigugur, Baros, Leuwigajah, and Utama) showed a non-normal distribution of mosquito count data, with a significance value (Sig.) of less than 0.05.

b. Kruskal-Wallis Comparison Test

The Kruskal-Wallis test was used to compare groups with non-normal data, assessing significant differences based on median values. Using IBM SPSS 25 (alpha = 0.05), an Asymp. Sig. (p-value) of 0.993 was obtained. Since the p-value (0.993) > α (0.05), the null hypothesis was not rejected, indicating no significant difference in the median number of mosquitoes among the compared groups. Thus, the number of mosquitoes across all villages was statistically similar.

Diversity

The Shannon-Wiener diversity index (H′) measures species diversity within a community by accounting for both species richness and evenness. A higher H′ indicates greater species diversity and a stable community, while a lower H′ suggests low diversity with dominant species, often reflecting an unstable ecosystem.

Table 2 Diversity and evenness index of mosquito species in mosquito biodiversity research in Cimahi City, January 2025

No	Villagess	Diversity Index (H')	Inform-ation
1	Citeureup	1,348	Medium
2	Cipageran	1,293	Medium
3	Cibabat	1,211	Medium
4	Pasirkaliki	0,381	Low
5	Cigugur	0,937	Low
6	Karang-mekar	0,656	Low
7	Baros	0,386	Low
8	Cimahi Tengah	0,655	Low
9	Padasuka	0,673	Low
10	Setia-manah	0,690	Low
11	Melong	0,628	Low
12	Cibeber	0,870	Low
13	Leuwi-gajah	0,421	Low
14	Utama	0,693	Low
15	Cibeureum	0,543	Low
Cimahi City		**1,035**	**Low**

Diversity index calculations revealed two levels of mosquito diversity across the villages: moderate (1 < H' < 3) and low (H' < 1). Only three villages (Citeureup, Cipageran, and Cibabat) exhibited moderate diversity, indicating more stable and even mosquito communities. Most villages, however, showed low diversity and strong dominance by a single species (e.g., *Ae. aegypti* in Pasirkaliki; *Culex* spp. in Baros, Leuwigajah, and Cibeureum). This imbalance suggests an unhealthy ecosystem, where species dominance can elevate the risk of specific disease transmission if the dominant species is a primary vector. Enhanced mosquito monitoring and management are crucial, particularly in villages with moderate diversity.

Evenness Index

The Evenness Index (J) measures the uniformity of individual distribution within an ecosystem's community, calculated by comparing the observed diversity (H′) to the maximum diversity (Hmax). This index reflects the degree of species distribution evenness. The Evenness Index results for mosquito species in Cimahi City are shown in Table 3.

Table 3 Mosquito species evenness index in mosquito biodiversity research in Cimahi City, January 2025

No	Villages	Evenness Index(J)	Interpretation
1	Citeureup	0,392	Distressed
2	Cipageran	0,376	Distressed
3	Cibabat	0,419	Distressed
4	Pasirkaliki	0,125	Distressed
5	Cigugur	0,365	Distressed
6	Karangmekar	0,249	Distressed
7	Baros	0,089	Distressed
8	Cimahi Tengah	0,273	Distressed
9	Padasuka	0,249	Distressed
10	Setiamanah	0,212	Distressed
11	Melong	0,188	Distressed
12	Cibeber	0,261	Distressed
13	Leuwigajah	0,100	Distressed
14	Utama	0,206	Distressed
15	Cibeureum	0,160	Distressed
Cimahi City		**6,084**	**Distressed**

Based on these results, all villages fell into the "Distressed Communities" category (J < 0.5), indicating a highly uneven species distribution and strong dominance by certain species. No villages were categorized as "Unstable" (0.5 < J < 0.75) or "Stable" (0.75 < J < 1). The most uneven distributions were observed in Baros (J = 0.089), Leuwigajah (J = 0.100), and Pasirkaliki (J = 0.125), where single species almost entirely dominated. Citeureup (J = 0.392), Cipageran (J = 0.376), and Cibabat (J = 0.419) showed comparatively better, though still stressed, species distribution.

Comparative studies in other Indonesian regions reveal significant variations in mosquito populations. In Bangsring Village, East Java, *Anopheles vagus* dominated collections (44% malaria, 19% dengue vectors). In Pulau Panggung Village, Muara Enim Regency, *Culex vishnui* and *Culex quinquefasciatus* were the most dominant in human landing and resting collections (e.g., *Cx. vishnui* MHD: 0.21/hour UOD, 2.29/hour UOL), while *Anopheles vagus* dominated cattle-baited collections (65.47% of total).[19,20]

These patterns suggest widespread distribution for species like *Ae. aegypti*, *Ae. albopictus*, and *Cx. quinquefasciatus*, likely due to similar environmental conditions and human activities. Studies in Yogyakarta identified light intensity, ventilation, poor drainage, and uncovered water containers as key contributors to mosquito breeding.[21,22] These findings highlight the role of environmental and behavioral factors in shaping mosquito species distribution across Indonesia.

CONCLUSIONS

A mosquito biodiversity study in fifteen villages in Cimahi City found that Culex spp. was the dominant species (54.67%), followed by *Ae. aegypti* (32.19%), *Armigeres spp.* (10.02%), and *Ae. albopictus* (3.19%), with a total of 439 mosquitoes collected. Baros village had the highest number of mosquito individuals (77), while Cimahi Tengah had the lowest (11). Most villages showed low species diversity (H′ ≤ 1), especially in Baros and Leuwigajah, while only Citeureup, Cipageran, and Cibabat had moderate diversity (1 < H′ < 3). The evenness index (J < 0.5) classified all areas as "distressed communities," indicating an uneven species distribution due to the dominance of Culex sp., although the differences in mosquito abundance were not statistically significant. The lowest evenness values were observed in Baros (J = 0.089), Leuwigajah (J = 0.100), and Pasirkaliki (J = 0.125). Furthermore, the Kruskal-Wallis test revealed no significant difference in mosquito counts between villages (p = 0.993).

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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