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Editorial: Innovative strategies for identifying and controlling insect vectors in public health

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Editorial on the Research Topic:
Innovative strategies for identifying and controlling insect vectors in public health

Insect vectors play a crucial role in the transmission of pathogens to humans and animals, making them a central focus of global public health initiatives. Vector-borne diseases account for over 17% of all infectious diseases and cause more than 700,000 deaths annually. The emergence and re-emergence of these diseases, especially in tropical and subtropical regions, underscore the urgent need for more effective and innovative surveillance and control strategies.

Climate change, urbanization, and land-use alterations have significantly affected the population dynamics, distribution, and behavior of vector species. These environmental changes directly influence vector development, survival, and pathogen transmission, as insect vectors are highly sensitive to fluctuations in temperature, precipitation, humidity, and host availability. Furthermore, anthropogenic activities such as deforestation, agriculture, mining, and dam construction have disrupted natural ecosystems, creating new opportunities for vector expansion and pathogen spillover. In this context, novel and integrated approaches to identifying, monitoring, and controlling insect vectors are more essential than ever.

This Research Topic brings together diverse contributions that address the challenges and advances in vector ecology, monitoring, and control.

Azevedo et al. presented a faunistic inventory and ecological analysis of Calliphoridae and Mesembrinellidae in the Três Picos State Park (Rio de Janeiro, Brazil). Although not classic disease vectors, these dipteran families are ecologically significant as decomposers and bioindicators. Their inclusion underscores the importance of broader biodiversity assessments within health-relevant entomology. The authors reported greater species richness and diversity in forested environments, with some species occurring exclusively in preserved areas. These findings support the use of these taxa as bioindicators of environmental quality and contribute to the development of ecological indicators that may guide vector control strategies in preserved and transitional habitats.

Dias et al. studied the effects of multiple water immersions on the eggs of *Aedes albopictus* and *Haemagogus*, two important arbovirus vectors. Understanding desiccation resistance and hatching patterns of mosquito eggs is crucial for integrated vector management, particularly in regions with irregular rainfall, where control strategies must anticipate population surges from dormant eggs. They found that *Ae. albopictus* and *Hg. leucocelaenus* hatched primarily during early immersions, whereas *Ae. terrens* and *Hg. janthinomys* required more than 20 immersions to reach peak eclosion. By simulating ecologically realistic conditions, the study reveals interspecific differences in hatching dynamics and provides practical implications for anticipating vector outbreaks under scenarios of climate variability.

Gnankine and Dabiré reviewed the natural occurrence of *Wolbachia* in *Anopheles* and *Aedes aegypti*. This research provides important insights in relation to the use of endosymbiotic bacteria in vector control strategies through reproductive manipulation while also highlighting the ecological considerations of leveraging natural infections in such strategies. The authors identified multiple naturally occurring *Wolbachia* strains in wild *Anopheles* populations and highlighted that such natural infections may interfere with or enhance transfection-based control programs. These effects may occur through competition with introduced strains or by altering cytoplasmic incompatibility dynamics, thus affecting the stability and success of population replacement strategies. By addressing both natural and artificially induced infections, their findings prompt a reassessment of current biocontrol frameworks and support the refinement of *Wolbachia*-based interventions, particularly in malaria-endemic regions.

Ogolla et al. enriched tsetse fly ecology by identifying the bloodmeal hosts of *Glossina austeni* and *G. pallidipes* in Kenya. These data are of fundamental importance when considering constructing effective bait-based control programs against Human African Trypanosomiasis, especially in wildlife-rich conservation areas. Their results showed that *G. pallidipes* preferred feeding preference on warthogs, whereas *G. austeni* fed primarily on bushbucks and suni antelopes. These host-specific patterns can inform the development of odor-based attractants tailored to each tsetse species, potentially increasing the effectiveness of trap-based control strategies.

Yang et al. proposed a new approach to surveillance using Google Trends to assess public interest in tick-borne disease prevention. The authors showed that search volumes for terms such as *tick bite*, *tick removal*, *Lyme disease*, and *tick prevention* were associated with Lyme disease incidence and seasonal outdoor activity. These findings suggest that real-time online behavior may serve as an early indicator of vector exposure risk. Their findings highlight the potential of digital data to complement traditional epidemiological tools, improving communication, public awareness, and early warning systems. The integration of digital epidemiology demonstrates how real-time behavioral data can inform and strengthen risk modeling and intervention strategies for vector-borne diseases.

Furthermore, a review by Nieboer et al. examined the controversial role of mosquitoes in transmitting the gram-negative bacterium *Francisella tularensis*. Although bacterial DNA has been detected in mosquitoes, evidence for biological or mechanical transmission remains inconclusive. The review underscores the need for rigorous vector competence studies before labeling a bacterium like *F. tularensis* as mosquito-borne and treating it as a vector-borne disease. Such caution helps prevent the misallocation of research efforts and control resources.

Together, the studies in this Research Topic reflect the multifaceted nature of vector research and its growing intersections with ecology, digital health, microbiology, and climate science. Azevedo et al. highlight ecological indicators based on species richness for improved surveillance; Dias et al. deepen our better understanding of egg dormancy to inform predictive control models; Gnankine and Dabiré challenge and refine *Wolbachia*-based biocontrol strategies; Ogolla et al. uncover species-specific bloodmeal patterns relevant to attractant design; Yang et al. incorporate digital behavior into surveillance frameworks; and Nieboer et al. clarify the limitations of current assumptions in pathogen-vector dynamics. Collectively, these contributions signal a shift toward precision public health, where control strategies are informed by ecological patterns, microbial symbionts, digital behaviors, and host-vector specificity.

By integrating traditional entomological research with novel technologies and interdisciplinary approaches, these studies advance the field toward smarter, more adaptive, evidence-based, and sustainable responses to one of the most persistent global health challenges. They provide innovative insights to enhance vector surveillance and control, contributing to the broader goal of reducing the global burden of vector-borne diseases.

We thank all the contributing authors and reviewers for their dedication and valuable input. We hope this Research Topic inspires further interdisciplinary collaboration and strengthens the scientific foundations needed to confront the evolving challenges posed by insect vectors in public health.

Author contributions

JA: Conceptualization, Writing – original draft, Writing – review & editing. SS: Writing – original draft, Writing – review & editing. CM: Writing – original draft, Writing – review & editing.

Conflict of interest

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