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AEDES MOSQUITO ECOLOGY ALONG AN URBANISATION GRADIENT IN IBADAN, NIGERIA: PATTERNS OF OVIPOSITION, SPECIES COMPOSITION, AND IMPLICATIONS FOR ARBOVIRUS CONTROL

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Abstract
Aedes aegypti and *Aedes albopictus* drive the transmission of major arboviruses in West Africa, but their oviposition patterns and community structure across different levels of urbanisation in Nigeria remain poorly understood. To address this gap, ovitrap surveillance was conducted bi-weekly from July 2017 to April 2020 in Ibadan, southwestern Nigeria, covering four urban sites (Orogun, University of Ibadan, Samonda, and Ijokodo) and four semi-urban sites (Ojoo, Shasha, Idi-Ose, and Akingbile). Ovitrap positivity (OI) and egg density (EDI) were determined, and the collected eggs were subsequently reared to adulthood for morphological identification. A total of 6,558 ovitraps were deployed, of which 82.2% were recovered and 4,429 were positive, yielding 227,557 eggs. Ovitrap positivity varied across sites, with urban areas showing slightly lower but more variable values (74.5–83.1%) alongside higher egg densities (EDI = 57.5), whereas semi-urban areas recorded more consistent positivity (84.1%) but lower egg densities (EDI = 45.6). Urban areas were largely characterised by a strong dominance of *Aedes albopictus* (47.5%) and *Aedes aegypti* (38.8%). In contrast, semi-urban sites supported a more even mix, with *Ae. aegypti* (37.6%) and *Ae. albopictus* (36.1%) occurring alongside lower-density sylvatic species such as *Ae. africanus, Ae. luteocephalus*, and *Ae. simpsoni.* Species diversity and evenness were higher in semi-urban areas (Shannon H′ = 1.49; J = 0.76) than in urban areas (H′ = 1.20; J = 0.62). These findings demonstrate that urbanisation strongly influences *Aedes* ecology in Ibadan, with urban areas dominated by *Ae. albopictus* and characterised by higher egg production, creating conditions favourable for explosive arbovirus transmission, while semi-urban zones, with richer and more balanced assemblages including sylvatic species, may help maintain arboviruses between outbreaks. This study offers the first structured assessment of how oviposition patterns vary across an urbanisation gradient in Ibadan, underscoring the importance of adopting surveillance and control strategies that are tailored to local habitat transitions in order to effectively reduce arboviral transmission in fast-growing African cities.

Keywords: *Aedes aegypti*; *Aedes albopictus*; oviposition; urbanisation; arbovirus risk

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INTRODUCTION

Aedes aegypti and *Aedes albopictus* are extensively recognised as the principal vectors of several medically important arboviruses, including dengue, yellow fever, chikungunya, and Zika. These pathogens continue to represent a significant global health burden (Lwande *et al*., 2020), with dengue alone accounting for an estimated 50 million cases annually (Naslund *et al*., 2021). In Nigeria, both *Ae. aegypti* and *Ae. albopictus* has been implicated as the primary vector of dengue and yellow fever, the two arboviral diseases of greatest public health concern in the country (Agboli *et al*., 2021; Onoja *et al*., 2022). The spread and abundance of these mosquitoes are greatly influenced by weather conditions as well as human activities. Warm temperatures, high humidity, and heavy rainfall provide suitable conditions that help them survive and breed (Agwu *et al*., 2016). Besides, unplanned urban development, inadequate sanitation, and the widespread presence of water-holding containers create numerous larval habitats (Ayukekbong, 2014; Diallo *et al*., 2022; Kumar *et al*., 2024). Being container-breeding mosquitoes, they often make use of artificial habitats such as discarded tyres, plastic containers, and household water storage vessels. Their egg-laying behaviour is also influenced by the physical characteristics of the habitat, such as colour and surface texture (Prasad *et al*., 2023).

Although there is an urgent need for targeted control measures, studies on the ecology of *Aedes* in Nigeria are still limited, especially those examining how environmental factors and mosquito behaviour interact in different urban settings. Existing research has mostly focused on species distribution and insecticide resistance (Chukwuekezie *et al*., 2018; Ukpai and Ekedo, 2018), with little attention given to how oviposition activity and egg production vary along urbanisation gradients. This knowledge gap makes it challenging to design locally adapted strategies for vector surveillance and control. To address this, the present study examined spatial differences in *Aedes* oviposition activity and egg production across urban and semi-urban areas of Ibadan. To the best of our knowledge, this represents the first systematic assessment of oviposition heterogeneity of *Aedes* mosquitoes along an urbanisation gradient in the city.

MATERIALS AND METHODS

Study Area: The study was conducted fortnightly from July 2017 to April 2020 in Ibadan, Oyo State, Nigeria. Ibadan is situated within the tropical rainforest zone and experiences a bimodal climate, with rainfall concentrated between April and October and a dry period from November to March. Annual precipitation typically ranges from 1,230 to 1,300 mm, with the heaviest rains occurring around June and again in September.

Eight communities were selected along an urban–semi-urban gradient. Four study sites situated within Ibadan North Local Government Area (LGA) represented the urban environment: the University of Ibadan (7.4416° N, 3.8961° E), Orogun (7.4473° N, 3.9138° E), Samonda (7.4222° N, 3.8964° E), and Ijokodo (7.4049° N, 3.8795° E). The semi-urban component of the study was represented by four settlements located within Akinyele LGA, namely Ojoo (7.4590° N, 3.9185° E), Shasha (7.4540° N, 3.9300° E), Idi-Ose (7.4903° N, 3.9028° E), and Akingbile (7.5125° N, 3.9180° E). The spatial distribution of these sites across the two urban landscapes is shown in Figure 1.

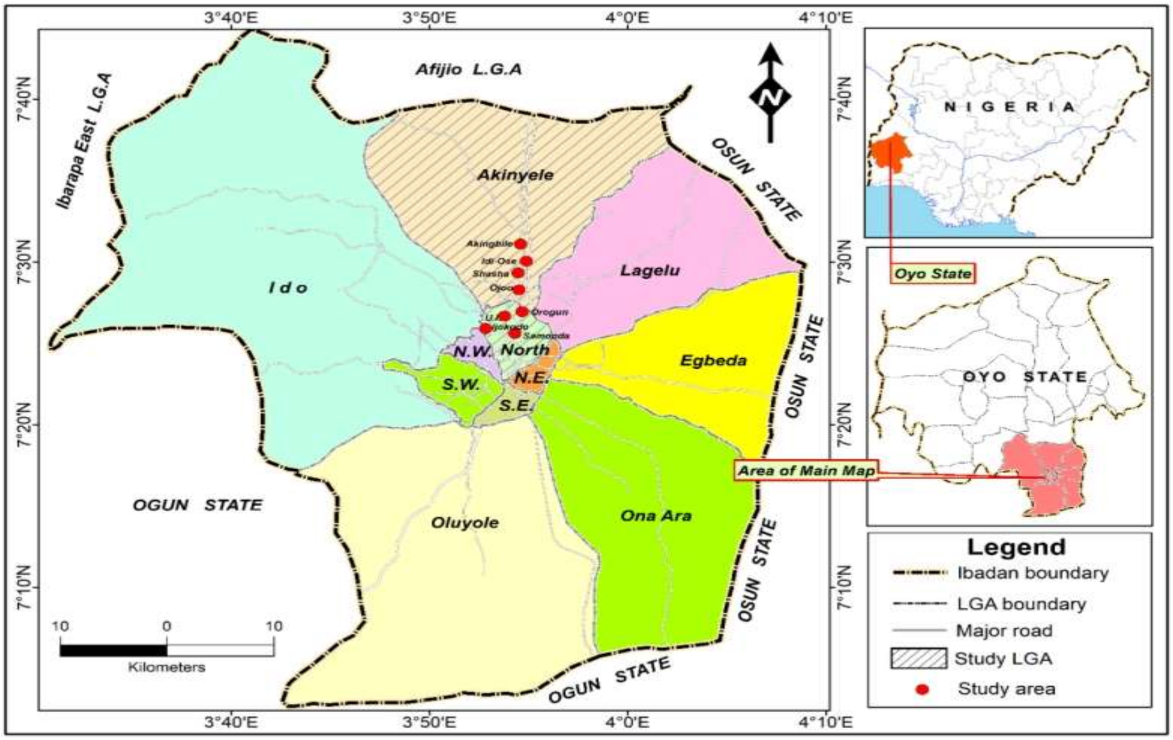

Figure 1: Map of study Sites showing urban and semi-urban communities in Ibadan North and Akinyele LGAs, Oyo State, Nigeria.

Ovitrap Surveillance: Ovitrap surveillance was conducted every fourth night during the study period, following the World Health Organisation's (WHO) recommendations for monitoring *Aedes* oviposition activity. Each ovitrap consisted of a black plastic container with a 300 ml capacity, filled with borehole water, and a roughened wooden or bamboo paddle (10 × 2.5 × 0.3 cm) to facilitate egg deposition. Four ovitraps were placed outdoors in randomly selected households within each community. After seven days, paddles were retrieved and then transported to the University of Ibadan insectary. Eggs were carefully rinsed off the paddles into labelled containers and reared with a standardised larval diet comprising low-fat cracker biscuits and baker’s yeast. Immature stages were observed daily until adult mosquitoes emerged, after which the adults were morphologically identified by species and sex. Adult *Aedes* specimens were identified under a stereomicroscope using recognized morphological keys. Sex was distinguished by antennal form: males had distinctly feathered antennae and comparatively elongated palps, whereas females showed simple, hair-like antennae and a well-developed proboscis used for blood feeding. Species determination was based on diagnostic scutal scale patterns. *Aedes aegypti* was confirmed by the presence of paired curved silver markings on the scutum, while *Aedes albopictus* was identified by its single, continuous white stripe running along the scutal midline.

Entomological Indices

Ovitrap Index (OI): Calculated as the proportion of ovitraps containing *Aedes* eggs. multiplied by 100

$$\mathrm{OI} = \frac{\text{Number of positive ovitraps}}{\text{Total number of ovitraps recovered}} X\,100$$

Egg Density Index (EDI): Represents the mean number of *Aedes* eggs found per positive ovitrap multiplied by 100

$$\text{EDI} = \frac{\text{Total number of Aedes eggs collected}}{\text{Number of positive ovitraps}} \text{ X } 100$$

Data Analysis

Oviposition data from all sites were initially explored using descriptive statistics. Differences in mean egg counts and Egg Density Index (EDI) among communities were tested with one-way ANOVA, while variations in Ovitrap Index (OI) were assessed using Chi-square tests. Egg production between urban and semi-urban areas was compared with a Student's t-test. Species diversity was quantified using the Shannon–Wiener index (H′), Simpson's index (D), and Pielou's evenness (J) to characterise community structure. Statistical significance was set at $p < 0.05$. All inferential analyses were conducted in SPSS version 22 (IBM Corp., Armonk, NY, USA), and diversity indices were generated in PAST version 3.0.

Ethics Statement

The study was conducted following ethical research standards. Access to each community was obtained through dialogue with local leaders, and households were included only after residents gave their voluntary informed consent. All activities were designed to respect the rights and well-being of participants

RESULTS

Oviposition Activity and Egg Production

Of the 6,558 ovitraps deployed, 5,391 (82.2%) were retrieved, and 4,429 (82.2%) were found positive for Aedes eggs (Table 1). In the urban locations, 2,154 traps were positive, with Ovitrap Indices (OI) ranging from 74.5% in Samonda to 83.1% in Ijokodo (mean OI = 80.2%; $\chi^2 = 10.17$, df = 3, $p = 0.017$). A total of 123,826 eggs were collected, with Samonda contributing the highest yield (46,782 eggs; mean 71.5 eggs/ovitrap; EDI = 96.1 ± 38.5), whereas Ijokodo recorded the lowest egg output (35.2 eggs/ovitrap; EDI = 42.3 ± 11.1). In the semi-urban sites, a slightly higher and more uniform mean OI was recorded (84.1%). Altogether, 103,731 eggs were collected in semi-urban sites, with Idi-Ose accounting for the largest share (26,997 eggs; mean 40.3 eggs/ovitrap; EDI = 49.4 ± 11.2). Despite their higher OI values, semi-urban locations had a lower Egg Density Index overall (EDI = 45.6 ± 11.6) compared with urban sites (EDI = 57.5 ± 30.1). When data from all sites were combined, ovitrap positivity remained consistently high (82.2%), yielding a total of 227,557 eggs (mean = 42.2 eggs/ovitrap; pooled EDI = 51.4 ± 23.4). Significant variation was observed in ovitrap recovery, total egg counts, mean eggs per ovitrap, and EDI ($\chi^2 = 34.71$, df = 3, $p < 0.05$; $\chi^2 = 54.27$, df = 3, $p < 0.05$), whereas ovitrap positivity and OI did not differ significantly across sites ($p > 0.05$).

Species Composition and Relative Abundance

Ovitrap collections from the four urban communities yielded 82,049 adult *Aedes* mosquitoes representing seven species (Table 2). The population was strongly dominated by *Aedes albopictus* (47.5%, n = 38,988) and *Aedes aegypti* (38.8%, n = 31,855), which together accounted for 86.3% of all specimens. *Ae. albopictus* proportions were consistently high across urban sites (45.7–49.3%), while *Ae. aegypti* also showed stable distribution (37.8–39.7%). Among secondary species, *Ae. africanus* ranked third (5.0%, n = 4,074), peaking in Samonda (5.1%). *Ae. simpsoni* contributed 3.1% (n = 2,540), with its highest proportion in Orogun (4.3%). Other species, such as *Ae.*

luteocephalus (2.1%, n = 1,694), *Ae. vittatus* (2.0%, n = 1,609), and *Ae. metallicus* (1.6%, n = 1,289), were consistently present but in lower numbers. Community-level yields of *Aedes* population in urban settlements were highest in Samonda (n = 31,329; 38.2%), followed by Orogun (22.7%), Ijokodo (19.7%), and the University of Ibadan (19.5%).

Semi-urban sites produced 68,679 adults, also comprising seven species (Table 3). Here, the assemblage was co-dominated by *Ae. aegypti* (37.6%, n = 25,845) and *Ae. albopictus* (36.1%, n = 24,810), together representing 73.8% of collections. *Ae. aegypti* peaked in Ojoo (39.9%) and was lowest in Idi-Ose (35.0%), while *Ae. albopictus* showed an inverse pattern, reaching 40.1% in Idi-Ose and 30.7% in Ojoo. Among the other species, *Ae. africanus* (8.6%, n = 5,917) was most frequent in Ojoo (9.3%) and Idi-Ose (8.9%), while *Ae. luteocephalus* (7.0%, n = 4,811) and *Ae. simpsoni* (4.2%, n = 2,887) were consistently represented across all sites. The least abundant species were *Ae. metallicus* (3.4%, n = 2,322) and *Ae. vittatus* (3.0%, n = 2,087), though both were widespread, peaking in Ojoo at 4.3% and 3.8%, respectively. Overall yields were balanced across semi-urban communities, with Ojoo (25.5%) and Idi-Ose (25.3%) contributing slightly more than Akingbile (24.7%) and Shasha (24.5%). Comparative analysis revealed significant differences in species composition along the urbanisation gradient ($\chi^2 = 4842.4$, df = 6, $p < 0.05$). Semi-urban habitats supported higher diversity (Shannon H’ = 1.49) and evenness (J = 0.76) compared with urban sites (H’ = 1.20, J = 0.62), indicating a more diverse and balanced *Aedes* community in semi-urban areas.

Table 1. Ovitrap Indices and Egg Density Patterns of *Aedes* Mosquitoes along an Urbanisation gradient in Ibadan, Nigeria

Settlements	Ovitraps Placed	Recovered Ovitraps	Positive Ovitraps	Ovitrap Index OI (%)	No. of Eggs	Mean Eggs/Ovitrap	EDI % (Mean ±SD)
Urban							
Orogun	816	697	574	82.4	28,661	41.1	49.9 ± 17.1
Univ.of Ibadan	816	678	548	80.8	25,316	37.3	46.2 ± 12.2
Samonda	894	654	487	74.5	46,782	71.5	96.1 ± 38.5
Ijokodo	768	656	545	83.1	23,067	35.2	42.3 ± 11.1
Urban Total	3,294	2,685	2,154	80.2	123,826	46.1	57.5 ± 30.1
Semi-urban							
Ojoo	816	674	583	86.5	24,673	36.6	42.3 ± 11.0
Shasha	816	687	577	84	26,129	38	45.3 ± 11.3
Idi-ose	816	670	547	81.6	26,997	40.3	49.4 ± 11.2
Akingbile	816	675	568	84.2	25,932	38.4	45.7 ± 10.7
Semi-urban Total	3,264	2,706	2,275	84.1	103,731	38.3	45.6 ± 11.6
Overall Total	6,558	5,391	4,429	82.2	227,557	42.2	51.4 ± 23.4

Table 2: Species composition and relative abundance of adult *Aedes* mosquitoes emerged from ovitrap collections from three study locations in the urban area of Ibadan

Species	Orogun (N, %)	University of Ibadan (N, %)	Samonda (N, %)	Ijokodo (N, %)	Overall Total (N, %)
Aedes vittatus	643 (3.46)	266 (1.67)	294 (0.94)	406 (2.51)	1609 (1.96)
Aedes metallicus	383 (2.06)	74 (0.46)	365 (1.17)	467 (2.89)	1289 (1.57)
Aedes simpsoni	791 (4.25)	645 (4.04)	551(1.76)	553 (3.42	2540 (3.1)
Aedes africanus	877 (4.72)	835 (5.23)	1606 (5.13)	756 (4.680	4074 (4.97)
Aedes luteocephalus	375 (2.02)	398 (2.49)	633 (2.02)	288 (1.78)	1694 (2.06)
Aedes albopictus	8505 (45.73)	7528 (47.13)	15435 (49.27)	7520 (46.57)	38988 (47.52)
Aedes aegypti	7025 (37.77)	6226 (38.98)	12445 (39.72)	6159 (38.14)	31855 (38.82)

Table 3: Species composition and relative abundance of adult *Aedes* mosquitoes emerged from ovitrap collections from three study locations in the Semi-Urban area of Ibadan

Species	**Ojoo** (N, %)	**Shasha** (N, %)	**Idi-Ose** (N, %)	**Akingbile** (N, %)	**Overall Total** (N, %)
Aedes vittatus	665 (3.8)	437 (2.6)	488 (2.80)	497 (2.93)	2087(3.04)
Aedes metallicus	754 (4.31)	533(3.17)	408 (2.34)	627 (3.70)	2322(3.38)
Aedes simpsoni	763 (4.36)	667 (3.96)	703(4.04)	754 (4.45)	2887 (4.2)
Aedes africanus	1625 (9.29)	1340 (7.96)	1552 (8.92)	1400 (8.26)	5917 9 (8.62)
Aedes luteocephalus	1335 (7.63)	1042 (6.19)	1183 (6.80)	1251 (7.38)	4811 (7.01)
Aedes albopictus	5371 (30.7)	6386 (37.94)	6971 (40.07)	6082 (35.88)	24810 (36.12)
Aedes aegypti	6984 (39.92)	6427 (38.18)	6094 (35.03)	6340 (37.40)	25845 (37.63

DISCUSSION

This study provides a detailed assessment of *Aedes* oviposition patterns, species composition, and community structure across urban and semi-urban areas of Ibadan, offering important insights into arbovirus risk and the development of location-specific vector control strategies. The consistently high ovitrap positivity (82.2 per cent) recorded across all sites shows that productive breeding containers are abundant and highlights the strong ability of *Aedes* mosquitoes to thrive in environments shaped by human activity. Comparable findings from other parts of West Africa indicate that practices such as water storage, container accumulation, and inadequate waste disposal play a major role in sustaining *Aedes* populations and increasing arbovirus transmission risk (Konan *et al*., 2013; Akagankou *et al*., 2025).

A key outcome of this study is the marked variation in *Aedes* oviposition activity across the urbanisation gradient in Ibadan. Semi-urban sites recorded a higher and more consistent ovitrap index (84.1 per cent), suggesting relatively stable ecological conditions and fewer disruptions to breeding habitats. This pattern aligns with earlier reports showing that semi-urban landscapes often provide predictable oviposition sites through the combination of shaded vegetation, natural containers, and regular household water storage practices (Abdulai *et al.* 2024; Zahouli *et al.* 2017). In contrast, ovitrap indices in urban areas were more variable (74.5 to 83.1 per cent), likely reflecting the diverse and frequently changing conditions associated with container type, water quality, and local waste management. Yet, despite this variability, urban habitats produced a considerably larger number of eggs overall, with an Egg Density Index of 57.5 per cent compared with 44.3 per cent in semi-urban areas. This indicates that although oviposition may occur less consistently in the urban setting, the sites that are used tend to support higher fecundity, probably due to nutrient-rich artificial containers and higher mosquito densities. Similar contrasts between oviposition frequency and egg production have been documented in other African and Asian cities (Zahouli *et al*., 2017; Kolimenakis *et al.,* 2021).

Temporal patterns further illustrate the distinct population dynamics along the gradient. In the urban sites, mean egg density and ovitrap index showed no significant differences across years, reinforcing the idea that dependable artificial habitats support stable *Aedes* populations in densely populated environments (Omoregie *et al.,* 2025). The peak egg density observed in 2019 (64.4 eggs per trap) most likely reflects short term environmental changes such as rainfall or sanitation, while the highest ovitrap index recorded in 2017 (83.7 percent) mirrors observations from Gampaha in Sri Lanka, where early season increases in trap positivity were associated with the onset of rains and the accumulation of water holding containers (Amarasinghe and Nadeeka 2021). By comparison, semi-urban sites showed clearer year-to-year fluctuations. Egg density rose to 48 eggs per trap in 2019 but declined to 32.5 eggs per trap in 2020, reflecting the stronger influence of rainfall variability, vegetation cover, and household water storage patterns in communities such as Ojoo, Shasha, Idi Ose and Akingbile. Although ovitrap indices did not differ significantly across years, they remained consistently high, with a peak of 87.7 per cent in 2017. This persistence resembles patterns seen in peri-urban Accra, where diverse microhabitats maintain steady oviposition even during periods of environmental change (Akorli *et al.,* 2025). Overall, these findings show how the degree of urbanisation shapes *Aedes* reproductive behaviour in Ibadan. Urban habitats favour high egg production even when oviposition is irregular, while semi-urban environments support more stable oviposition but with lower egg output. These dynamics correspond with patterns reported in Oshogbo (Adeleke *et al*., 2013) and across tropical West Africa, where urban *Aedes* populations often remain stable, whereas peri-urban populations respond more strongly to environmental fluctuations (Djiappi Tchamen *et al.,* 2021; Bire *et al.,* 2025). The rise in egg density in 2019 is also consistent with reports of heavy rainfall across Nigeria that year, conditions known to increase container productivity and stimulate oviposition (Adamu 2020). Another important outcome of this study is the strong co-dominance of *Aedes albopictus* and *Aedes aegypti,* which together accounted for more than 70% of all specimens collected. Their joint prominence underscores their significant epidemiological role within the Ibadan metropolis, where both species readily exploit the abundant container habitats that accompany rapid urban expansion. Similar patterns of coexistence have been observed in other Nigerian cities, including Abeokuta and Oshogbo (Adeleke *et al*., 2008; Adeleke *et al.,* 2013), as well as Abuja, Kaduna, and Enugu (Nwangwu *et al.,* 2024; Chukwuekezie *et al.,* 2018). Co-dominance of these species is also widespread across neighbouring West African countries such as Ghana, Benin and Cameroon (Kamgang *et al*., 2017; Captain Esoah *et al.,* 2020; Padonou *et al*., 2023), reflecting their ability to occupy overlapping ecological niches and their shared reliance on artificial containers.

The presence of *Ae. albopictus* alongside *Ae. aegypti* is particularly noteworthy. *Ae. albopictus* is recognised globally as a highly invasive mosquito species capable of thriving in disturbed and rapidly changing environments because of its ecological plasticity and strong competitive ability (Bonizzoni *et al*., 2013). Its successful establishment in Ibadan indicates favourable conditions for further spread and potential shifts in local vector dynamics. The coexistence of both species carries significant public health relevance because it expands the potential routes for arbovirus transmission. *Ae. aegypti* continues to serve as the principal vector of dengue, chikungunya and yellow fever, while *Ae. albopictus* is now frequently reported as an effective secondary or bridging vector in both urban and semi-urban environments (Chepkorir 2020).Together, their dominance reinforces the need for targeted vector surveillance strategies that consider species interactions, ecological adaptability and the changing landscape of urbanisation in southwestern Nigeria.

The Ibadan data also revealed a distinct shift in species composition along the urban to semi-urban gradient. *Aedes albopictus* was more prevalent in the urban neighbourhoods, where discarded tyres, plastic containers and other artificial receptacles provided highly productive breeding sites. In contrast, *Aedes aegypti* was more frequently encountered in the semi-urban zones, where lower levels of waste accumulation and reduced habitat disturbance created conditions that favour its persistence. Similar patterns of increasing *Ae. albopictus* presence in some locations, and early signs of displacement of *Ae. aegypti, have* been reported across Nigeria (Adeleke *et al.,* 2008; Adeleke *et al*., 2010; Nwangwu *et al.,* 2024) and parts of Central Africa (Kamgang *et al*., 2017; Tedjou *et al*., 2020). In Nigeria, the spread of *Ae. albopictus* has long been associated with the importation of second-hand tyres beginning in the 1990s (Mbanugo and Okpalaonuju 2003), and discarded tyres in Ibadan continue to serve as highly productive breeding habitats (Adeleke *et al*., 2008). Comparable reports from Cameroon and Central Africa document a gradual replacement f *Ae. aegypti* by *Ae. albopictus* under suitable ecological conditions (Ngoagouni *et al*., 2015). However, cases that contradict this displacement trend also exist. Studies from Oshogbo (Adeleke *et al.,* 2013), northern Nigeria (Isa *et al*., 2023), and other West African settings (Zahouli *et al*., 2016) have reported *Ae. aegypti* as the dominant species, underscoring the strong influence of local ecological characteristics and socio-environmental conditions on species outcomes. Evidence from Côte d'Ivoire further illustrates this context specificity: at the container terminal of the Autonomous Port of Abidjan, *Ae. aegypti* accounted for nearly all specimens (98.39 per cent), while *Ae. albopictus* occurred at very low levels (1.17 per cent) during its first detection in the country, likely introduced via international shipping (Konan *et al*., 2013). The contrast between Ibadan and Abidjan highlights how *Aedes* community structure is shaped by highly localised factors and how transport hubs continue to serve as key gateways for invasive mosquito species.

Patterns of species diversity in Ibadan also aligned with the urbanisation gradient. Semi-urban areas displayed higher richness and evenness and consistently supported sylvatic species such as *Ae. africanus*, *Ae. luteocephalus* and *Ae. simpsoni*. Though present at lower densities, these species indicate spillover from nearby natural habitats and point to the possibility of interactions between sylvatic and human transmission cycles. This suggests that semi-urban environments may present a more complex epidemiological landscape, with multiple species potentially contributing to arbovirus transmission. In contrast, urban areas exhibited reduced diversity and were dominated mainly by the two container breeding species, a pattern frequently observed in rapidly urbanising African cities.

CONCLUSION

This study demonstrates that urbanisation strongly shapes *Aedes* mosquito ecology in Ibadan, producing distinct species patterns across neighbourhoods. Urban areas, dominated by *Aedes albopictus* and characterised by higher egg productivity, represent zones of elevated epidemic potential. Semi-urban sites, although less productive, support more diverse communities that include sylvatic species capable of sustaining viruses between outbreak periods. These findings highlight the importance of location-specific vector management. Focused control of *Ae. aegypti* and *Ae. albopictus* is needed in densely populated urban districts, while semi-urban areas require continuous monitoring to detect spillover from sylvatic mosquito species. Incorporating these ecological insights into routine monitoring will strengthen early-warning systems and improve arbovirus prevention strategies in rapidly expanding Nigerian cities.

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