3.3 Seasonal differences among mosquito species

Different mosquito species exhibit distinct seasonal patterns driven by their ecological adaptations and habitat preferences. *Aedes aegypti* typically peaks during warm wet seasons when artificial containers fill with water in urban environments, whereas *Ae. albopictus* may show greater abundance in more vegetated suburban or rural areas with higher humidity (Blanco-Sierra et al., 2024; García-Súarez et al., 2024). Anopheline mosquitoes responsible for malaria transmission often display seasonality closely tied to agricultural practices and natural water availability; for example, *Anopheles vagus* thrives in flooded rice paddies during rainy seasons (Rakotoarison et al., 2025). Species like *Culex sitiens* and *Culex gelidus* show differing peak abundances within the same region one peaking early in the rainy season and another later reflecting niche partitioning (Laojun et al., 2025).

Seasonal timing also affects life stage distributions within species populations. Stage-structured models reveal that eggs, larvae, pupae, and adults respond differently to environmental cues such as temperature and rainfall throughout the year. This results in shifts not only in total abundance but also in population age structure which can influence disease transmission potential (Baafi and Hurford, 2025). Moreover, urbanization gradients modify these seasonal dynamics by altering habitat availability and microclimate conditions favoring some species over others (García-Súarez et al., 2024; Whittaker et al., 2022). Understanding these interspecific differences is critical for designing targeted vector control strategies that consider both temporal windows of peak risk and species-specific ecology.

4 Types and Characteristics of Mosquito Habitats

4.1 Natural habitats

Natural mosquito habitats in tropical environments primarily include standing water bodies such as ponds, swamps, slow-moving streams, and phytotelmata water-holding structures in plants like bromeliads and bamboo internodes. These habitats provide essential aquatic environments for mosquito larvae development. For example, *Anopheles funestus*, a major malaria vector in southeastern Tanzania, predominantly breeds in small spring-fed pools, natural ponds that retain water most of the year, and slow-moving river tributaries with clear water and emergent vegetation (Nambunga et al., 2020). Similarly, phytotelmata in tropical forests support diverse mosquito communities; bamboo internodes have been shown to harbor high species richness and abundance due to favorable microhabitat conditions such as temperature and pH (De Almeida et al., 2025). Vegetated areas adjacent to water bodies often offer shaded breeding sites that protect larvae from predators and extreme environmental fluctuations.

The physicochemical characteristics of these natural habitats influence mosquito species composition and larval productivity. Studies in Iran found significant differences among mosquito species in their preferences for chloride content and water temperature but not for pH or turbidity (Amini et al., 2020). In addition, dissolved oxygen levels, alkalinity, and emergent plant coverage have been linked to larval abundance for various species including *Anopheles vagus* and *Culex quinquefasciatus* (Bashar et al., 2016). The permanence of water bodies also plays a role; permanent or semi-permanent habitats tend to support stable populations of certain vectors by providing consistent breeding sites throughout the year (Dida et al., 2018; Nambunga et al., 2020). Understanding these natural habitat features is critical for identifying key breeding sites for vector control efforts.

4.2 Artificial habitats

Urbanization creates numerous artificial aquatic habitats that serve as prolific breeding grounds for mosquitoes, especially container-breeding species like *Aedes aegypti*. Common urban habitats include buckets, flower pots, ornamental bromeliads, discarded tires, drainage systems, and water storage containers. Research conducted in Miami-Dade County demonstrated that *Ae. aegypti* was highly concentrated in specific neighborhoods where such artificial containers were abundant (Wilke et al., 2019). These man-made habitats often lack natural predators and provide stable microclimates favorable for larval development. The spatial clustering of these breeding sites within urban landscapes highlights the importance of targeted source reduction strategies.