



BANANA PLANT AXILS: OVERLOOKED BREEDING SOURCE OF *Aedes albopictus*, PERSISTENT EVEN IN WINTER: AN EXPERIENCE IN JHARGRAM, WEST BENGAL

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Aedes albopictus and *Stegomyia* infestations are now common in both rural and urban areas. Countries that had successfully controlled dengue earlier have been reinfested. This swift and extensive proliferation of the tiger mosquito can be attributed to its remarkable ability to reproduce in both anthropized and natural breeding sources. *Aedes albopictus* is the predominant vector of dengue in the Jhargram district, West Bengal, India. Dengue is no longer seasonal. It is transmitted throughout the year, even in winter. To the breeding sources of vectors, which are crucial for implementing effective

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interventions, entomological surveillance for dengue vectors was conducted at the rural sentinel site from January to December 2024. This was done in accordance with national guidelines. The methods of larval collection included dipping and pipetting techniques. Subsequently, the environmental parameters were analyzed in relation to the vector indices. A study revealed that the banana plant axils, commonly found in almost every peridomestic area of rural households, serve as significant, substantial, and persistent breeding grounds for *Ae. albopictus*, even during post-monsoon to winter. The breeding of *Aedes* vectors reached its peak during the monsoon, with a high abundance in anthropized containers. The study also indicated that, even in the absence of rainfall, breeding continued in the axils of banana plants, with water reservoirs being the primary anthropogenic breeding sites during that period. Moreover, rainwater retention during monsoon, along with the accumulation of dewdrops during the dry (winter) season, provides an additional support for consistent and enduring breeding at banana plant axils. Altogether, this complementary seasonal availability of two categories of breeding sources may enable very sustainable growth of *Ae. albopictus*, thereby facilitating dengue transmission throughout the entire season. Category-specific positivity rates of breeding containers indicate that the banana plant axils consistently exhibited a higher positivity rate throughout the year, reinforcing the feral nature of *Ae. albopictus*. In the control programme, considering Integrated Vector Management, we also need to include plant axils management during Larval Source Management.

INTRODUCTION

Asian Black tiger mosquito, the *Aedes (Stegomyia) albopictus* (Skuse, 1894) being originated from the tropical rain forest of Southeast Asia is now recognized as one of the 100 most invasive species in the world (GLOBAL INVASIVE SPECIES DATABASE, 2025) with its successful colonization in every continent of earth except Antarctica over the last 50 years (BATTAGLIA ET AL., 2022). With the invasion of *Aedes albopictus*, *Stegomyia* infestations are now common in both rural and urban areas, and every country that had achieved dengue control earlier has been reinfested (GARTZ, 2004). This swift and extensive proliferation of the tiger mosquito can be attributed to its remarkable ability to reproduce in both artificial and natural breeding sources, its tendency to bite during the day, and its preference for feeding on human blood (BENELLI ET AL., 2020).

Currently, *Aedes albopictus* is the predominant vector for dengue in the Jhargram district, West Bengal, India. Dengue transmission is no longer a problem limited to urban areas in the district or the entire state of West Bengal. Over the past three consecutive years, reports have indicated that dengue transmission has been initiated from rural areas within the district, as well as reported throughout the year, even in winter.

Entomological surveillance for dengue vectors is being routinely conducted to pinpoint the specific breeding habitats of local vectors, enabling the selection and implementation of targeted interventions as needed in dengue vector control programmes. As per the NCVBDC guidelines and manual on Integrated Vector Management in India (NVBDCP, 2024a,b), the practical and cost-efficient strategy for reducing *Ae. albopictus* populations in peri-urban and rural regions will rely on the active participation of an informed community alongside the assistance of skilled mosquito control workers.

The diapause habit of *Ae. albopictus* helps it to survive in winter by laying desiccation-resistant eggs. This helps to continue its lifecycle by overcoming the cold and dry conditions in winter. But is it the only option for them every time to lay eggs before winter and wait until the next monsoon? This study highlights the unhindered environmental support available for such a feral species in rural areas of Jhargram, which may help in formulating an effective programme strategy for the prevention and control of dengue.

MATERIAL AND METHODS

Monthly dengue entomological surveillance has been conducted over the years at sentinel sites in rural areas, and local vector-specific breeding habitats have been identified and noted, followed by categorisation of these habitats. The data set was compiled and analysed to follow the seasonal trend of predominant types of breeding sites.

- (i) **Study Location:** In 2023, the Gopiballavpur-I block was the epicentre of the district for dengue transmission, and for this reason, it was selected as the sentinel site for this study. The study was conducted from January to December 2024.

- (ii) Larval sample collection & identification at the district entomological laboratory:** During each entomological visit, 45-50 households were thoroughly checked for wet containers, and larval samples were collected from each of the larva-positive containers. The methods of larval collection included dipping and pipetting techniques, in accordance with national guidelines. The types of containers with larvae (breeding sources) were noted. Larval species identification of some of the collected samples was conducted at the district entomological laboratory, and the remaining samples were processed in the laboratory for hatching, species identification, and confirmation.
- (iii) Entomological parameters recorded:** The container index (CI) was calculated as the total number of *Ae. albopictus* larvae positive containers (including both natural, i.e. banana plant axils, and anthropized breeding containers) / total wet containers of these two categories of breeding pockets searched) \times 100 was recorded on a monthly basis to understand the breeding preference in this study.

In addition, the House Index (HI), Pupal Index (PI) & Breteau Index (BI), as well as other environmental parameters such as maximum and minimum temperatures, humidity, and precipitation (rainfall in the last 7 days), were recorded as part of dengue entomological surveillance (NVBDCP, 2023) for future reference.

To understand the breeding preferences the CI of plant axils and anthropized containers were calculated individually: (a) CI of banana plant axils = (total number of plant axils found positive with *Ae. albopictus* larvae / total number of plant axils with water accumulation searched) \times 100, and (b) CI of anthropized containers = (total number of anthropized containers found positive with *Ae. albopictus* larvae/total number of wet anthropized containers searched) \times 100.

RESULTS

Aedes albopictus was identified as the predominant *Aedes* species in the study area. The recorded monthly overall CI value showed a peak during the monsoon season (July–August) and a gradual decrease from the post-monsoon to the winter season (September to February). The container's specific CI in relation to the month of the year is presented in Tables 1, 2. Overall container positivity rate was found to be

higher for ‘Banana plant axil’ as compared with ‘Anthropized containers’. Anthropized containers serve as the primary breeding sources specifically during monsoon to post-monsoon, whereas the natural containers are the persistent ones throughout the season, including winter.

Table 1: The Total Containers Index and contribution of plant axil and anthropized containers in percentage

Survey Months	CI (TOTAL)	% of Banana Plant Axils	% of Anthropized containers
January	3.03	1.52	1.52
February	7.64	3.82	3.82
March	10.78	3.88	6.90
April	3.00	1.00	2.00
May	9.80	2.61	7.19
June	9.60	3.39	6.21
July	26.29	5.18	21.12
August	25.67	3.83	21.84
September	16.36	2.91	13.45
October	13.11	3.28	9.84
November	11.86	5.15	6.70
December	6.00	3.00	3.00

Table 2: Category specific Containers Index over the months

Survey Months	CI of Banana Plant Axils	CI of Anthropized containers
January	20.00	1.64
February	24.00	4.55
March	23.08	8.29
April	11.11	2.20
May	14.81	8.73
June	33.33	6.92
July	50.00	23.56
August	21.28	26.64
September	24.24	15.29
October	47.06	10.57
November	50.00	7.47
December	21.43	3.49

DISCUSSION

Aedes albopictus, the vector predominant in West Bengal, was reported in 2021 (BANERJEE ET AL., 2021). ROOP ET AL (2016) had noticed the presence of dengue vector breeding in different containers as well as in natural breeding sites in Delhi. *Aedes* has been observed breeding in various types of habitats related to agricultural crops in Kerala, like coconut, rubber, areca nut, cocoa and pineapple (ROOP ET AL., 2016). Bhaskar Rao in 2010, had studied in Calicut; his studies indicated that *Aedes* is primarily a forest-fringe mosquito breeding in natural sites including rock pools, leaf axils, tree holes, cut bamboo stumps, etc. ((RAO, 2010). A study in Srilanka indicated that females of *Aedes* mosquitoes have adapted to oviposit in a wide range of natural breeding habitats. The study emphasized that leaf axils of economically valuable crops and plants, such as pineapple, banana, and other ornamental plants, are some of the best examples. It highlighted the need to adopt vector control measures in such areas (GUNATHILAKAI ET. AL., 2000).

Our study observed similar findings, where *Ae. albopictus* breeding occurs in natural sites, such as the axils of the widely available banana plant in the rural belt. Year-round surveillance revealed that banana plant axils serve as significant natural breeding sites for *Ae. albopictus*, even during the winter, highlighting their entomological importance and the need for attention. A comparison of the overall CI value, shown in Figure I, with the CI of specific breeding sources—such as banana plant axils (natural source) and anthropogenic breeding sites—reveals that during the monsoon months, *Ae. albopictus* primarily breeds in anthropized containers (Fig. 1), with a notable abundance in these sources. However, as the monsoon season ends, the number of anthropized breeding sites gradually decreases due to the drying of containers, while breeding in plant axils increases there by enabling the dengue vector to survive and sustain its lifecycle.

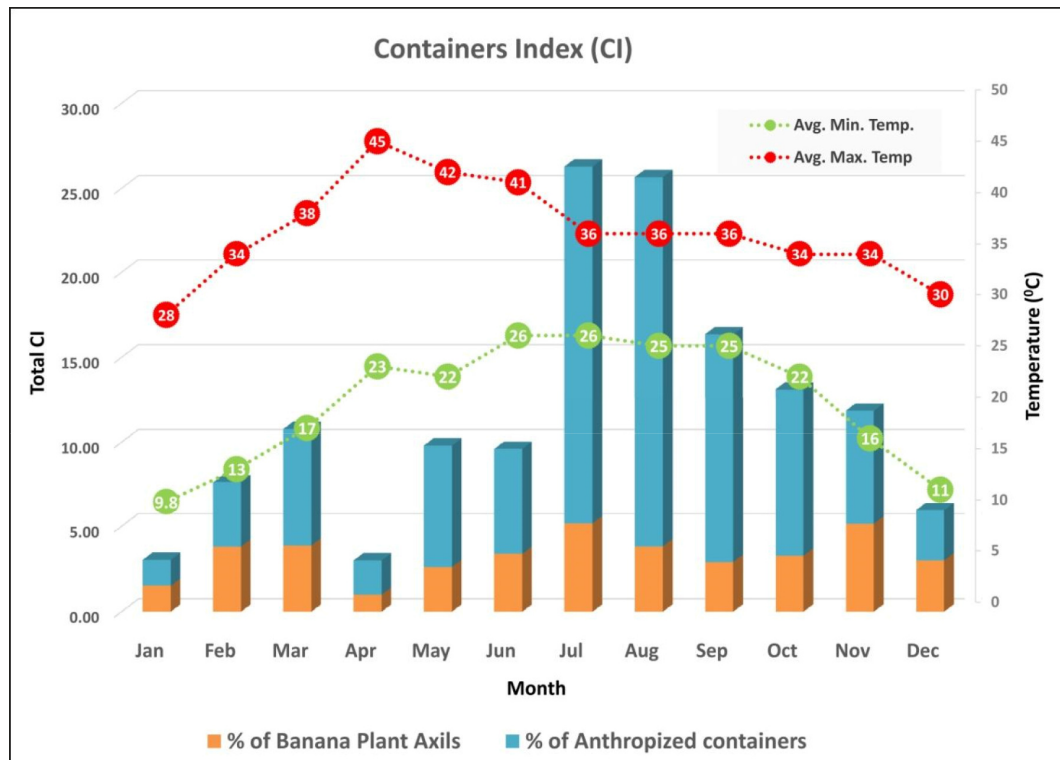


Fig. 1. Month wise comparative analysis of Containers Index (along with the share of two specific categories of breeding container)

Therefore, after the post-monsoon to the entire winter months, i.e. from November to February, the plant axil contributes a comparatively larger share, unlike that during monsoon. This habit of the vector may be due to the warm microenvironment within the plant axil, resulting from the high day temperatures. With the rise of temperature (in late winter), the proportion of breeding in plant axils decreases, which may be due to the drying up of water accumulation, but the breeding never stops completely. It has also been recorded that the *Ae. albopictus* breeding is continued in banana plant axils even in a lower temperature condition of 9-12° C (Fig. 4) to a higher temperature value of 45° C.

The complementary availability of two categories of breeding sources enables a highly sustainable reproduction of *Ae. albopictus*, resulting in dengue transmission throughout all the seasons. The breeding was also correlated with the

‘average last 7 days (from the date of survey) rainfall’. We noticed that in zero rainfall, the water reservoirs were the only major anthropized breeding resources. However, the breeding persisted in the axils of banana plants even at that time. The accumulated dew drops may provide additional support for consistent breeding at banana plant axils, throughout the year (except in April, which was the middle of summer and the hottest month of the study year), irrespective of rainfall. This emphasizes that plant axils have significant importance, apart from anthropized breeding resources, for persistent propagation throughout the year (Fig. 2).

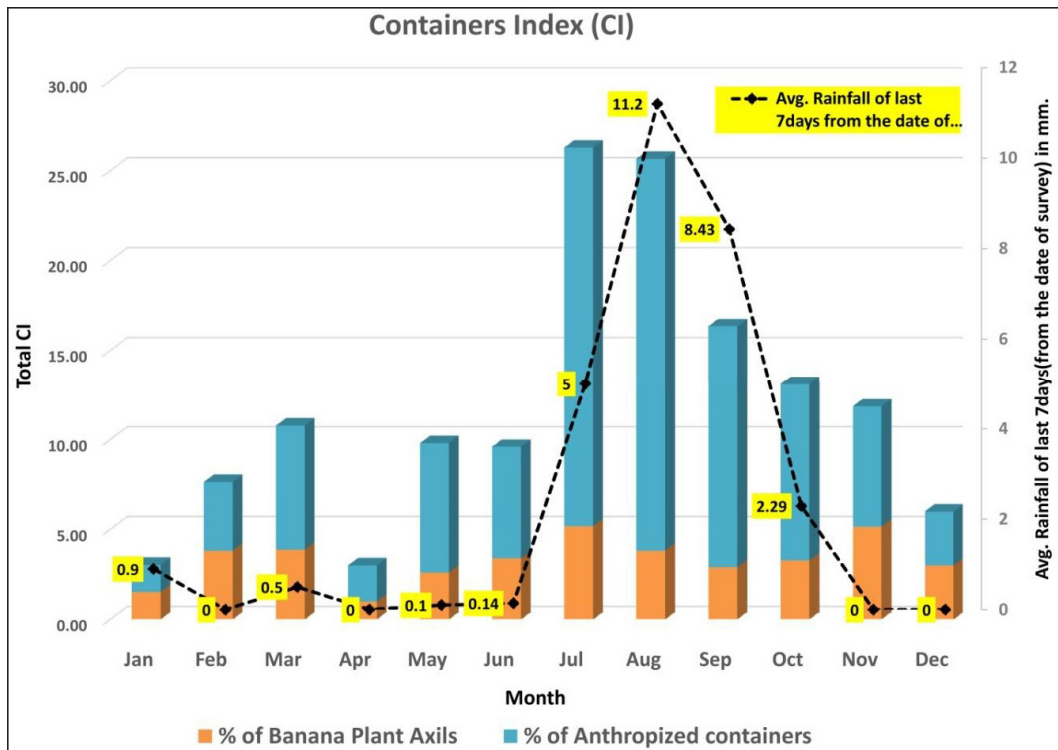


Fig. 2. Month wise comparative analysis of Containers Index vs average rainfall of last 7 days (from the date of survey)

Figure 3 shows the comparison between the specific container indices of the two particular categories (CI of natural containers banana plant axils vs. CI of anthropized containers). The results indicate that the banana plant axils consistently exhibited a higher positivity rate throughout the year (except in the peak of

monsoon when the abundance of anthropized containers is relatively much higher), reinforcing the feral nature of *Ae. albopictus*, suggesting that in the vector control programme, we need to include plant axil management as well during Larval Source Management (LSM).

But these plant axils remain masked and often go unnoticed, to facilitate vector breeding persistently throughout the year, especially when the other environmental / weather conditions become unfavourable and thus the vector continues its life cycle. These unnoticed areas, such as the axils of banana plants and other natural containers, provide an ideal environment for uninterrupted vector breeding during the winter. This may contribute to the increase in vector density with the rise of temperature or the onset of early summer, ultimately sparking/initiating the transmission of dengue.

In rural areas with abundant vegetation, the presence of *Stegomyia* vectors, which are transovarian in nature, further supports this cycle of transmission. This is a contributing factor, where dengue transmission starts in rural areas much earlier than in urban areas, as has been observed in Jhargram District over the last three years. However, other contributing factors supporting early dengue transmission in rural areas need to be studied and explored.

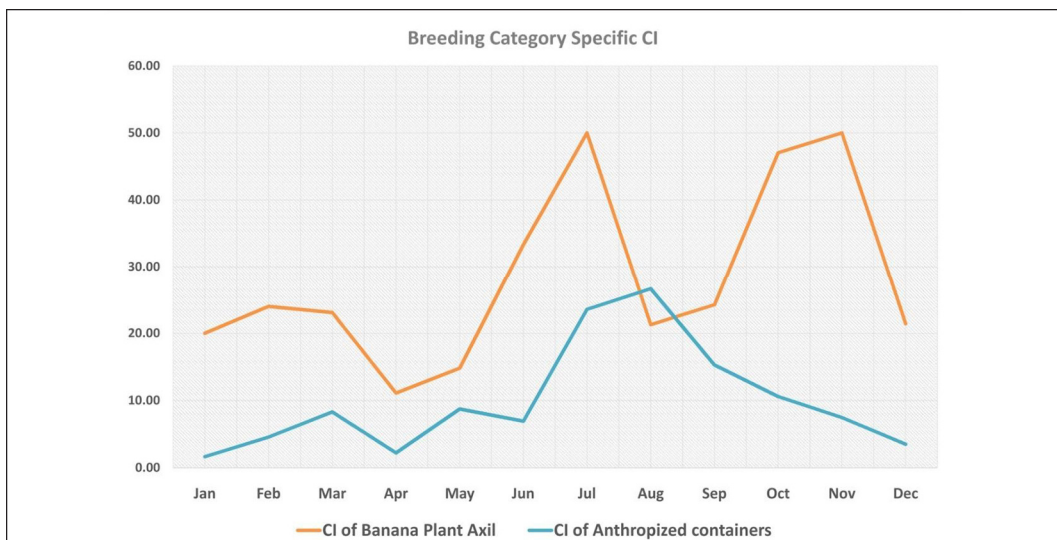


Fig. 3. Monthly category specific CI based *Aedes albopictus* larva positivity rate

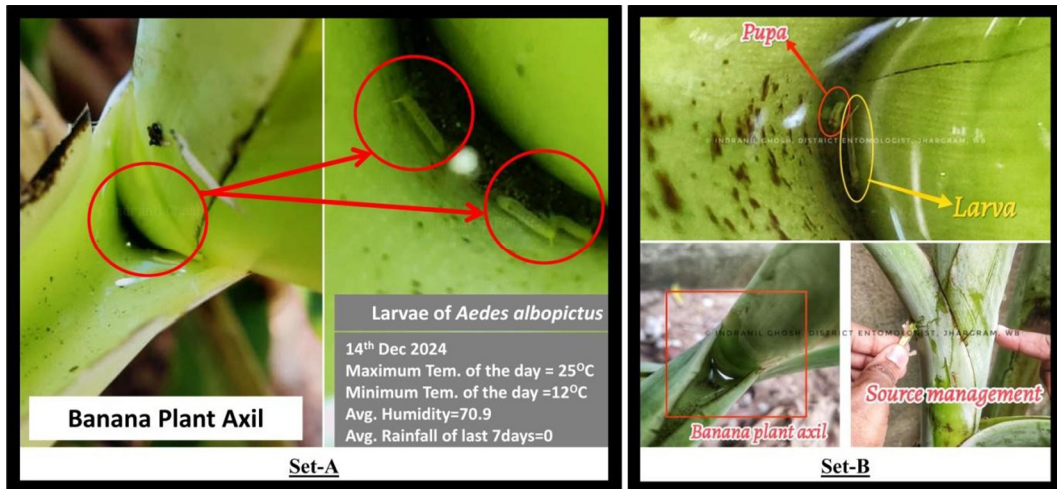


Fig. 4. Set-A: *Aedes albopictus* larvae positive banana plant axils. Sample collected in Dec 2024 having a minimum recorded temperature of 12°C & Set-B: *Aedes albopictus* pupa & larva. Source management by making hole on the same.



Fig. 5. Major Anthropized/Man-made containers found positive with *Aedes albopictus* during the survey : (a) Bamboo internodes, (b) Unmanaged cattle feeding containers [local Bengali name - 'tar'], (c) Earthen container, (d) Tarpaulin sheet, (e) Earthen containers - 'diya', (f) Discarded tyres, (g) Flower tub, (h) Discarded plastic bucket, (i) Discarded domestic containers - a spice storage tray or masala dani, (j) Discarded plastic article - a fan blade & (k) Discarded shoe.

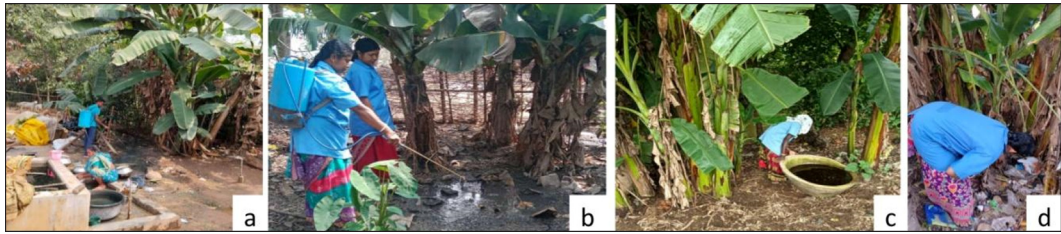


Fig. 6. Vector Control Team (VCT) workers spraying larvicide at drain (pic-a & b), managing unmanaged cattle feeding containers at peridomestic area (pic- c) and collecting solid waste from bakyards (pic- d) whereas the banana plant axils i.e. perennial *Aedes albopictus* breeding pockets remain left untouched



Fig. 7. Vector Control Teams later started manipulating the banana plant axils

The management of banana plant axils (and axils of other plants, such as arum and pineapple) is recommended for inclusion in routine IEC messages to raise community awareness. The Vector Control Team members should also be trained for the same, especially for actions in the winter when the anthropized sources are limited in numbers (Figs. 4-7). It can make an effective contribution to the successful prevention and control of dengue transmission, where the feral Asian black tiger, *Aedes albopictus* is the predominant vector.

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