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ORIGINAL RESEARCH

Household Container Characteristics Associated with Mosquito Larval Presence in a Highland Community of Tana Toraja, Indonesia

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ABSTRACT

Introduction: Dengue continues to pose a major mosquito-borne public health problem in tropical countries, including Indonesia, where household water containers frequently serve as habitats for mosquito larvae. However, studies examining household container characteristics associated with mosquito larval presence in highland communities remain limited.

Methods: A community-based cross-sectional study was conducted in Bombongan Urban Village, Makale District, Tana Toraja Regency, South Sulawesi, Indonesia. The study included 100 households and 128 water-holding containers. Container type, functional container category, container condition, and mosquito larval presence were recorded through direct field observation. Associations were examined using Pearson's chi-square test and a binary logistic generalized estimating equations (GEE) model to account for household-level clustering.

Results: Of the 128 inspected water-holding containers, 89 (69.5%) were positive for mosquito larvae, and 94 (73.4%) were open. At the household level, 71 of 100 households had at least one larva-positive container, resulting in a House Index of 71.0%, a Container Index of 69.5%, and a Breteau Index of 89. Discarded containers had the highest proportion of larval positivity (91.7%), whereas animal drinking containers were the most frequently observed type. Functional container category was associated with larval presence in the bivariate analysis ($p = 0.025$) and remained significant as an overall variable in the GEE model (Wald $\chi^2 = 12.178$, $df = 3$, $p = 0.007$), although none of the individual categories differed significantly from animal drinking containers. Open containers had substantially higher adjusted odds of larval presence than closed containers (aOR = 73.56; 95% CI: 21.74–248.87; $p < 0.001$).

Conclusion: Open container condition was independently associated with mosquito larval presence, whereas functional container category showed a significant overall association. Discarded containers had the highest larval positivity, whereas animal drinking containers were the most frequently observed. Household mosquito-control measures may prioritize covering, emptying, cleaning, and appropriately disposing of water-holding containers.

Keywords: Mosquito Larvae; Household Containers; Container Condition; Larval Surveillance; Highland Community

INTRODUCTION

Diseases transmitted by mosquitoes remain an important global public health issue, particularly in tropical and subtropical environments where ecological conditions facilitate vector persistence and breeding activity (1). Dengue fever, in particular, has shown a steady rise in incidence in recent years, placing nearly half of the global population at risk of infection (2). The burden is particularly high in tropical areas, where climatic conditions such as elevated temperatures and humidity, along with rapid urbanization, increase the breeding potential and transmission efficiency of Aedes mosquitoes. Recent global reports have further indicated a significant surge in dengue cases, highlighting the critical need for comprehensive, sustainable, and evidence-driven approaches to vector control (2,3).

Dengue transmission is primarily mediated by Aedes aegypti and Aedes albopictus, two mosquito species that frequently adapt to human-populated environments and domestic surroundings (4–6). They predominantly breed in artificial water-holding containers located within and surrounding households. Common domestic items, such as buckets, flower pots, discarded containers, and animal drinking vessels, offer suitable habitats for oviposition and larval development (7–10). In many tropical settings, household water storage practices remain widespread due to irregular water supply and sociocultural factors, further increasing the availability of breeding sites (11).

Environmental conditions and human behavior play a critical role in shaping mosquito breeding dynamics (12,13). Mosquito breeding within household environments is affected by various environmental and behavioral factors, including container characteristics, water storage methods, sanitation quality, and maintenance activities carried out by residents (14,15). Previous studies have consistently shown that poorly managed containers, particularly those that are left uncovered or infrequently cleaned, significantly increase the risk of larval infestation (16). As a result, household environments serve as key ecological settings that sustain dengue transmission (17,18).

Environmental management has been increasingly promoted as a sustainable approach to vector control (19). This approach emphasizes the reduction or elimination of mosquito breeding habitats through environmental management measures, such as proper water storage practices, routine cleaning of containers, and the removal of discarded materials capable of retaining water (20). Compared to chemical-based interventions, environmental management is considered more sustainable because it addresses the underlying ecological determinants of mosquito proliferation (21,22). Identifying high-risk containers and understanding their environmental characteristics are therefore essential for designing effective intervention strategies (23).

Indonesia remains endemic for dengue transmission throughout the year, with all four dengue virus serotypes reported across diverse ecological settings (24,25). South Sulawesi Province, in particular, exhibits considerable geographical variation, ranging from coastal lowlands to highland areas (26). These ecological differences may influence mosquito breeding patterns and vector dynamics. Tana Toraja Regency represents a tropical highland setting where household water storage remains common, and recent reports indicate an increasing trend in dengue incidence in the area (27).

Although evidence on mosquito larval habitats has expanded, information from highland communities remains limited, particularly regarding the distribution of household water-holding containers and their association with larval presence. Previous studies have largely focused on lowland or densely populated urban settings. This study therefore aimed to describe household container characteristics and examine their association with mosquito larval presence in a highland community of Tana Toraja, Indonesia.

METHODS

Study Design and Study Area

This community-based cross-sectional study examined the association between household water-holding container characteristics and mosquito larval presence at the time of observation. The study was conducted from December 2024 to January 2025 in Bombongan Urban Village, Makale District, Tana Toraja Regency, South Sulawesi, Indonesia. The study area is located at an elevation of more than 500 m above sea level. Elevation was used only to describe the geographical context of the study and was not analyzed as an exposure variable. Temperature, humidity, rainfall, and variation in elevation within the study area were not measured.

Study Population and Sampling

The study population comprised all households in Bombongan Urban Village, Makale District, Tana Toraja Regency, totaling approximately 2,100 households according to local administrative records. The minimum sample size was calculated using the single population proportion formula with a 95% confidence level, an assumed proportion of 0.50, and an absolute precision of 0.10. The calculation yielded a minimum sample size of 96 households, and 100 households were ultimately included. This calculation was designed to determine the number of households required for the household survey; it was not a power calculation for the subsequent container-level multivariable GEE. Accordingly, the precision of the GEE estimates is interpreted cautiously.

The household was the sampling unit, whereas the water-holding container was the unit of analysis. A total of 128 containers were observed across the 100 participating households. Because more than one container could originate from the same household, household-level clustering was considered in the statistical analysis.

Sampling Technique
Households were selected using convenience sampling based on accessibility and residents' willingness to participate during the data collection period. This approach was applied because access to some households was limited and participation depended on residents' consent to inspect household water-holding containers. Therefore, the findings should be interpreted in relation to the surveyed households and should not be generalized without caution to the entire population of Bombongan Urban Village.

Inclusion and Exclusion Criteria
Households were included if they were located within the study area, occupied at the time of data collection, and had at least one accessible water-holding container that could be inspected. Participation also required consent from an adult household member. Households were excluded if they were vacant, if residents declined participation, or if no water-holding container was available for inspection.

Data Collection
Data were collected through direct observation using a structured checklist. Each water-holding container located within the surveyed household environment was inspected and recorded as a separate observation. The checklist documented the household identification number, container type, container condition, and the presence or absence of mosquito larvae. Container condition was classified as open when the water surface was accessible to mosquitoes and as closed when the container was covered in a manner that restricted direct access to the water.
Larval presence was assessed by direct visual inspection during the daytime. When the contents of a container could not be examined clearly from the surface, a dipping method was used to facilitate observation. A container was classified as larva-positive when at least one live mosquito larva was observed. The outcome was recorded as a binary variable: larva-positive or larva-negative.

Larval Observation and Field Classification
Larvae were identified in the field through direct visual observation of general mosquito larval characteristics. Observed features included an elongated aquatic body, active wriggling movement when disturbed, repeated movement between the water surface and deeper parts of the container, and respiration near the water surface through a visible siphon. Some larvae also showed field characteristics broadly consistent with Aedes-like larvae, including active movement, an angled position near the water surface, and a relatively short visible siphon.
These characteristics were used only for field screening. No microscopic examination, morphological key-based confirmation, rearing, or molecular testing was performed. Therefore, the study classified the outcome as mosquito larval presence rather than species-specific identification of Aedes aegypti.

Standardization of Observation
All observations were conducted using the same structured checklist and standardized field procedures. Before data collection, field observers received training on container classification, assessment of open and closed container conditions, recognition of general mosquito larval characteristics, and consistent recording of larval presence. Operational definitions were applied uniformly throughout the survey to reduce observer variation. A formal observer blinding procedure was not incorporated into the field protocol because container characteristics and larval presence were assessed during the same direct inspection; this is acknowledged as a potential source of observer-related measurement bias.

Data Quality Control
Completed observation forms were reviewed to assess completeness and consistency before data entry. The data were then coded and entered into the analytical database. Before statistical analysis, frequency distributions and cross-tabulations were examined to identify possible coding errors, missing values, and inconsistencies between variables. The variables included in the reported analyses—functional container category, container condition, and larval presence—were available for all 128 inspected containers; therefore, all 128 containers from 100 household clusters were retained in the analytic dataset and no container was excluded from the reported bivariate or GEE analyses.

Data Analysis
Descriptive statistics were used to summarize container type, functional container category, container condition, and mosquito larval presence. Categorical variables were presented as frequencies and percentages. The House Index, Container Index, and Breteau Index were calculated to describe larval occurrence among the surveyed households and containers. These indices were not interpreted as direct measures of adult mosquito density, viral infection, or dengue transmission.
For inferential analysis, the seven container types recorded during field observation were regrouped after data collection into four functional categories to reduce sparse cells while preserving functional interpretability. This post-data-collection grouping was introduced for the revised inferential analysis and was not prespecified before fieldwork. Water-storage containers comprised buckets, clean-water storage containers, and bathroom water containers (n = 41); domestic non-storage containers comprised flower pots and water dispensers (n = 29); discarded containers comprised cans, paint containers, bottles, and tires (n = 24); and animal drinking containers remained a separate category (n = 34). The association between functional container category and larval presence was assessed using Pearson's chi-square test; all expected cell counts exceeded

five. Container condition was also examined using Pearson's chi-square test, and crude odds ratios with 95% confidence intervals were calculated.

Because multiple containers could originate from the same household, multivariable analysis was conducted using a binary logistic generalized estimating equations (GEE) model. Household identification number was specified as the clustering variable, with a binomial distribution, logit link, robust covariance estimator, and exchangeable working correlation structure. Functional container category and container condition were entered as categorical predictors; animal drinking containers and closed containers were the reference categories. The model included 128 containers nested within 100 household clusters and yielded finite parameter estimates for all specified coefficients. The retained analysis output did not separately document a formal convergence-status indicator; therefore, formal convergence is not claimed. Formal collinearity diagnostics were not performed; accordingly, no claim of absence of collinearity is made. These reporting limitations were considered when interpreting the adjusted estimates. Adjusted odds ratios, 95% confidence intervals, Wald χ^2 statistics, and p-values were reported. Statistical significance was determined at $p < 0.05$.

Ethical Approval

Ethical clearance for this research was granted by the Research Ethics Committee of the Faculty of Public Health, Hasanuddin University (Approval Number: 1996/UN4.14.1/TP.01.02/2024). Before the survey was conducted, informed consent was obtained from all participating households after explaining the objectives and procedures of the study. Participation was entirely voluntary, and respondents were free to decline or discontinue their involvement at any stage without penalty. All information obtained during the study was treated confidentially, and no identifying personal data were documented. In addition, official permission to carry out the research was secured from the relevant local authorities.

RESULTS

Container Characteristics

A total of 128 water-holding containers were identified across 100 surveyed households, with one to two containers observed per household. Mosquito larvae were detected in 89 containers (69.5%), whereas 39 containers (30.5%) were larva-negative. At the household level, 71 of 100 households had at least one larva-positive container, corresponding to a House Index of 71.0%. The Container Index was 69.5%, and the Breteau Index was 89 larva-positive containers per 100 households.

Table 1. Distribution of Household Water-Holding Container Types

Container Type	Frequency (n)	Percentage (%)
Buckets	18	14.1
Flower pots	25	19.5
Clean water storage containers	17	13.3
Discarded containers (cans, paint containers, bottles, and tires)	24	18.8
Water dispenser	4	3.1
Animal drinking containers	34	26.6
Bathroom water containers	6	4.7
Total	**128**	**100.0**

Source: Primary data, 2025.

Table 1 shows that animal drinking containers were the most frequently observed container type, accounting for 34 of the 128 containers (26.6%). Flower pots represented 19.5% of the inspected containers, followed by discarded containers at 18.8%. Water dispensers were the least frequently observed type, comprising only 3.1% of all inspected containers.

Functional Container Categories and Mosquito Larval Presence

To facilitate inferential analysis, the original container types were grouped according to their household functions into four functional categories.

Table 2. Functional Container Categories and Mosquito Larval Presence

Functional container category	Larva-positive, n (%)	Larva-negative, n (%)	Total, n (%)
Water-storage containers	26 (63.4)	15 (36.6)	41 (100.0)
Domestic non-storage containers	16 (55.2)	13 (44.8)	29 (100.0)
Discarded containers	22 (91.7)	2 (8.3)	24 (100.0)
Animal drinking containers	25 (73.5)	9 (26.5)	34 (100.0)
Total	**89 (69.5)**	**39 (30.5)**	**128 (100.0)**

Source: Primary data, 2025.

Table 2 shows that discarded containers had the highest proportion of mosquito larval positivity, with 22 of 24 containers testing positive (91.7%). Animal drinking containers had the second-highest positivity proportion at 73.5%, followed by water-storage containers at 63.4% and domestic non-storage containers at 55.2%. The association between functional container category and mosquito larval presence was statistically significant (Pearson's $\chi^2 = 9.354$, df = 3, $p = 0.025$).

Entomological Indicators

To complement the container-level findings, entomological indices were calculated to summarize mosquito larval occurrence at the household and container levels. Among the 100 surveyed households, 71 had at least one larva-positive container. Of the 128 containers inspected, 89 were larva-positive.

Table 3. Household Entomological Indicators in the Surveyed Households

Indicator	Calculation	Value
House Index (HI)	71 larva-positive households / 100 households × 100	71.0%
Container Index (CI)	89 larva-positive containers / 128 containers × 100	69.5%
Breteau Index (BI)	89 larva-positive containers / 100 households × 100	89

Source: Primary data, 2025.

Table 3 shows that 71 of the 100 surveyed households had at least one larva-positive container, resulting in a House Index of 71.0%. The Container Index was 69.5%, based on 89 larva-positive containers among the 128 containers inspected. The Breteau Index was 89 larva-positive containers per 100 households. These indices describe mosquito larval occurrence within the surveyed households and containers and do not directly measure adult mosquito density, viral infection, or dengue transmission.

Container Condition and Mosquito Larval Presence

The distribution of mosquito larval presence according to container condition is presented in Table 4.

Table 4. Association Between Container Condition and Mosquito Larval Presence

Container condition	Larva-positive, n (%)	Larva-negative, n (%)	Total, n	Crude OR (95% CI)	p-value
Open	84 (89.4)	10 (10.6)	94	48.72 (15.37–154.41)	<0.001*
Closed	5 (14.7)	29 (85.3)	34	Reference	
Total	**89 (69.5)**	**39 (30.5)**	**128**	—	

* Statistically significant at $p < 0.05$; Pearson's chi-square test.
Pearson's $\chi^2 = 65.689$, df = 1, $p < 0.001$.
Source: Primary data, 2025.

Table 4 shows that mosquito larval presence was identified in 84 of 94 open containers (89.4%), compared with 5 of 34 closed containers (14.7%). Open containers had 48.72 times the crude odds of mosquito larval presence than closed containers (95% CI: 15.37–154.41; $p < 0.001$). The association between container condition and mosquito larval presence was statistically significant.

Multivariable Analysis of Container Characteristics and Mosquito Larval Presence

A binary logistic generalized estimating equation was used to examine the independent associations of container condition and functional container category with mosquito larval presence while accounting for the clustering of multiple containers within the same household.

Table 5. Generalized Estimating Equation Analysis of Factors Associated with Mosquito Larval Presence

Variable	Category	aOR	95% CI	p-value
Container condition	Open	73.56	21.74–248.87	<0.001*
	Closed	Reference	—	
Functional container category	Overall effect	—	—	0.007*
	Water-storage containers	0.28	0.05–1.81	0.183
	Domestic non-storage containers	0.26	0.04–1.60	0.146
	Discarded containers	4.88	0.59–40.66	0.143
	Animal drinking containers	Reference	—	—

* Statistically significant at $p < 0.05$.
Binary logistic generalized estimating equation with robust covariance estimation and an exchangeable working correlation structure; household ID was specified as the clustering variable.
aOR: adjusted odds ratio; CI: confidence interval.
Overall effect of functional container category: Wald $\chi^2 = 12.178$, df = 3, $p = 0.007$.
Effect of container condition: Wald $\chi^2 = 47.767$, df = 1, $p < 0.001$.
Source: Primary data, 2025.

Table 5 shows that container condition remained independently associated with mosquito larval presence after adjustment for functional container category and household-level clustering. Open containers had 73.56 times the adjusted odds of mosquito larval presence than closed containers (95% CI: 21.74–248.87; $p < 0.001$). Functional container category also

showed a significant overall association with larval presence (Wald χ^2 = 12.178, df = 3, p = 0.007). However, none of the individual functional container categories differed significantly from animal drinking containers after adjustment.

DISCUSSION

This study found a substantial occurrence of mosquito larvae in household water-holding containers in the surveyed highland community. Container condition showed the strongest independent association with mosquito larval presence, whereas functional container category also showed a significant overall association with larval occurrence. These findings indicate that container accessibility and household function are important environmental characteristics for understanding mosquito larval habitats in the study setting.

The observed data demonstrate frequent mosquito larval occurrence in water-holding containers within the surveyed highland community. The House Index was 71.0%, the Container Index was 69.5%, and the Breteau Index was 89. These indices describe larval occurrence among the surveyed households and containers and should not be interpreted as direct measures of adult mosquito density, viral circulation, or dengue transmission. Because temperature, humidity, rainfall, within-area elevation variation, and household behavioral practices were not measured, the present study cannot determine whether these factors explain the observed larval distribution. Evidence from previous studies suggests that local environmental conditions can influence mosquito habitats, but such mechanisms remain external contextual explanations rather than findings of the present study (4,5).

Animal drinking containers were the most frequently observed container type (34/128; 26.6%), whereas discarded containers had the highest proportion of larval positivity (22/24; 91.7%). These observations distinguish container frequency from larval positivity and do not establish why either pattern occurred. The study did not record whether individual containers were located indoors or outdoors, their cleaning or refilling frequency, duration of water retention, rainfall exposure, or animal-care practices. Consequently, explanations involving these characteristics should not be attributed to the observed containers unless directly measured. Previous studies have described water retention and limited maintenance as possible mechanisms in discarded containers, but these mechanisms were not tested here (7,23,28).

The analytical findings further clarify the relationship between container characteristics and mosquito larval presence. As shown in Table 2, functional container category was significantly associated with larval presence in the bivariate analysis (Pearson's χ^2 = 9.354, df = 3, p = 0.025). In the multivariable GEE model presented in Table 5, functional container category also remained statistically significant as an overall variable after adjustment for container condition and household-level clustering (Wald χ^2 = 12.178, df = 3, p = 0.007). However, none of the individual functional container categories differed significantly from animal drinking containers, which served as the reference category. This pattern indicates that the overall distribution of larval presence varied across container functions, although no single category showed an independently significant contrast with the reference group.

Container condition showed the strongest independent association with mosquito larval presence. Open containers had substantially higher adjusted odds of larval presence than closed containers (aOR = 73.56; 95% CI: 21.74–248.87; p < 0.001). This result indicates a strong association between observed water-surface accessibility and larval presence in the surveyed containers; it does not establish a causal effect of opening or closing a container. The direction of the association is consistent with previous literature on container accessibility and mosquito oviposition (8,11,18). However, the very wide confidence interval indicates substantial statistical uncertainty in the magnitude of the adjusted odds ratio and warrants cautious interpretation.

The descriptive results further showed that discarded containers had the highest larval-positive proportion, whereas animal drinking containers were the most frequently observed type. The present data support only these observed differences and do not identify the behavioral or environmental processes responsible for them. Water retention, cleaning frequency, refilling practices, rainfall exposure, and household maintenance behavior were not measured; therefore, any explanation involving these factors should be regarded as a hypothesis for future investigation rather than a finding of this study (29).

Animal drinking containers warrant attention because they represented the largest observed container category and 25 of 34 were larva-positive. This finding identifies their frequency and larval status within the surveyed households but does not demonstrate that animal-care routines, repeated refilling, prolonged water storage, or household neglect produced the observed larval presence. Those practices were not directly assessed. Future studies should measure these behaviors prospectively if their role in larval habitat persistence is to be evaluated.

Previous research has reported associations between accessible or inadequately managed water-holding containers and immature mosquitoes (14,18), and has identified discarded receptacles as potential larval habitats in several tropical settings (9,22). Other studies have likewise documented container characteristics relevant to Aedes larval habitats (7,23). In the present study, however, the inference is restricted to measured container characteristics. Functional container category was associated with larval presence as an overall variable in the adjusted GEE model (Wald χ^2 = 12.178, df = 3, p = 0.007), but none of the individual categories differed significantly from animal drinking containers after adjustment. By contrast, open container condition showed a strong independent association with larval presence. These results support attention to directly observed container characteristics without attributing the pattern to unmeasured household practices.

The findings should be interpreted within several limitations. First, the cross-sectional design establishes contemporaneous associations and does not permit causal or temporal inference. Second, larval assessment relied on direct visual field observation without microscopic, morphological key-based, rearing, or molecular confirmation; the outcome therefore represents mosquito larval presence and cannot be assigned definitively to Aedes aegypti or another species. Third, larval abundance, larval density, pupal productivity, and adult emergence were not quantified. Fourth, potentially relevant variables—including water source, water-storage duration, cleaning and refilling frequency, shading, organic matter, rainfall exposure, indoor/outdoor location, animal-care practices, and household prevention behavior—were not measured and cannot be used to explain the observed associations. Fifth, the household sample size was calculated for a single-proportion household survey and was not specifically powered for the container-level multivariable GEE. Although all 128 containers from 100 household clusters were included in the model, the limited number of observations and the sparse distribution of

some category-outcome combinations reduce precision, as reflected by the wide confidence intervals. Formal collinearity diagnostics were not performed, which should also be considered when interpreting the adjusted estimates. Finally, convenience sampling from one highland community limits representativeness and generalizability beyond the surveyed households (30).

The results have practical implications that should be framed as evidence-informed priorities rather than tested intervention effects. Because open container condition was strongly associated with larval presence, programs may prioritize inspecting open water-holding containers and implementing measures that restrict mosquito access to the water surface. The high observed larval positivity among discarded containers and the frequency of animal drinking containers also support the inclusion of these container types in routine larval surveillance. Covering, emptying, cleaning, or appropriately disposing of containers are established mosquito-control practices, but their effectiveness was not evaluated in this study. Intervention studies are therefore needed to determine their effect in this highland setting.

Future research should use longitudinal or repeated-measures designs to examine seasonal changes and clarify the temporal relationship between container characteristics and mosquito larval presence. Further studies should directly assess household practices, including container cleaning, covering, refilling, water-storage duration, animal care, and waste disposal, rather than inferring these behaviors from container characteristics. Species identification using microscopic or molecular methods is also needed to determine whether the observed larvae are *Aedes aegypti*, other *Aedes* species, or different mosquito genera. In addition, measuring larval abundance, pupal productivity, and adult mosquito emergence would provide a more accurate estimate of the relative contribution of each container category to mosquito population production. Expanding the research across different altitudes, seasons, and ecological settings would improve generalizability and support the development of context-specific mosquito- and dengue-control strategies.

CONCLUSION

This study documented frequent mosquito larval presence in household water-holding containers in a surveyed highland community of Tana Toraja, Indonesia. Open container condition was strongly associated with larval presence after adjustment for functional container category and household clustering (aOR = 73.56; 95% CI: 21.74–248.87; $p < 0.001$), although the wide confidence interval indicates limited precision. Functional container category was significant as an overall variable (Wald $\chi^2 = 12.178$, df = 3, $p = 0.007$), but no individual category differed significantly from animal drinking containers. Animal drinking containers were the most frequently observed type, whereas discarded containers had the highest proportion of larval positivity.

These findings are limited to the observed container characteristics and should not be interpreted as evidence that unmeasured household practices or environmental conditions caused larval presence. Larvae were identified visually without species confirmation, and the cross-sectional design precludes causal inference. For mosquito-control planning, the findings support prioritizing surveillance of open, discarded, and animal drinking containers; established practices such as covering, emptying, cleaning, and appropriate disposal may be considered, but their effectiveness was not tested here. Future studies should include species confirmation, longitudinal or repeated observations, direct measurement of household practices and environmental exposures, and measures of larval and pupal productivity.

DECLARATIONS

Author contributions: NN: Conceptualization; Investigation; Formal analysis; Writing – original draft. AAA: Supervision; Methodology; Writing – review & editing. HI, IA, MM, MNM, and AM: Writing – review & editing. All authors read, reviewed, and approved the final manuscript and accept accountability for the integrity and accuracy of the work.

Conflicts of interest: The authors state that no conflicts of interest exist in relation to this publication. The study was carried out without any commercial, financial, or other relationships that could potentially influence the research findings or interpretation.

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