BOOK OF ABSTRACTS

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2nd inoVEC

Conference

"Tackling vectors of emerging arboviruses through Research & Innovation"



October 07-08, 2026

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Background

Vector-borne diseases, which account for approximately 17% of infectious diseases, currently represent a major global public health challenge. Long associated with countries in the Global South, they have experienced a resurgence worldwide, particularly mosquito-borne arboviral diseases (dengue, Zika, chikungunya), driven by the combined effects of urbanization, increased global mobility, and climate change. These dynamics have led to an unprecedented expansion of vectors, notably *Aedes albopictus* and *Aedes aegypti*.

Prevention of these diseases still relies largely on vector control. However, the global resurgence of arboviral diseases — particularly dengue — highlights the limitations of currently available tools and underscores the urgent need to develop more sustainable, innovative, accessible, and community-engaged vector control strategies grounded in a One Health approach. These approaches must simultaneously integrate improvements in population health and well-being, biodiversity conservation, environmental protection, and local ownership of control actions.

During the 1st International INOVEC Conference held in Dar es Salaam (Tanzania) in August 2024, several key gaps and recommendations were identified, notably the need to strengthen intersectoral and international collaboration in order to foster innovation and accelerate the implementation of new chemical, biological, and genetic vector control methods. The discussions also highlighted the importance of policy advocacy to facilitate the integration of these new tools into existing public health strategies, as well as the critical role of community engagement and operational research in deploying sustainable solutions adapted to local contexts.

These themes are addressed during the 2nd INOVEC Conference, which aims to present the latest advances and innovations in the surveillance and control of vectors of emerging arboviral diseases. By leveraging multidisciplinary approaches — spanning biological sciences, social and human sciences, geography, and engineering — the conference convenes leading actors from research and innovation, industry, and public health to drive practical, sustainable, and context-specific solutions for the control of arboviral disease vectors across Europe and worldwide.

Reference: Poinsignon A, Fournet F, Ngowo HS, Franco Martins Barreira V, Pinto J, Bartumeus F, Kaindoa EW, Corbel V. Advances in surveillance and control methods for Aedes-borne diseases and urban vectors: report of the International Conference, August 2024, Tanzania. Parasit Vectors. 2025;18(1):212. doi: 10.1186/s13071-025-06838-4.

Scope, Objectives and Format of the Conference

The 2nd International Conference, organized by IRD with the support of the Horizon Europe INOVEC project, provides a platform for exchange and dialogue among key actors involved in the prevention and control of vectors of emerging arboviral diseases. The conference aims to review emerging evidence on vector ecology, biology and control, strengthen scientific and operational partnerships, and promote both basic and translational research, with the ultimate goal of reducing the burden of vector-borne diseases.

Objectives

i) To foster knowledge sharing in the biology, ecology and genetics of vectors of arboviral diseases in Europe and beyond;

ii) To assess the effectiveness of innovative tools, approaches and technologies for vector control, and to identify key gaps, challenges and research priorities;

iii) To strengthen intersectoral and international collaboration, and to facilitate dialogue leading to actionable outcomes that support improved public health responses to vector-borne diseases.

Format

The conference is held at **Agropolis International in Montpellier, France**, and consists of two days of scientific presentations. Keynote speakers provide internationally recognised expertise and strategic perspectives in the field. A call for abstracts was launched to ensure broad participation and a balanced representation of speakers. In addition, a round-table discussion explores how innovation can be effectively translated into vector control policies. Finally, an industry session allows companies to present the latest advances in vector control products and technologies. The scientific programme is structured around three thematic areas:

Theme 1 – Biology, Ecology & Genomics of Vectors

Theme 2 – Integrated Approaches for the Control of Vectors of Arboviral Diseases

Theme 3 – Advances and Innovation in Vector Control

Keynote Speakers



K1 — "INOVEC: a research and Innovation Partnership for enhancing the surveillance and control of mosquito Vectors of emerging arboviruses"

Vincent Corbel (Institut de Recherche pour le Développement / IOC-Fiocruz, Rio de Janeiro, Brazil)

With over 20 years of experience in medical entomology, he has worked in Africa, Asia, and South America. In 2016, he launched the WIN network, supported by WHO NTD & TDR, to assist member states in timely insecticide resistance surveillance and vector control strategies. Building on its success, he initiated the WIN-SA network with Fiocruz to coordinate insecticide resistance research in South America. Since 2023, he has coordinated the EU-HORIZON-MCSA INOVEC consortium to develop and promote new tools for the surveillance and control of emerging arbovirus vectors in Europe and beyond.



K2 — "Impact of climate change on vector-borne diseases and future challenges for control efforts"

Cyril Caminade (The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy)

Cyril Caminade is a climatologist by training with specialized expertise in spatial epidemiology and biogeography. His research focuses on the intersection of climate dynamics and vector-borne diseases (VBDs), encompassing a wide range of human and veterinary pathogens including malaria, dengue, Rift Valley fever, plague, bluetongue virus, and helminthiases. A multidisciplinary scientist, Cyril has established extensive collaborations across a broad spectrum of disciplines, working alongside biologists, statisticians, entomologists, epidemiologists, and public health experts. His work bridges the gap between environmental variables and disease transmission cycles in both human and animal populations. Currently, he is based at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. His present research focuses on the mechanistic modeling of climate impacts and the efficacy of vector control interventions on disease burden.



K3 — "These arboviral diseases that threaten Europe"

Anna-Bella Failloux (Arboviruses and Insect Vectors, Department of Virology, Institut Pasteur, Paris, France)

Anna-Bella Failloux, PhD, is professor of medical entomology and chief of the unit "Arboviruses and Insect Vectors" at the Institut Pasteur in Paris. Her work mainly focuses on investigations of arbovirus–mosquito interactions in order to decipher the factors leading to the viral emergence. Failloux develops three

complementary lines of research: (i) intervene on the front line of emergence by offering her scientific expertise for public health actions, (ii) contribute to research activities by deciphering molecular mechanisms that modulates arbovirus infections in mosquitoes, and (iii) propose alternative control strategies to mitigate insecticide-based control measures. Failloux has an extended expertise on vectors of alphaviruses, flaviviruses and phleboviruses. She participates actively in teaching medical entomology as director of several courses and a MOOC.



K4 — "Community participation in the prevention and control of vectors of emerging arboviruses"

Jocelyn Raude (École des hautes études en santé publique, Rennes, France)

Jocelyn Raude is a Professor of Health Psychology at the School of Advanced Studies in Public Health (EHESP, Rennes) and a researcher within the Health Services Research team at the ARENES Joint Research Unit (University of Rennes, CNRS, INSERM). After completing his PhD at the School for Advanced Studies in the Social Sciences (EHESS, Paris) in 2006, he pursued interdisciplinary research on preventive behaviors related to emerging infectious diseases in tropical settings. This included a postdoctoral fellowship at the London School of Economics in 2008, followed by a research position at the French Research Institute for Sustainable Development (IRD) from 2016 to 2018. His main research focuses on how populations respond to infectious disease outbreaks, particularly how these events influence individual and collective behaviors that affect disease transmission, including hygiene practices, social interactions, and vaccination. Over the past decade, his work has focused more specifically on the processes of social and cognitive adaptation to the risks and uncertainties associated with emerging infectious diseases, as well as on intervention strategies aimed at promoting health-protective behaviors in contemporary societies.



K5 — "Integrating for impact: Network approaches to addressing shared vector threats"

Audrey Lenhart (U.S. Centers for Disease Control and Prevention)

Audrey Lenhart, PhD, MPH, is the Chief of the Entomology Branch at the U.S. Centers for Disease Control and Prevention in Atlanta, Georgia, USA. The Entomology Branch works with partners worldwide regarding vector surveillance and control, including providing technical guidance to the U.S. President's Malaria Initiative (PMI). Dr. Lenhart also leads CDC's VecNet Program, which supports regional public health entomology networks in 6 regions across the globe. She previously led the Entomology Branch's Insecticide Resistance and Vector Control Team, heading a research group that focused on the biology and control of mosquitoes and laboratory activities centered on the molecular mechanisms that cause insecticide resistance in mosquito vectors of human disease. She is an Honorary Research Fellow at the Liverpool School of Tropical Medicine and adjunct faculty in the Department of Environmental Sciences at Emory University.

Scientific Session 1. Biology, Ecology & Genomics of Vectors

Invasion patterns of *Aedes albopictus* across the native range of *Aedes aegypti* within arboviral foci in Abidjan, Côte d'Ivoire

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In Côte d'Ivoire, *Aedes albopictus* has recently been introduced into forested parks within arboviral hotspots where *Aedes aegypti* is well established. However, their dispersal ranges and behaviours are still obscure. This study assessed the distributional and behavioural patterns of *Ae. albopictus* and *Ae. aegypti* across urban-forest and ground-canopy gradients within sympatric areas in forest parks of Abidjan, Côte d'Ivoire. From December 2023 to November 2024, *Aedes* mosquito eggs, larvae and adults were sampled during dry and rainy seasons. Sampling was done in National Floristic Center (NFC), Banco National Park (BNP), Bingerville Botanical Garden (BBG), Dahlia-Fleur Nature Reserve (DNR) and Nangui-Abogoua University Forest (NUF), Côte d'Ivoire. Sampling was conducted across horizontal transects from urban area (-500 m) to forest interior (+300 m), and vertically at ground, understory, mid-height and canopy levels. Adult females' ovaries were examined for parity. *Ae. albopictus* were sequenced and phylogenetic tree was constructed. Overall, *Ae. albopictus* and *Ae. aegypti* exhibited reverse horizontal, but similar vertical invasion trends. *Aedes albopictus* were mostly found in CNF and NUF (>40%), where proportions increased gradually from urban environment (0.1% at -500 m) to forest interior (77.3% at +300 m). Conversely, *Ae. aegypti* occurred abundantly at all sampling points of all five study sites, but with reduced proportions (<60%) in CNF and NUF. However, both species proportions decreased from ground (>57.4%) to canopy (<15.8%). All females were predominantly parous. Abundances were higher during rainy seasons, with lower seasonal variations in the forest interieur and canopy. The phylogenetic analysis of cytochrome oxidase c subunit I gene fragment of *Ae. albopictus* revealed a close relationship to tropical Asian populations. In Abidjan, Côte d'Ivoire *Ae. albopictus* appears to be well established in NFC and NUF where it is excluding *Ae. aegypti* from its naïve range. Their compensatory spread invasion patterns across forest-urban and ground-canopy gradients make them potential bridge vector, linking urban and sylvatic, and terrestrial and arboreal cycles of arboviruses, exposing residents, workers and visitors at these human-wildlife interfaces. Thus, the results offer the first comprehensive insights on the invasiveness of local *Ae. albopictus* and *Ae. aegypti* populations in sympatric areas and could help designing a One Health-based arboviral control at the urban forested parks.

Fungal Microbiota of *Aedes aegypti*: Implications for Vector Competence and Arboviral Disease Control

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Arboviruses such as dengue, chikungunya, Zika, and Mayaro represent major global public health challenges and are primarily transmitted by *Aedes aegypti*. The efficiency of virus transmission is influenced by complex interactions between the vector and its microbiota. While bacterial components of the microbiota have been extensively studied, the role of fungal communities remains largely unexplored, despite increasing evidence that fungi can modulate insect physiology and vector competence. In this study, we characterize the fungal microbiota of field-collected and laboratory-conditioned *A. aegypti* mosquitoes and evaluate its impact on host physiology, vector competence, and arbovirus interactions. In this study, we characterize the fungal microbiota of field-collected and laboratory-conditioned *A. aegypti* mosquitoes and assess how environmental factors shape its composition and influence host physiology and vector competence. We further evaluate the antiviral activity, metabolite production, and virulence profiles of isolated fungi. ITS sequencing revealed a diverse fungal community dominated by *Ascomycota* and *Basidiomycota*. Fungal composition was strongly influenced by sugar feeding, indicating that dietary carbohydrates shape the mosquito mycobiome. Additionally, laboratory confinement significantly altered community structure with specific associations with fungal taxa such as Clasdoporium, Fusarium and Malassezia, whereas Wolbachia sp. infection showed limited overall effects. We isolated 40 fungal strains, including *Meyerozyma guilliermondii*, *Candida intermedia*, *Candida metapsilosis*, *Rhodotorula mucilaginosa*, and *Penicillium citrinum*, with *M. guilliermondii* and *R. mucilaginosa* being the most prevalent. Functional assays demonstrated that a *M. guilliermondii* isolate exhibits significant antiviral activity against Zika virus in mosquito cells, particularly when administered prior to infection. Metabolomic analysis identified multiple secreted compounds, including fucose, a candidate mediator of antiviral activity. Additionally, *M. guilliermondii* isolates displayed variable virulence factors and antifungal resistance profiles, suggesting that mosquitoes may harbor fungi with potential pathogenicity to vertebrate hosts. Overall, our findings highlight the complexity and functional relevance of the fungal microbiota in A. aegypti and support its exploration as a novel target for strategies aimed at disrupting arbovirus transmission.

Metabolic resistance of the tiger mosquito to pyrethroid insecticides in La Réunion Island likely results from local adaptation

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The resistance of mosquitoes to insecticides is a valuable model system for studying the genetic bases of xenobiotic adaptation in insects. The spread of the Asian tiger mosquito *Aedes albopictus* combined to the massive use of pyrethroid insecticides to limit arbovirus transmission resulted in the rise of resistance in various continents. Here, we investigated the genetic mechanisms underlying the recent adaptation of this mosquito to deltamethrin in La Réunion island. Bioassays confirmed the presence of resistance alleles in field populations. The resistance phenotype was further enhanced in the laboratory following a few generations of controlled selection. Combining whole genome Pool-seq and RNA-seq revealed no evidence of target-site

resistance mutations but the over-expression and variant selection of detoxification enzymes associated with pyrethroid metabolism including cytochrome P450s, transferases and ABC-transporters. Among over-expressed detoxification genes, only one was linked to a gene duplication while polymorphism data suggest most of them being trans-regulated. Genome-wide selection signatures also revealed a 9 Mb inversion acting as a superlocus potentially under insecticide selection. Altogether, this study indicates that the multigenic metabolic resistance phenotype observed in this insular territory mainly results from local adaptation. From an applied perspective, this study provides a set of markers to track pyrethroid resistance in the tiger mosquito in the South-West Indian Ocean. As this region is subjected to recurrent arbovirus outbreaks, the additive resistance phenotype that may arise from the introduction of Kdr mutations from other territories also calls for improving resistance surveillance at the regional scale.

Uncovering the plant-feeding ecology of *Aedes albopictus* through DNA metabarcoding and botanical mapping

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Plant-derived sugars are the primary energy source of most adult mosquitoes, yet the identity of the plants they exploit in nature remains largely unknown. In species such as *Aedes albopictus*, sugar feeding influences survival, activity, and reproductive success. Identifying the plant resources used by this invasive mosquito is therefore essential for understanding its ecology and developing innovative vector control strategies.Here, we investigated the plant-feeding behavior of *Ae. albopictus* in the Montpellier Botanical Garden using DNA metabarcoding of field-collected mosquitoes sampled between April to November 2023. By combining molecular identification of plant meals with a comprehensive georeferenced botanical inventory, we reconstructed patterns of plant use and explored the spatial relationship between feeding and resting sites in 124 individual mosquitoes. We detected a diverse range of plant taxa, with *Acanthus mollis*, *Hedera helix*, *Asparagus densiflorus*, *Robinia pseudoacacia*, *Viburnum tinus*, and *Zelkova serrata* among the most frequently consumed species. Plant diversity was greater in females than in males and increased during late-season collections (September–October) compared with early-season collections (June–July). Integrating metabarcoding data with spatial botanical records revealed that mosquitoes regularly exploit plant resources located well beyond their immediate resting environment, with average minimum feeding distances exceeding 100m (163m on average for females and 128m for males). These distances remained relatively stable throughout the sampling period. Accounting for the relative abundance of plant species within the garden further revealed evidence of selective plant use, with several taxa consumed disproportionately to their availability. Our findings provide new insights into the phytophagous ecology of *Ae. albopictus* and demonstrate the value of integrating DNA metabarcoding with detailed botanical surveys to investigate mosquito–plant interactions in natural environments. Such knowledge may help identify key plant resources sustaining mosquito populations and open new avenues for vector surveillance and control.

A WIP-based Atlas of Insects: an epistemic representation of insect biodiversity for trustworthy AI-assisted vector surveillance.

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The emergence and spread of arthropod vectors demand surveillance systems capable of identifying insects rapidly, accurately, and at scale. While artificial intelligence has greatly advanced automated species identification, most current systems operate under a closed-world assumption: they can only recognize the diversity represented in their current knowledge, since they are inevitably trained on a finite and incomplete sample of insect biodiversity. A fundamental requirement for AI-assisted surveillance is therefore not only to identify what the system knows, but also to recognize when new observations may lie beyond the limits of its current knowledge. We propose a framework in which the primary objective is not simply species classification, but the construction of an evolving representation of insect biodiversity, learned here from Wing Interference Patterns (WIPs), the structural optical signatures naturally present on insect wings. Rather than encoding species as isolated categories, the learned representation organizes specimens according to their taxonomic relationships while preserving the flexibility to capture additional biological variation. This common representation becomes the foundation for multiple operations, including species identification, continual learning, and the assessment of observations that may correspond to previously unseen diversity. We introduce the WIP-based Atlas of Insects as an interpretable visualization of this representation: a map of the system's current knowledge of insect biodiversity that evolves as validated observations are incorporated. Rather than replacing taxonomic expertise, the Atlas is designed to support it by organizing biological knowledge, highlighting observations deserving further investigation, and facilitating the progressive integration of new evidence. Beyond improving species identification, this framework opens new opportunities for biodiversity monitoring, vector surveillance, and the discovery of biologically meaningful traits encoded in WIPs.

An Integrated WIP-Based Diptera Recognition Setup: Light DL Networks and a Portable Acquisition System

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Many blood-sucking dipters play a central role in the transmission of arboviruses responsible for the spread of diseases such as dengue, chikungunya, and malaria. Among these, certain species such as *Aedes albopictus* and *Aedes aegypti* are of particular concern due to their strong ability to adapt to human-modified environments and their vector competence. Their rapid expansion in urban areas, largely driven by climate change, underscores the urgency of developing monitoring tools for their identification and control. However, identifying these insects using conventional methods, whilst effective, can be time-consuming, costly, and not suitable for field use. A computer vision-based system that uses wing interferential patterns

(WIPs) could help solve this problem. A dataset of close to 5000 images covering 150 is used to train, validate, and test deep-learning classification models. This study has contributed to the development of deep architectures with low computational requirements and short inference times, as well as a desktop application with an interface that allows users to select different model architectures for prediction and can easily be used with a portable microscope. This approach enables the automatic identification of a large number of winged insect species, including arbovirus vectors and cryptic species, with high accuracy (over 90% depending on the selected subset). This performance is an advance for near field processing and thus represents a great potential for vector control.

Are Malagasy *Aedes aegypti* a distinct species? Morphological evidence from a basal evolutionary lineage

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Aedes aegypti is one of the most important arbovirus vectors worldwide and understanding its evolutionary origin may help clarify the biological traits that have shaped its success as a vector. Recent genomic data indicate that Malagasy *Aedes aegypti* occupy a basal position relative to populations from continental Africa and the rest of the world, suggesting that Madagascar may have played an important role in the evolutionary history of this species complex. This discovery raises a key taxonomic question: do Malagasy populations correspond to *Aedes aegypti* sensu stricto, or do they represent a distinct taxonomic entity? To test whether the genetic differentiation observed in Madagascar is accompanied by morphological differentiation, we established a matrix of approximately 70 taxonomic characters scored in adults, larvae and pupae. Malagasy specimens were compared with closely related taxa from the Indian Ocean, Africa and other regions of the world. Morphological analyses show that the Malagasy forms display several diagnostic characters, particularly in adults, male genitalia, pupae and larvae. These characters distinguish them from African forms and from other insular morphotypes, while confirming their close relationship with the *Aedes aegypti* group. Overall, our results support the genomic evidence for the evolutionary distinctiveness of Malagasy populations and suggest that they may correspond to a new species within the subgenus Stegomyia, closely related to *Aedes aegypti*. This study highlights the importance of Madagascar for understanding the origin, diversification and vector evolution of the *Aedes aegypti* complex.

Does urban greening drive vector abundance? The case of the Asian tiger mosquito *Aedes albopictus* in the Lyon metropolitan area, France

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Nature-based Solutions (NbS) promote urban green spaces for environmental and public health benefits, but may also favor undesired biodiversity, including disease vectors like the Asian tiger mosquito (*Aedes*

albopictus). While temperature and stagnant water availability are well-known drivers of its proliferation, the role of urban vegetation remains understood. This study investigates to which extent NbS influence *Ae. albopictus* proliferation and identifies the most influential environmental drivers including meteorological, microclimatic, socio-demographic and landscape variables, in the Lyon metropolitan area (France). From June to October 2025, adult mosquitoes were sampled weekly using 48 BG-Pro traps deployed across eight urban sites. Overall, 29,519 adult mosquitoes representing 14 species were collected, including 25,200 *Ae. albopictus*. Concurrently, 182 potential breeding sites and 128 plant species were recorded. Environmental data on microclimate, land cover, meteorology, and sociodemographic characteristics were also compiled from field measurements and open-access databases. Preliminary analyses using bivariate negative binomial models show that NbS classification and public/private ownership are not significantly associated with mosquito abundance. In contrast, meteorological variables, including precipitation, temperature, wind, and atmospheric pressure, appear to significantly influence capture rates, although potential non-linear threshold effects remain to be explored. Vegetation structure, mosquito associated microbiota composition, and socio-demographic factors are currently being integrated into the model parameters. Overall, these findings highlight that urban greening alone is not a direct predictor of *Ae. albopictus* abundance. Instead, mosquito dynamics appear to be primarily shaped by short-term meteorological variability, potentially involving non-linear responses. Ongoing integrative analyses will further refine the understanding of multi-scale drivers of urban mosquito ecology.

Scientific Session 2. Integrated Approaches for the Control of *Aedes* and Other Vectors of Arboviral Diseases

Evaluating the Effect of a *Wolbachia*-Based Intervention on Entomological Indices and Dengue Incidence in Colombo, Sri Lanka

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Dengue fever is a major public health problem in Sri Lanka. Conventional insecticide-based vector control methods fail to provide long term efficacy and develop vector resistance. Wolbachia endosymbionts are known to offer a sustainable strategy to disrupt dengue transmission within *Aedes aegypti* populations. Current study evaluated Wolbachia interventions in two medical administrative areas in Colombo: CMC-D1 and Nugegoda compared to Kolonnawa as a non-interventional control, from 2019 to 2022. *Ae. aegypti* vector densities were assessed using ovitrap and Prokopack aspirator collections. Entomological indices including Ovitrap Index (OI), Egg Density Index (EDI), Adult House Index (AHI), Adult Density (AD), and Resting Ratio (RR) were calculated. We used negative binomial regression framework (NB-GLMMs) to model the Wolbachia-based intervention on mosquito densities and dengue incidence while accounting for temporal trends, climate covariates and hierarchical clustering. Following the Wolbachia-based intervention, all vector indices showed spatial uniformity across the study areas ($p > 0.05$). Both maximum temperature ($\beta = -0.128$, $p = 0.014$) and minimum temperature ($\beta = -0.114$, $p = 0.001$) were significantly and negatively associated with the OI. Conversely, climatic variables did not contribute meaningfully to variations in the EDI. Maximum temperature exerted a pervasive negative influence on adult mosquito densities; it was strongly associated with reductions in the AHI ($\beta = -0.450$, $p = 0.001$), AD ($\beta = -0.498$, $p = 0.002$), and the RR ($\beta = -0.564$, $p < 0.001$). Statistically distinguishable reduction in dengue incidence occurred in CMC-D1, indicating a localized impact of the Wolbachia-based intervention ($\beta=-1.44$; $p<0.001$). In conclusion, the study demonstrates that Wolbachia- based intervention can successfully suppress localized dengue incidence without altering mosquito densities. These findings establish the intervention as an evidence-based and ecologically sustainable strategy to mitigate the escalating dengue burden in Sri Lanka.

Environmental detection of arboviruses in water and mosquito excreta: a decision-support tool for vector control and an early-warning system for arboviral surveillance.

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The rapid expansion of arboviral diseases across Europe calls for a shift from reactive to anticipatory vector control. Current surveillance systems rely primarily on confirmed human or animal cases of chikungunya (CHIKV), dengue (DENV), and West Nile virus (WNV), while asymptomatic, misdiagnosed, or delayed infections can allow viral transmission to expand before control measures are optimally targeted. As a result, interventions are often deployed after the viral circulation is already established, impeding efficient preventive larval control targeting Culex populations for WNV circulation, or requiring intensive adulticide applications for *Aedes albopictus*-borne virus outbreaks. This increases environmental impacts, reduces public acceptance and control efficiency, and puts pressure on logistical, financial, and human resources. Within the MISARBO project, we implemented a field-deployable surveillance workflow combining mosquito excreta collection for molecular xenomonitoring, water sampling from larval breeding sites, and wetland water sampling at host–vector interfaces. RNA was extracted from heterogeneous matrices and analysed by multiplex RT-digital PCR targeting CHIKV, DENV, WNV, USUV, mosquito RNA and inhibition controls. In mainland France in 2025, during an unprecedented autochthonous chikungunya season (>800 cases), environmental sampling around human cases helped delineate active transmission areas. CHIKV RNA was detected in mosquito excreta and/or breeding-site water in four active transmission areas, supporting targeted entomological investigations and vector control perimeter adjustment. For WNV/USUV surveillance, wetland water monitoring detected WNV RNA early in the season, before the first reported human/equine alerts, demonstrating its value as an early-warning signal in enzootic contexts. Environmental arbovirus surveillance provides a scalable, non-individual and operational decision-support layer. By moving from case-triggered reaction to earlier detection of viral circulation, it can help prioritize surveillance, refine intervention zones and reduce unnecessary adulticide treatments, supporting integrated and more acceptable vector control, "treat better to treat less", within a One Health framework.

Mosquito Alert Apps in Burkina Faso

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Conventional rhetoric establishes differences between "making" knowledge – the specialist domain of scientists – and "using" knowledge – the wider function of society as a whole. However, during the 1950s, a growing interest in the relationship between scientific experts and the public began to foster different types of connection, and one of the areas of theory influencing this thinking has been the phenomenon of citizen science. It put forward the contextualization of science understood as a process in which the knowledge production has to be made, not just through the work of scientists, but considering also the citizens contributions. Mosquito alert app, a digital surveillance and participation to vector control is one of the aspects of this citizen science which has been used as a case study to involve community in dengue control. The activities have been done through the promotion and use of the Mosquito Alert mobile app in local communities as a tool for citizen-based surveillance of dengue mosquitoes. Community engagement based on two-way approach has been used to promote the Mosquito Alert Apps. Mosquito Alert, an open-source

global digital initiative, has been translated in local language Moore and Dioula to optimize the use of the apps by community members. The preliminaries findings show that the public is interested in the app. They appreciated its ability to educate on mosquito species and habitats and how to protect themselves from mosquito proliferation. The next step, that of community involvement in mosquito surveillance will be based on the interests of community. However, the findings highlighted internet access and its high cost as challenges that can slow down the use of the app. Citizen -science by Mosquito- Alert apps generates reflexive relations between researchers and community members who are both the subjects and objects of knowledge production. This genuine collaboration could impact positively the outcomes of the research and their ownership

Climate-Integrated Predictive Surveillance for Vector-Borne Disease Surge Prediction: An ERA5-DHIS2 Methodology Validated in High-Burden West African Settings

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Vector-borne disease surveillance systems in sub-Saharan Africa consistently fail to detect transmission surge conditions before they overwhelm facility capacity. Routine health information systems capture disease burden after surges occur, not before. This methodological gap is shared across vector-borne disease contexts from Anopheles-driven malaria to *Aedes*-driven arboviral diseases including dengue, Zika, and chikungunya because the climate intelligence that predicts vector breeding conditions is not integrated into standard health surveillance architectures. This paper presents a climate-integrated predictive surveillance methodology developed and field-validated in Northwest Nigeria using ERA5 climate reanalysis data integrated with DHIS2 national health information system data. ERA5, freely available from the Copernicus Climate Change Service at 0.25-degree spatial resolution, provides satellite-derived precipitation accumulation and temperature variables at monthly temporal resolution. DHIS2 provides facility-level vector-borne disease case data. The integration methodology uses July rainfall accumulation lag signals to predict August transmission surge magnitude across three high-burden states. Retrospective validation across 36 months of DHIS2 surveillance data covering 10,992,312 confirmed cases achieved R-squared of 0.965 between predicted and actual surge magnitude, with 100% directional accuracy across three consecutive validation years. The model correctly predicted surges of 35.4%, 22.1%, and 19.9% month-on-month above July baseline in each year from a July baseline showing near-zero change in routine surveillance data providing a minimum four-to-six-week advance warning window. The methodological contribution to vector control research is threefold. First, ERA5 is freely available globally, eliminating proprietary data barriers for LMIC health systems. Second, DHIS2 is deployed across 73 countries the integration architecture is immediately replicable for *Aedes*-driven arboviral surveillance where the same climate-transmission relationship operates. Third, the model runs offline on basic Android devices, addressing connectivity constraints in the settings where arboviral disease burden is highest. This presentation argues that climate-integrated digital surveillance is a deployable cross-vector methodology, not a pathogen-specific tool, and presents the validated ERA5-DHIS2 architecture for adaptation across arboviral disease surveillance contexts.

ArtScience for Health Awareness: experiences and practices in Brazil

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Promoting health awareness is important but challenging for ensuring public health. Recent examples include the need to control *Aedes aegypti* to reduce urban transmission of dengue, Zika, chikungunya, and yellow fever, as well as the need to increase vaccination under a social environment of fake news anti-vac movements. Surveillance and education activities related to neglected infectious diseases elimination are also challenging examples. The Brazilian education system promotes a fairly narrow view of health as an absence of disease. This is a view of health that has been contested by the World Health Organization (WHO) since 1946 because of fails to acknowledge the social context in which health is created. Vertical models of communication in use since the 1980s have failed successively to combat dengue epidemies in Brazil. In the present meeting we will present Oswaldo Cruz Institute experiences on new strategies and actions that can engage education actors (teachers, public health vigilance agents, health management services, and academic centers) as well as the general population in expanding health awareness. We will focus on recent community activities related to Dengue and Chagas diseases control using the concept and definitions of the ArtScience Manifesto, introducing ArtScience activities into education strategies to foster health and creativity. ArtScience is an interdisciplinary concept that hybridizes science and art practices and methods designed to favor creativity and innovation. It focuses on processes rather than on products, having the latter as a consequence of multiple engagements of awareness-raising, reasoning, and emotion of activity participants. Our approach is based on the Ottawa Charter and Adelaide Statement, addressing health in all policies and the social determinants of health, reinforcing the goals of the United Nations' 2030 agenda (UN 2015), in which its sustainable development objectives strengthen the need for a global pact to improve the quality of life on the planet. We also contributed to the "ecology of knowledge" of teenagers and adults in socio-environmentally vulnerable areas with a high disease prevalence. We integrate the activities in the context of (1) basic and translational research on health and education, (2) "university extension" (the social link between academy and society), and (3) education (not only training) to empower the target population of the activities in a real praxis of social activism as defended by Paulo Freire's pedagogy of autonomy for popular education. Dialogue, emancipation, reflexive capacity, hope, passion, critical analysis, and awareness about their own living conditions and the conditions of the whole planet are essential elements of this pedagogy. Other essential elements are respect toward people's diversity of knowledge and cultures; confidence in the mutual construction of new knowledge that emerges from these dialogues, known as "ecology of knowledge".

GaroMoustik, a collaborative board game to promote social mobilisation against *Aedes* vectors

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Aedes mosquitoes are among the world's most important vectors of human arboviruses, transmitting pathogens such as dengue, chikungunya, Zika, and yellow fever viruses. The global burden of these diseases has increased dramatically in recent decades, driven by urbanization, globalization, climate change, and the

geographic expansion of vector populations. Large and recurrent epidemics affect tropical regions, particularly Brazil and many African countries, while the risk of local transmission is increasing in temperate areas. In Europe, the establishment of *Aedes albopictus* has led to a growing number of locally acquired dengue and chikungunya cases, and recurrent outbreaks continue in overseas territories such as La Réunion. Sustainable control of *Aedes* mosquitoes relies on integrated vector management, combining vector control interventions, elimination of breeding sites, and community participation. Although public awareness campaigns have improved knowledge of preventive measures, translating this knowledge into sustained behavioural change remains challenging. Innovative approaches are therefore needed to strengthen public engagement and foster collective responsibility for vector control. To address this need, we developed GaroMoustik, a collaborative board game designed to (1) promote good practices for *Aedes* vector control, (2) encourage dialogue among stakeholders, including citizens, and (3) foster collective action. Following an iterative co-development process with field testing conducted between 2022 and 2023, we produced a version tailored to the context of La Réunion. In the game, players work together to identify and eliminate mosquito breeding sites in neighborhood courtyards, gardens, and streets. A European version has since been developed, and adaptations for Africa and Brazil are underway. A simplified memory-game version has also been created for use at public events. To date, around 30 facilitators have been trained, and more than 500 participants have played one of the game versions. The final games will be available for free online under a Creative Commons license to facilitate their adaptation and dissemination in diverse settings.

Entomofavela. citizen-based surveillance of *Aedes* in a complex urban favela of Rio de Janeiro, Brazil

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Aedes aegypti is a major vector of arboviruses such as dengue, Zika, chikungunya, and yellow fever, posing a significant public health challenge. Control strategies rely on the elimination or treatment of artificial larval breeding sites and the use of insecticides, while the release of Wolbachia-infected mosquitoes has emerged as an alternative approach. However, poor urban infrastructure, inadequate sanitation, and sociopolitical and security constraints, particularly in favelas, facilitate mosquito proliferation and limit access for surveillance and control. In addition, the effectiveness of insecticides has been increasingly compromised by the spread of resistance, especially to pyrethroids, highlighting the need for continuous monitoring of vector density, arbovirus circulation, insecticide resistance, and *Wolbachia* dissemination. In this context, egg collections were conducted with the participation of trained young residents from the Maré complex (Rio de Janeiro) to assess *Aedes* infestation levels—distinguishing between *Ae. aegypti* and *Ae. albopictus*—in three favelas (Parque União, Nova Holanda, and Vila Pinheiros). Molecular analyses were performed to estimate the frequency of kdr mutations associated with pyrethroid resistance, the prevalence of Wolbachia, and the occurrence of arbovirus infection via transovarial transmission across seasons (2025–2026). More than 40,000 eggs were collected, revealing heterogeneous spatial and temporal distribution. Entomological indices and heat maps indicated consistently high densities of *Ae. aegypti* throughout the year. Molecular analyses showed that over 95% of individuals carried kdr-associated genotypes, approaching fixation of alleles conferring high resistance to pyrethroids, with no wild-type alleles detected in three of the

four seasons analyzed. Wolbachia-infected mosquitoes were detected only in two seasons and in one favela, and no mosquito pools tested positive for arboviruses. These results demonstrate the feasibility of entomovirological and molecular surveillance in complex urban settings and highlight the critical role of community-based agents in enabling effective surveillance through the integration of local knowledge and technical approaches.

Fine-scale urban determinants of *Aedes aegypti* oviposition in a Rio de Janeiro favela. a 12-cycle ovitrap study coupled with georeferenced ultra-high-resolution environmental classification

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Dengue and other arboviruses remain pressing public health challenges in tropical urban centers, with transmission risk concentrated in marginalized neighborhoods where socio-environmental complexity hinders vector surveillance. The Maré complex, a high-density favela cluster in Rio de Janeiro, exemplifies the operational and methodological constraints to fine-scale *Aedes aegypti* risk characterization. The objectives were to identify environmental and socioeconomic determinants of *Ae. aegypti* oviposition at the trap and household scale in a high-density urban favela setting and quantify their relative contribution across multiple spatial scales. Following structured field-worker training, 90 ovitraps were deployed and monitored across three Maré favelas over 12 monthly cycles (June 2024–June 2025). At each trap, household and immediate-environment variables (housing type, vegetation, waste management, water access, installation microsite) were recorded within 20 m. In parallel, a georeferenced ultra-high-resolution (UHR) aerial-imagery database was constructed, classifying 29 surface categories within 20, 30, 40 and 50 m buffers; inter-rater agreement was assessed (Cohen's κ, Gwet's AC1, ICC). Explanatory analysis used a DAG-guided variable selection strategy and mixed-effects negative binomial regression (glmmTMB) with AR(1) intra-trap temporal correlation. Residual spatial autocorrelation was evaluated via Moran's I and empirical variogram. Preliminary results indicate elevated oviposition in vegetated areas with inadequate waste management and higher population density. External domestic microsites (yards, balconies) showed markedly higher egg medians than sheltered indoor locations across all 12 cycles, suggesting stable peri-domestic risk. Inter-cycle variation appears driven by rainfall, urban management, and resident behavior. UHR-derived landscape metrics show coherent spatial structure consistent with vector ecology hypotheses. To conclude integration of trap-level surveillance with UHR urban characterization provides a transferable framework for entomological risk assessment in highly heterogeneous urban contexts. Future work will couple these empirical estimates with the Arbocarto mechanistic model to evaluate its predictive performance and support targeted vector control planning.

Scientific Session 3. Advances and Innovation in Vector Control

Building an integrated evidence ecosystem for vector control. connecting innovation, policy and implementation for emerging arboviral diseases

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The pipeline of innovations for the control of *Aedes*-borne diseases is expanding rapidly, encompassing biological, genetic, chemical and environmental interventions, alongside advances in surveillance and implementation science. While this presents unprecedented opportunities, it also creates increasing complexity for countries seeking to identify, prioritise and implement the most appropriate interventions. Strengthening the systems that translate research into policy is therefore becoming as important as the innovations themselves. This presentation describes WHO's evolving vision for an integrated evidence ecosystem that connects research, evidence synthesis, guideline development and implementation across vector-borne diseases. Using *Aedes*-borne diseases as an illustrative example, it will outline how coordinated evidence generation, living systematic reviews, evidence gap maps, multidisciplinary guideline development, and structured Evidence-to-Decision frameworks can provide a continuous pathway from emerging evidence to evidence-informed policy. Rather than evaluating interventions in isolation, this integrated platform aims to identify common evidence needs across diseases and interventions, reduce duplication of effort, strengthen collaboration, and enable more timely updates as new evidence emerges. As the pace of innovation accelerates, robust and adaptive evidence systems will be essential to maximise public health impact. An integrated evidence ecosystem offers an opportunity to strengthen collaboration between researchers, innovators, policy makers and implementation programmes, ensuring that promising technologies are evaluated consistently, translated efficiently into policy, and implemented in ways that are feasible, equitable and sustainable. This approach provides a foundation for more responsive and integrated vector control strategies capable of addressing both current and future arboviral threats.

Community-led larval source management reduces *Aedes aegypti* densities in urban Abidjan, Côte d'Ivoire

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Rapidly increasing dengue transmission represents a growing public-health challenge, particularly in urban areas where day-biting, highly human-preferring *Aedes* mosquitoes exploit numerous small water containers as larval habitats. In sub-Saharan Africa, dengue vector-control programmes remain limited and are often restricted to sporadic, centrally organised adulticide spraying. Such interventions generally provide only temporary relief, require repeated implementation, and may raise environmental and sustainability

concerns. Because many *Aedes* breeding sites are located in and around households, effective control requires approaches that are practical for residents and adapted to local urban conditions. In partnership with communities in Abidjan, Côte d'Ivoire, we assessed household-level interventions designed to reduce larval habitats and catch adult mosquitoes with traps. We conducted a cluster-randomised controlled trial including 40 clusters, equally allocated to four study arms. larval source management (LSM), adult trapping (AT) using Biogents *Aedes* gravid traps, combined LSM+AT, and a control arm without intervention. The interventions and how their management were implemented with resident participation, allowing households to identify, remove, cover, or manage water-holding containers that could support mosquito development. LSM reduced adult *A. aegypti* densities by 37% (95% CI. 16, 52%), indicating a substantial impact on the local vector population. In contrast, AT alone did not provide clear evidence of a reduction, with an estimated confidence interval spanning both possible decrease and increase (95% CI. -27, 33%). These findings suggest that through a participatory co-design of the LSM strategy can effectively suppress *A. aegypti* populations in densely populated urban neighbourhoods, even where breeding sites are widespread and difficult to eliminate through centrally managed, top-down vector-control strategies alone.

Terpene-loaded nanoemulsions and hydrogels as innovative larvicidal and repellent platforms against *Aedes aegypti*

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Aedes aegypti is a major vector of emerging and re-emerging arboviruses, including dengue, Zika, chikungunya, and yellow fever, posing a persistent challenge to global public health. Conventional vector-control strategies rely heavily on chemical insecticides; however, increasing insecticide resistance, environmental concerns, and toxicity toward non-target organisms highlight the urgent need for safer and more sustainable alternatives. In this context, plant-derived terpenes represent promising bioactive compounds, although their practical application is limited by low aqueous solubility, high volatility, and poor stability. This study aimed to develop terpene-loaded nanoemulsions containing p-cymene and myrcene and to evaluate their potential as larvicidal and repellent systems against *Ae. aegypti*. Nanoemulsions were prepared and characterized regarding droplet size, polydispersity, zeta potential, morphology, terpene content, stability, and in vitro release. Biological performance was assessed using larvicidal assays against susceptible and insecticide-resistant *Ae. aegypti* strains, while safety was investigated in human keratinocytes, Galleria mellonella, and zebrafish models. In a second stage, nanoemulsions were incorporated into topical hydrogels, which were characterized by rheological, mechanical, bioadhesive, release, and skin permeation studies, followed by repellent activity assays. The nanoemulsions exhibited nanoscale droplet size, physical stability for up to 60 days, controlled terpene release, and larvicidal activity against both susceptible and resistant mosquito strains. The formulations also showed favorable biocompatibility profiles in non-target models. Hydrogels containing the nanoemulsions displayed pseudoplastic and thixotropic behavior, suitable for topical application, as well as controlled release and limited skin permeation. Repellency studies indicated that nanoemulsion-based hydrogels enhanced the functional performance of the terpenes, with molecular docking suggesting interactions with odorant-binding proteins involved in mosquito host-seeking behavior. Overall, this work demonstrates that terpene-loaded nanoemulsions and hydrogels are promising nanotechnology-based platforms for integrated *Ae.*

aegypti management, contributing to innovative, safer, and environmentally compatible strategies to reduce arbovirus transmission.

Acacia-Based Semiochemical Blends. An Innovative Approach for the Management of *Aedes aegypti*

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The increasing spread of *Aedes aegypti* and the limitations of conventional insecticide-based interventions highlight the need for innovative and environmentally sustainable vector control tools. Plant-derived semiochemicals play a critical role in mosquito sugar-feeding behaviour and may provide novel attractants for vector management. This study evaluated acacia-derived semiochemical blends as potential tools for surveillance and management of dengue vectors. Synthetic blends mimicking the natural ratios of four volatile compounds (1-octen-3-ol, linalool oxide, sulcatone, and nonanal) identified from *Acacia tortilis*, *A. laeta*, and *A. nilotica* were tested using a Y-tube olfactometer. Dose–response assays were conducted against a dichloromethane (DCM) control. The most attractive doses were compared among blends and against linalool oxide (LO), a known plant-derived attractant. Attraction varied with blend composition, concentration, and sex. The *Acacia tortilis* blend (TB) elicited the strongest attraction, with both female and male *Ae. aegypti*. When compared at optimal doses, TB was significantly more attractive than blends from *A. laeta* and *A. nilotica*. TB also outperformed LO, eliciting significantly greater attraction in both females and males. The superior performance of TB suggests that natural ratio semiochemical blends provide more effective olfactory cues than single compounds. These findings highlight the importance of blend composition in mediating mosquito attraction and plant-seeking behaviour. Acacia-derived semiochemical blends, particularly the *A. tortilis* blend, represent promising attractants for *Ae. aegypti* and could be incorporated into Attractive Toxic Sugar Bait (ATSB) systems and other innovative vector control tools targeting outdoor mosquito populations.

Ethical and Regulatory Governance of Emerging Mosquito Biotechnologies in Africa. A Policy Review of Gene Drive, Wolbachia, and Sterile Insect Technique Frameworks

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Africa bears approximately 95% of the global malaria burden while simultaneously confronting escalating dengue transmission. Gene drives, Wolbachia-based biological control, and the Sterile Insect Technique (SIT) offer transformative potential to interrupt vector-borne transmission cycles in Africa, yet they introduce unprecedented ethical, ecological, and regulatory challenges. The suspension of the Target Malaria gene drive trial in Burkina Faso in 2025 following a judicial raid on a research facility makes governance reform urgent. This study aims to assess the governance architecture underpinning these biotechnological platforms, identify structural gaps, and inform regulatory reform priorities in Africa. A systematic policy review analyzed national biosafety regulations, African Union biotechnology policies, WHO/IAEA guidance documents, and peer-reviewed literature (2010–2025) across 10 countries with active vector biotechnology programs. Burkina Faso, Mali, Uganda, Ghana, Kenya, Nigeria, Tanzania, South Africa, Sudan, and Ethiopia. They were evaluated across five governance pillars. biosafety oversight, environmental risk assessment

(ERA) standards, community engagement, ethical provisions, and transboundary coordination. Fewer than four out of ten countries provide operational guidance for the environmental release of modified mosquito strains, while none maintains a gene-drive-specific regulatory pathway. SIT and Wolbachia presented more tractable governance profiles than gene drives with direct implications for regulatory prioritization. Six structural governance gaps were identified, which include the absence of gene-drive-specific regulatory pathways; inconsistent regional ERA methodologies; community-level engagement limited to information dissemination; absence of authentic community-consent mechanisms; inadequate ecological monitoring for post-release surveillance; and no African treaty mechanism for transboundary gene drive coordination. These regulatory deficiencies risk impeding responsible innovation and undermining community trust in next-generation vector control. Developing adaptive, transparent, and community-centered regulatory frameworks differentiated by technology risk profile and grounded in African sovereignty is essential for ensuring scientifically credible, ethically sound, and socially acceptable arboviral vector control across Africa.

Evaluating bottled and yeast-based CO2 lures for BG-Pro mosquito traps under low-moderated abundance conditions

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Efficient trapping methodologies are essential for robust mosquito surveillance and control interventions. The lack of harmonised trapping approaches limits the comparability of entomological data across studies and field sites, especially in areas where mosquito abundance is low. This study evaluated the performance of the BG Pro trap (Biogents) supplemented with two carbon dioxide (CO_2) sources. (i) pressurised CO_2 bottle and (ii) a patented yeast-based fermentation mixture. The study took place in two locations with moderate (Teltow-Berlin) and low (Brensbach) mosquito abundance, Germany, in August 2025. A Latin square sampling design was applied at both sites with three trap treatments. without attractant (CONTROL), supplement with bottled CO_2 (BOTTLE) and with yeast-based CO_2 (YEAST). Sampling was conducted over 12 consecutive days in the Teltow Zoo and 21 in a residential garden in Brensbach. Results were analysed using generalised linear mixed models (GLMMs), with trap position and treatment as explanatory variables and collection date treated as a random effect. Negative binomial GLMMs provided the best model fit for total mosquito catches at both sites. Overall mosquito abundance estimates were not significantly affected by treatment. Trap position influenced catches in Teltow, where one position yielded significantly fewer mosquitoes. Day-to-day variation was negligible. For *Aedes* mosquitoes, treatment effects differed between sites. In Teltow, both CO_2 sources significantly increased catches (five-fold for YEAST; twenty-fold for BOTTLE). In Brensbach, where *Aedes*/mosquito abundance was very low, YEAST was associated with a significant reduction in *Aedes* collections, while BOTTLE showed no significant effect. Species recorded included *Aedes vexans*, *Aedes geniculatus*, and *Aedes japonicus*. These findings highlight that CO_2 supplementation can improve trapping efficiency but the effectiveness of different CO_2 sources depends on site and mosquito abundance.

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Using drones to upscale the release of sterile male mosquitoes

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The Sterile Insect Technique is an innovative vector control technology under development against *Aedes* mosquitoes. More than 38 countries are currently testing it and the automation of mass-production, sexing and release of sterile males are necessary to reduce its cost and allow its upscale at the territory level. Several research and exchange activities conducted within the Inovec framework in connection with other research projects (OpTIS, Optimoustik) allowed substantial improvements that lead to its operational use in Reunion Island within the OpTIS project. In addition to the technical improvements allowing its safe use in urban areas, artificial intelligent agents are also under development to optimize the release routes and density of sterile males, in order to optimize the efficiency of SIT. The results in Reunion Island show that drone release allow the regular treatment of large areas within a very short time without reducing the quality of the sterile males. We will present recent technological developments, field testing results and discuss new opportunities under development, like the use of autonomous ground robots to complement aerial releases.

Operational deployment of the Sterile Insect Technique (SIT) against *Aedes albopictus* in France. insights from contrasted urban contexts

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In mainland France, *Aedes albopictus* is both a major nuisance and an increasing public health concern. Since 2025, the Sterile Insect Technique (SIT) has been deployed operationally by Terratis for municipalities. In 2026, interventions covered 500 hectares distributed across different regions of France, requiring adaptation to diverse urban environments and initial infestation levels. Terratis applies SIT across sites selected by client municipalities, representing a range of urban contexts including cemeteries, vegetated residential areas, and less vegetated residential zones. These areas also differ in initial mosquito densities. From April to October, bi-weekly releases of sterile males are conducted at a typical density of 3,000 males/ha. Field indicators are monitored weekly as part of routine operations, and results are shared with clients throughout the mosquito season. After one to two operational seasons, field feedback shows that SIT consistently leads to a reduction of *Ae. albopictus* populations across all treated contexts. However, the pace and trajectory of reduction vary depending on the initial situation, particularly landscape characteristics and baseline densities. When an early start in April is not feasible, initiating releases later during the peak season can still reduce population levels and effectively prepare for improved control in the following season. These observations provide practical insights into how SIT performance evolves over time in heterogeneous urban environments. This work presents real-world operational results from SIT deployments and opens the discussion on the conditions and timelines required to achieve effective population suppression. Such feedback is essential to guide expectations, optimize deployment strategies, and support the broader adoption of SIT in urban mosquito control.

Industry Session

A climate-responsive disease risk projection platform – v2 dengue release and opportunities for partnership and early adoption

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Arboviral diseases such as dengue, Zika, and chikungunya are expanding rapidly, driven by urbanization, climate change, and the spread of key vectors including *Aedes albopictus* and *Aedes aegypti*. Translating the growing body of vector biology and ecological research into operational, decision-ready tools remains a critical gap. models exist, but they are rarely accessible to the public health agencies, vector control programs, and industry stakeholders who need them most. Here we present the EpiWise Integrated Decision Platform, a disease risk projection platform designed to deliver rapid, reputable, and customizable geospatial risk estimates to support policy, public health, and industrial decision making worldwide. EpiWise's core mission is translational. working in partnership with local and international research laboratories to bring state-of-the-art models — integrating climate, environmental, and demographic data — into tools accessible to decision makers worldwide. Risk indices are delivered via an interactive spatial data infrastructure with a dashboard tailored for easy interpretation by non-specialist users and API access to support integration into existing decision workflows. A responsible commercial model aims to provide long-term sustainability while prioritizing equitable access. EpiWise's dengue risk products, scheduled for release coinciding with this INOVEC conference, projects spatial and temporal transmission risk under current and future climate scenarios. Ongoing work will extend the platform to a wider variety of vector-borne and zoonotic diseases. We invite early adopters and collaborators from research, public health, and industry to engage with the platform, guide prioritization of future disease products, and align risk services with specific stakeholder needs — ensuring EpiWise becomes a dependable resource for anticipating and mitigating disease risk in a rapidly changing world.

The Debug Project. Expanding *Wolbachia* techniques for control of mosquito borne disease

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Debug, a Google initiative to reduce mosquito-borne diseases, has spent over a decade developing end-to-end technologies to help protect the 4 billion people worldwide at risk of dengue. By integrating custom software, hardware automation, scientific innovation, and AI, Debug delivers both mosquito suppression and replacement solutions at scale. At the core of this approach is *Wolbachia,* a naturally occurring bacterium that serves as a precise, chemical-free way to stop mosquitoes from spreading disease. In Singapore we have driven down *Ae. aegypti* populations by more than 90% resulting in a 77% reduction in dengue transmission in partnership with the National Environmental Agency. Working alongside conservation groups in Hawai'i we have developed novel approaches for delivering Culex male mosquitoes to the rainforest habitats of critically endangered native birds in an attempt to protect them from invasive avian malaria. In Europe we are partnering with academic and business leaders to bring at scale *Ae. albopictus* suppression to Italy and Spain. In 2026 Debug launched our first Wolbachia based population replacement tools in South and Central

America aimed at protecting populations against dengue. We are excited to see where the next 10 years of advancement takes us and the fight against mosquito-borne disease.

The In2Care® Mosquito Station. From Mechanism to Field Impact across Laboratory, Semi-Field, and Field Evaluations

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The expansion of mosquito vectors, increasing insecticide resistance, and the challenge of controlling container-breeding mosquitoes highlight the need for more practical and sustainable vector control solutions. The In2Care® Mosquito Station addresses these challenges through an autodissemination-based approach that extends control beyond conventional application boundaries and targets multiple mosquito life stages simultaneously. In2Care® utilizes a dual-action autodissemination mechanism by turning mosquitoes into carriers of pyriproxyfen and Beauveria bassiana, enabling control far beyond traditional application boundaries. Gravid females are attracted to the station, where they become contaminated with a powder formulation applied to electrostatically charged gauze. After leaving the station, mosquitoes transfer pyriproxyfen to surrounding and often hard-to-find breeding sites, where it disrupts larval development. Simultaneously, Beauveria bassiana induces delayed mortality in adult mosquitoes, giving them sufficient time to disseminate the larvicide to breeding sites before succumbing to the infection. Moreover, the fungal infection delivers immediate public health advantages even prior to mosquito death by suppressing viral replication (such as Dengue) and triggering pre-lethal effects, including reduced biting behaviour and diminished reproductive capacity. Across laboratory, semi-field, and field studies, this mode of action has consistently translated into measurable entomological effects. Laboratory and cage experiments show effective uptake and transfer of the active ingredients, while semi-field trials confirm the ability of mosquitoes to disseminate pyriproxyfen under controlled conditions. Field studies further demonstrate reductions in ovitrap indices, larval abundance, and adult mosquito populations across different ecological and operational settings. The In2Care® Mosquito Station represents a robust and resistance-independent tool that can complement existing integrated vector management strategies. Its targeted mode of action, low amount of active ingredient, and compatibility with biological control approaches support its use within more sustainable and practical vector control programs.

AquaBac Field Performance. Bti-Based Larvicide Case Studies

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AquaBac® represents a *Bacillus thuringiensis israelensis* (Bti)-based larvicide with demonstrated field performance across diverse application scenarios. Backpack application trials comparing AquaBac against alternative Bti-based larvicides demonstrated consistent performance across multiple distances and spray widths, highlighting important operational considerations for vector control programs. Additional case studies will explore innovative application approaches, including unmanned aerial systems (UAS), and their role in supporting effective, operationally practical mosquito larval control programs. These examples illustrate the versatility of Bti-based larvicides across diverse treatment environments and application

methods, providing insights to support evidence-based vector control decision-making. Together, these case studies provide insight into the effectiveness and operational flexibility of Bti-based larval control across a range of application methods and environments. Attendees will learn how field performance data can support larvicide selection, application strategy development, and integrated vector management programs aimed at improving mosquito control outcomes and operational efficiency.

Integrating chemical ecology into consumer goods for sustainable innovative behavior-based approaches to mosquito control

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Emerging arboviral diseases continue to reveal critical gaps in conventional vector control, particularly for outdoor and daytime exposure where insecticide-based tools offer limited protection. Addressing these gaps requires integrated, sustainable solutions that reduce human–mosquito contact while fitting seamlessly into everyday life. Here, we present a behavior-based vector control strategy that disrupts mosquito host seeking and can be deployed through familiar consumer products. Grounded in chemical ecology, this approach translates fundamental insights into practical formats by embedding mosquito active solutions into routine personal and household care products—providing protection without requiring changes in daily behavior. We demonstrate that this translational pathway delivers meaningful bite reduction alongside positive user perception, supporting the feasibility of self-deployed, community compatible interventions. By leveraging everyday products as protective interfaces, this work illustrates how behavior-based tools can complement existing vector control strategies and contribute to more sustainable, user centered innovation in the fight against emerging arboviral diseases.

Turbo talk Abstracts

Larvicidal and Growth Regulator- Like Activities of Croton aromaticus Leaf Extract Against the Dengue Vector *Aedes albopictus*

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Dengue and chikungunya remain critical public health threats in Sri Lanka, with *Aedes albopictus* as a dominant vector, while synthetic insecticide-based control is increasingly limited by resistance and environmental concerns. This study investigated the larvicidal and growth regulator (IGR)-like effects of leaf extracts of Croton aromaticus, an abundant, least-concern indigenous plant, against *Ae. albopictus*. Leaf extracts prepared using ethanol and ethyl acetate were evaluated for larvicidal activity against third–fourth instar larvae at 1500–5000 ppm (ethanolic) and 1000–3000 ppm (ethyl acetate) using triplicate assays (10 larvae/replicate) with controls; mortality was recorded at 24, 48, and 72 hours, and LC_{50} and LC_{90} were calculated via probit analysis. Based on preliminary results, sub-lethal concentrations of 1-150 ppm of the ethyl acetate extract were separately applied to third–fourth instar and first–second instar larvae, using the same experimental procedure. Bioassays demonstrated significant concentration- and time-dependent larvicidal activity ($p < 0.05$), with the ethyl acetate extract showing greater potency (LC_{50} at 24 h = 2.59×10^3 ppm, 72 h = 1.28×10^3 ppm) than the ethanolic extract (LC_{50} at 24 h = 4.73×10^3 ppm, 72 h = 2.09×10^3 ppm). Sub-lethal exposure to the ethyl acetate extract caused complete developmental arrest of early instars at all tested concentrations, with larvae remaining arrested for 9–15 days without molting before death. 25 ppm was the lowest effective concentration producing complete IGR-like effects in third–fourth instar larvae, resulting in developmental arrest for up to 31 days prior to death. Thus, 25 ppm represents the minimum effective concentration required to induce complete growth arrest in *Ae. albopictus*. This study provides the first evidence of C. aromaticus's larvicidal and IGR-like activity, highlighting its potential as a biodegradable larvicide for sustainable dengue vector control.

Hard Ticks in Lebanon. A Molecular Snapshot of Associated Pathogens.

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Tick-borne diseases pose a growing threat to livestock production and public health in Lebanon. Despite the considerable diversity of tick vectors in the Mediterranean region, comprehensive surveillance data in Lebanon remain scarce. This study aimed to inventory tick species and investigate the bacterial and parasitic pathogens associated with them across several Lebanese governorates. A total of 4,202 tick specimens were collected during three sampling seasons (2018, 2021, and 2023) from a variety of hosts, primarily cattle and small ruminants, and less frequently from cats, dogs, turtles, and rodents. Tick identification was performed morphologically using regional taxonomic keys. Pathogen screening was conducted on 838 tick specimens grouped into 170 pools. Screening employed a high-throughput microfluidic platform enabling simultaneous real-time PCR amplification of specific genes targeting 24 bacterial and parasitic species belonging to seven

genera. Additional species within these genera could also be identified through amplicon sequencing. Positive findings were systematically validated using conventional PCR and Sanger sequencing to confirm pathogen identity. Morphological analysis identified 13 tick species. *Rhipicephalus sanguineus s.l.* (the predominant species), *Rhipicephalus spp*. (unidentified), *R. annulatus, R. bursa, Hyalomma aegyptium, H. rufipes, H. parva, H. excavatum, H. marginatum, H. dromedarii, Haemaphysalis parva, Hae. erinacei,* and Ixodes ricinus. Molecular screening revealed a diverse pathogen profile, including *Babesia ovis* (3/170), *Theileria ovis* (4/170), *Hepatozoon spp*. (6/170), *Anaplasma ovis (*46/170), *Ehrlichia spp.* (34/170), and Spotted Fever Group *Rickettsia spp.* (63/170), among which *Rickettsia massiliae* was identified in 10/170 pools. In addition, two pools tested positive for Francisella and Coxiella species, likely corresponding to non-pathogenic symbiotic bacteria. These findings highlight the wide diversity of tick-borne pathogens circulating in Lebanon and emphasize the urgent need for integrated vector surveillance and control strategies. Identifying and mapping hotspots of pathogen circulation can support targeted interventions, reduce animal morbidity, and help mitigate potential zoonotic risks

Resting site habits of *Aedes albopictus* in Occitania. From habitat preferences to rapid density assessment

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The invasive mosquito *Aedes albopictus*, a major vector of dengue and chikungunya viruses, is now widely established in mainland France and caused to the unprecedented 2025 chikungunya outbreak (>800 cases). In outbreak settings, rapid assessment of vector density is essential to assess transmission risk, guide control interventions and prioritize treatment in high-risk areas. However, current entomological investigations remain largely qualitative, often classifying sites as positive upon detection of a single mosquito, which limits quantitative risk comparison. A better understanding of adult resting-site ecology could provide a complementary and field-adapted basis for targeted, rapid density estimation. In a first phase, we identified and characterized resting sites used by *Ae. albopictus* in a temperate urban environment. Fieldwork conducted in southern France combined ovitrap monitoring (April–December 2023) and standardized aspiration and human landing catches (HLC) across 75 resting sites. Microclimatic and environmental variables were recorded, and captured adults were dissected to assess physiological status. Resting-site selection appears to be driven by microclimatic conditions, including relative humidity, temperature, and Plant Area Index. Dense vegetated areas, like cane vegetation, were identified as "super resting sites" habitats, harboring high densities of parous and blood-fed females as well as swarms. In contrast, cable chambers predominantly hosted immature adults and were identified as emergence sites. In a second phase, we evaluated whether counts of landing females during short HLC sessions could serve as a rapid proxy of local vector density in these key habitats. Across 1,293 sampling events, landing times (<60 s) were shortest in vegetated sites and in the presence of swarms, closely reflecting mosquito abundance measured through aspiration data. These results show that coupling resting-site identification with short HLC measurements

provides a practical, targeted, and quantitative approach for risk assessment and vector control in temperate urban outbreak contexts.

Laboratory testing of Spatial Emanators and Volatile Insecticides. A toolkit

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Spatial emanators including those releasing volatile pyrethroids such as transfluthrin received a conditional WHO recommendation for indoor use in malaria control in 2025. Transfluthrin products are reported to be effective across domestic and peridomestic spaces, and emanators deployed in and around the home also expose *Aedes*. This provides the opportunity for integrated vector control using. But it also creates a need the arbovirus-vector community will share with those working in malaria control. a way to monitor susceptibility to volatile actives. Cross-resistance is already a concern, with Kokkas et al. (2026) showing that pyrethroid-resistant *Aedes aegypti* strains had markedly reduced response to transfluthrin, and it is likely that resistant populations may be differentially tolerant to emanators. Existing susceptibility bioassays combine tarsal contact and vapour exposure and cannot isolate airborne effects or detect resistance specific to volatile exposure. We present a suite of non-contact methods to test spatial emanators and volatile insecticides in the lab, a toolkit developed for Anopheles but applicable to *Aedes*, spanning routine field-deployable monitoring through to detailed behavioural characterisation. Developed for susceptibility testing, methods are also being adapted as a lab-based screen for new volatile actives. The Two Tube Volatile Assay adapts standard WHO tube hardware to deliver vapour-only transfluthrin exposure, generating concentration- and time-dependent knockdown and 24-hour mortality in a simple, low-cost, scalable option for routine susceptibility monitoring. A Peet-Grady chamber assay allows us to use video-tracking to characterise mosquito behaviour alongside mortality, resolving dose-dependent differences between strains and capturing sub-lethal endpoints relevant to emanator performance. Other methods are in development to measure the effect of exposure on blood feeding as a lab-based proxy for protective efficacy measured via human landing catch. We seek collaboration to apply these methods to further populations and compounds, and to validate and develop harmonised guidance for the *Aedes* community.

SMARTBO. Field-Based calibration and operational validation of a spatiotemporal Aedes *albopictus* dynamic model using connected smart traps, for vector control optimization in mainland France

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Modeling mosquito vector dynamics and assessing control interventions efficiency are critical for improving the effectiveness of vector control strategies. Arbocarto, developed by UMR TETIS for the French Ministry of

Health, simulates the spatiotemporal dynamics of *Aedes albopictus* populations and intervention outcomes. However, coarse estimates of environmental carrying capacities and the lack of validation against field-based entomological data still strongly limit its operational use in mainland France. This project aims to strengthen Arbocarto by integrating high-resolution entomological datasets collected during vector control operations around imported and autochthonous *Aedes*-borne arbovirus cases in mainland France. These datasets include improved estimates of local environmental carrying capacities and an innovative trapping protocol deployed in southern France, based on high frequency connected traps, with real-time counting of adult mosquito, to understand post-intervention recolonization dynamics of *Aedes albopictus*. By quantifying recolonization rates and patterns, the project will provide key insights into the spatial and temporal dynamics governing mosquito population recovery. These findings will enable the optimization of both targeting and timing of intervention strategies to improve vector control efficacy. Model simulations will also support small-scale identification of high-risk areas and monitoring of post-intervention arboviral risk. Overall, the project will enhance the operational relevance of Arbocarto for Regional Health Agencies and vector control operators in mainland France. It will deliver decision-support indicators and propose an integrated monitoring framework combining field data and modeling to guide real-time risk assessment and intervention planning.

Integrated Surveillance of *Aedes* Vectors in Benin. From Breeding Site Ecology to Arboviral Risk Prediction and Insecticide Resistance Monitoring

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Arboviruses represent an increasing public health threat in West Africa. In Benin, *Aedes aegypti* and *Aedes albopictus*, vectors of dengue, chikungunya, yellow fever, and Zika, are widely distributed. The recent circulation of multiple dengue serotypes and the emergence of insecticide resistance highlight the need for an integrated approach to anticipate transmission risks and guide vector control strategies. Entomological surveillance of dengue vectors was conducted in several communes in southern Benin (Porto-Novo, Adjarra, Avrankou, Ifangni, Ketou, Pobe, Dassa-Zounmè, Bohicon, Lokossa). Investigations combined larval prospections, adult collections, characterization of breeding sites, analysis of biting and resting behavior, and calculation of Stegomyia indices. Dengue virus circulation was assessed by RT-PCR. Ecological data were integrated with insecticide resistance monitoring, including bioassays, detection of kdr mutations, and metabolic resistance mechanisms. Across surveyed sites, *Aedes aegypti* was the predominant species. The most productive larval habitats were discarded tires and domestic water storage containers. Populations exhibited exophagic and exophilic behavior, with hematophagic activity peaks in the morning and late afternoon. Stegomyia indices exceeded WHO risk thresholds in several communes. Virological surveillance revealed intense dengue circulation, with infection rates up to 96%. Three serotypes were detected DENV 1 (dominant), DENV 3, and DENV 4. Moreover, *Aedes aegypti* populations showed high resistance to pyrethroids, associated with mutations V1016G, F1534C, and S989P, as well as elevated enzymatic activity. In contrast, chlorfenapyr and pyriproxyfen remained highly effective, strongly inhibiting adult emergence and reproduction. High vector density, abundant artificial breeding sites, active circulation of multiple dengue serotypes, and widespread insecticide resistance create favorable conditions for arbovirus transmission in Benin. Integrating ecological, virological, and genetic data enables predictive risk mapping

and identification of priority intervention zones. This innovative approach strengthens surveillance and optimizes vector control strategies in the context of environmental and climatic changes.

Poster Abstracts

Serotypes of Dengue Virus and Kdr Mutations (F1534C, S989P, V410L, V1016I, and V1016G) in *Aedes aegypti* and *Aedes albopictus* Mosquitoes from the commune of Abomey-Calavi, Southern Benin

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Dengue is a viral infection transmitted by mosquitoes of the *Aedes* genus, responsible for millions of cases each year. In Benin, several outbreaks have been reported, particularly in Abomey-Calavi, where the first dengue-related death was recorded in 2019. In the absence of a specific treatment, vector control remains the primary preventive measure. However, the emergence of insecticide resistance, notably through kdr mutations, could compromise its effectiveness. This study aims to identify the dengue virus serotypes circulating in the commune of Abomey-Calavi and to assess the frequency of kdr mutations V410L, V1016G, V1016I, F1534C, and S989P in *Aedes aegypti* and *Aedes albopictus* mosquitoes. Mosquitoes were collected in August 2024 from four arrondissement Togba, Calavi, Akassato, and Godomey through morning and afternoon spraying. After morphological identification, molecular analyses were conducted to detect the viral serotypes and kdr mutations. A total of 218 *Aedes* mosquitoes were collected, with a predominance of *Aedes aegypti* (68.8%) compared to *Aedes albopictus* (31.2%). The overall dengue positivity rate was 23.39% (95% CI. 17.9 - 29.6). The most frequent serotype was DENV-3 (12.4%), followed by DENV-2 (6.9%), DENV-1 (5%), and DENV-4 (0.09%). Six mosquitoes were co-infected with two serotypes. Kdr mutations were detected in both species, with frequencies of 45% for V1016G, 44% for S989P, 40% for F1534C, 22% for V410L, and 19% for V1016I. Four mosquitoes carried three simultaneous mutations, while twenty-two carried two. These results highlight the active circulation of the dengue virus and the presence of kdr mutations in *Aedes* mosquitoes in Abomey-Calavi. However, no significant association was observed between dengue infection and kdr mutations, and their distribution was independent of the viral serotype. These findings emphasize the need for regular monitoring of kdr mutations to adapt vector control strategies and limit the spread of dengue.

Silent Exposure to Arboviral Vectors in Cameroon. What the Nterm-34 kDa *Aedes* Salivary Biomarker Reveals

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Accurate assessment of human exposure to *Aedes* mosquito bites is critical for monitoring arboviral disease transmission risk and evaluating the effectiveness of vector control interventions. Classical entomological methods have well-known limitations, making immunological biomarkers such as the anti-Nterm-34 kDa IgG response a promising complementary approach. The present study aimed to evaluate human exposure to *Aedes* bites using this salivary biomarker in four localities of Cameroon.
A cross-sectional study was conducted in four sites. Kekem, Njombé, Belabo, and Ouami. Dry blood samples were collected from 173 individuals. Anti-Nterm-34 kDa IgG levels were measured by ELISA, and human exposure was expressed as the deltaDO (ΔOD) index. Information on vector control tool use (LLINs, coils, sprays), vegetation cover, and breeding site proximity was recorded by questionnaire. Data was analysed using Graph Path Prism. Overall seropositivity (ΔOD > 0.2) was 26.0% (45/173). Kekem showed the highest exposure level, with 77.5% seropositivity and a mean ΔOD of 0.321 ± 0.198, significantly higher than Njombé (16.4%; 0.112 ± 0.092), Belabo (7.8%; 0.126 ± 0.192), and Ouami (3.7%; 0.083 ± 0.050). LLINs were the predominant vector control tool used (82.7% of participants), yet individuals using LLINs still presented higher mean exposure (ΔOD = 0.164 ± 0.182) than those using coils or sprays. Adults aged 15 years and above tended to show higher exposure levels compared to younger age groups. The anti-Nterm-34 kDa IgG biomarker reveals substantial heterogeneity in *Aedes* exposure across Cameroonian localities, with Kekem presenting the highest transmission risk. The persistence of significant exposure despite LLIN use highlights the need to reinforce integrated vector control strategies targeting *Aedes* mosquitoes in these settings.

Canine olfactory detection of *Aedes albopictus* larval habitats. a citizen science approach for vector surveillance and control

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Aedes albopictus, the tiger mosquito, has colonised the entire Occitanie region and has been present in Montpellier since 2008. Since 2014, foci of autochthonous arbovirus transmission are detected annually in colonised areas. The elimination of larval habitats is a cornerstone of preventive vector control strategies against *Aedes* mosquitoes and the diseases they transmit, and their monitoring is a key parameter for risk assessment analysis. However, *Ae. albopictus* females require only minimal amounts of standing water to lay eggs, making larval sites virtually innumerable, difficult to locate, and challenging to treat or eliminate. Current strategies rely primarily on community mobilisation, which remains difficult to implement effectively and durably, particularly in public spaces. We propose an innovative approach combining canine olfactory detection with citizen science to address these limitations. Dogs possess an extraordinary olfactory sensitivity, widely exploited in medical, veterinary and conservation biology contexts. Here, we present the proof-of-concept results demonstrating the capacity of trained dogs to detect and specifically identify *Ae.*

albopictus larval habitats. Three dogs were evaluated using rigorous double-blind protocols. Results show a sensitivity of 79–96% and a specificity of 85–93% for discrimination from *Culex pipiens*, a native sympatric species. Building on these results, we are developing a participatory surveillance network in the Montpellier area. Volunteers and their dogs will be trained using a method specifically designed around canine cognitive abilities and natural detection behaviour, rather than conventional conditioning techniques. This approach makes the training accessible to non-professional dog handlers and leverages the human-dog bond as a driver of civic engagement in public health. This project brings together canine detection, chemical ecology of larval habitat volatiles, and social sciences to evaluate the operational impact and social dynamics of this citizen science device. It offers a scalable, non-invasive and low-cost complementary tool for urban vector surveillance.

Evidence of Farm-Associated Dengue Transmission during Ghana's First Recorded Outbreak

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Dengue is an emerging public health threat in Africa, yet little is known about the ecological drivers of transmission in many endemic settings. In July 2024, Ghana reported its first confirmed dengue outbreak, affecting farming communities in the Eastern and Central Regions. We investigated mosquito vectors and potential transmission environments associated with the outbreak. Entomological surveys were conducted between September and December 2024 in Amoani and Kwaboadi using Human Landing Catches (HLC) and BG-GAT oviposition traps deployed in residential areas and adjacent cocoa farms. Mosquitoes were morphologically identified and screened for flaviviruses and dengue virus (DENV) using RT-PCR. A subset of samples underwent metagenomic sequencing using Oxford Nanopore Technology. Oviposition preference was assessed by comparing traps baited with water alone and traps containing water plus discarded cocoa pods. A total of 1,076 mosquitoes representing six species were collected. *Aedes* mosquitoes accounted for 52.1% of collections, with more than 94% captured in cocoa farms. *Aedes albopictus* was the predominant species, followed by *Aedes aegypti*, mainly the sylvatic form *Ae. aegypti* formosus. Diurnal biting activity of *Aedes* mosquitoes was consistently higher in cocoa farms than in nearby communities. Traps containing cocoa pods captured significantly more *Aedes* mosquitoes than water-only traps ($p = 0.0125$), suggesting that discarded cocoa pods may serve as attractive breeding habitats. DENV-1 and DENV-4 RNA were detected in three of six *Aedes* pools collected from farms in Kwaboadi. Our findings suggest that cocoa farms may represent important ecological foci for dengue transmission in Ghana, potentially increasing exposure among agricultural workers. The association between discarded cocoa pods and *Aedes* abundance highlights a novel vector management opportunity. Integrating agricultural environments into arbovirus surveillance and vector control programs may strengthen preparedness for future dengue outbreaks in West Africa.

Emerging deltamethrin resistance in *Aedes albopictus*, a key arbovirus vector in Madagascar

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Aedes albopictus is the main vector of arboviruses across the south-western Indian Ocean islands and is presumably a major arbovirus vector in Madagascar. Understanding its insecticide resistance status is therefore essential to support outbreak preparedness and guide vector control strategies. This study evaluated the susceptibility of *Ae. albopictus* populations to deltamethrin across Madagascar and assessed the impact of differing diagnostic doses used over time. Seventeen *Ae. albopictus* populations were tested during surveys conducted in 2016, 2018 and 2024 using WHO tube bioassays. The 0.05% diagnostic dose developed for Anopheles mosquitoes was used in 2016 and 2018, whereas the WHO-recommended 0.03% dose specific for *Ae. albopictus* was applied in 2024. Mortality data were analyzed using a generalized linear mixed model with binomial error distribution and logit link function to standardize mortality estimates at a reference concentration of 0.03% deltamethrin. Log-transformed insecticide concentration was included as a fixed effect and site as a random effect. Phenotypic resistance, defined by WHO criteria as mortality below 98%, was detected in seven populations. One resistant population was identified in Mahajanga I District in 2016, whereas six resistant populations were detected in 2024, including two each in Nosy Be and Antsiranana Districts and one each in Toamasina I and Mahajanga I Districts. Standardized mortality estimates revealed marked spatial heterogeneity between districts. Notably, after standardization to 0.03% deltamethrin, the populations from Toliary Town and Aeroport Morondava shifted from susceptible to resistant status, indicating that susceptibility may have been overestimated in surveys using the higher 0.05% diagnostic dose. Urban environments, particularly tourist areas such as Nosy Be, may contribute to selection pressure through intensive domestic insecticide use. These findings indicate that deltamethrin resistance is emerging in *Ae. albopictus* populations in Madagascar and highlight the need for continued surveillance to support arbovirus outbreak control and regional investigations into mosquito dispersal within the south-western Indian Ocean.

Insights from routine monitoring of insecticide resistance and operational efficacy of deltamethrin-based adulticide treatments against arbovirus vectors in La Réunion, Indian Ocean

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The increasing prevalence of insecticide resistance in *Aedes* mosquitoes represents a major challenge for vector control programs worldwide, particularly regarding pyrethroids such as deltamethrin, which remain central to adulticide interventions. We present a comprehensive assessment of resistance patterns and operational efficacy of adulticide treatments in La Réunion Island, based on combined laboratory and field investigations conducted between 2020 and 2025. Standardized WHO tube bioassays performed on *Aedes albopictus* populations collected across 11 sentinel sites revealed widespread and sustained phenotypic

resistance to deltamethrin, with mortality rates frequently below 90%, confirming widespread resistance on the island. By contrast, the limited *Aedes aegypti* populations sampled exhibited higher susceptibility. Molecular analyses suggest that resistance in *Ae. albopictus* is primarily driven by metabolic mechanisms, including overexpression of detoxification enzymes, rather than target-site mutations (kdr), although the potential emergence of such mutations remains a concern. Operational efficacy of adulticide treatments was mostly evaluated through sentinel cage experiments. Vehicle-mounted ultra-low volume (ULV) treatments demonstrated low efficacy, resulting in their discontinuation. In contrast, handheld applications (sprayers and thermal foggers) achieved high mortality rates, often exceeding the operational threshold of 90%, provided that environmental and application conditions were optimal. Despite confirmed resistance using WHO bioassays in the laboratory, deltamethrin-based adulticide treatments retain significant operational efficacy in La Réunion. The findings highlight the importance of integrated vector management, continuous resistance surveillance, and regular field efficacy assessments to optimize intervention strategies and sustain arbovirus risk reduction.

From field surveillance to BSL-3 vector competence. establishing an integrated *Aedes* arbovirus research platform at GIMM, Portugal

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The expansion of *Aedes albopictus* across Southern Europe is increasing the need for local research capacity to support arbovirus preparedness, vector surveillance and evidence-based control. Here, we describe the establishment of an integrated *Aedes* research platform at the Gulbenkian Institute for Molecular Medicine (GIMM), Lisbon, combining field surveillance, insectary colonization, susceptibility testing and high-containment experimental infection capacity. A university-linked ovitrap surveillance network was implemented across selected urban and peri-urban sites in Lisbon to monitor the presence and spatial distribution of *Ae. albopictus*. Field-derived mosquitoes were used to establish laboratory colonies under controlled insectary conditions, enabling standardized phenotypic assays and preparation for downstream vector competence studies. In parallel, the GIMM *Aedes* insectary was developed to support the maintenance of *Ae. albopictus* populations from Lisbon and Algarve and to perform assays relevant for vector biology, insecticide susceptibility and arbovirus transmission. As first outputs of this platform, adult insecticide susceptibility assays and larval *Bacillus thuringiensis israelensis* bioassays were performed using Portuguese *Ae. albopictus* populations, generating baseline data with direct relevance for local vector control decision-making. In addition, BSL-3 procedures are being adapted to enable controlled mosquito infections with emerging arboviruses, establishing the basis for ongoing vector competence studies. Together, this work establishes a new integrated pipeline for invasive *Aedes* research in Portugal, linking field monitoring, insectary-based colonization, susceptibility profiling and high-containment arbovirus infection studies. This platform will strengthen national capacity to assess vector competence, monitor control-relevant phenotypes and support preparedness for dengue, Zika, chikungunya and other emerging arboviral threats.

VECGETO. One Health excreta-based framework for simultaneous detection of mosquito hosts, nectar sources, arboviruses and plant viruses in urban school revegetation contexts

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Urban school revegetation policies in Occitanie region address climate change by reducing heat islands and restoring biodiversity in targeted hotspots. However, these landscaping changes may also reshape mosquito trophic ecology by altering the availability of vertebrate hosts and plant sugar resources, with potential consequences for the transmission risk associated with *Aedes albopictus*, an invasive vector of arboviruses. In this context, the project aims to develop and validate a multi-target detection approach based on mosquito excreta, enabling the simultaneous identification of (i) vertebrate blood meal sources, (ii) plant sugar sources, and (iii) viral excretion (arboviruses and plant viruses) in a One Health framework. Methodological development will first be conducted under controlled laboratory conditions, followed by validation in vegetation-rich environments (i.e. Jardin des Plantes, Montpellier). In a second phase, the optimized approach will be implemented in three schools of Montpellier monitored through the ESCOOLA initiative, before, during, and after revegetation interventions. This stepwise strategy will establish the feasibility of high-resolution trophic profiling and lay the groundwork for scalable monitoring of ecological and epidemiological changes associated with urban revegetation. A collaborating team in Virginia (U.S.) will implement the same protocol in contrasting ecological contexts to support comparative analyses. VECGETO ultimately aims to deliver integrated indicators of vector risk of revegetation policies by linking plant diversity, mosquito feeding behavior and pathogen circulation. In the longer term, the metrics generated could help guide the design of risk-adapted revegetation strategies and contribute to evidence-based public health policies in climate-resilient cities.

Beyond the prototype. making AI-based vector surveillance work in the real world

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There is no shortage of publications showing that a deep learning model can identify a mosquito species from a photograph with acceptable accuracy. What is extremely rare is for such a system to be employed by the relevant health agency in their mosquito surveillance activities. And this is the true challenge. This work reflects on what needs to be considered to go from developing AI-driven systems for mosquito surveillance to actually employing such a technology, using our own experiences in developing DeepSquitoes, a mobile app used to classify mosquito species in Mauritius, as well as other initiatives globally. All the technical elements are in place. First, smartphones in tropical areas have sufficient penetration for meaningful citizen science. Second, lightweight DL architectures such as MobileNetV2 function well on mid-range hardware, and third, cloud computing of pipelines is affordable. Nevertheless, there are very few operational systems. One important aspect is that of data. Training a model using 154 pictures of wings belonging to eight different Mauritian species is insufficient and cannot work in Réunion island, in Senegal, and in French Guiana if the same vector species are available there. Indeed, generating adequate and relevant data sets for projects such

as INOVEC needs concerted and continuous field activities across the partnership members. Such a process does not result from an isolated scientific community. A second important aspect is the post-upload step when a citizen sends an image. There are issues of validation, which means that an expert entomologist has to check whether the automatic classification is correct or not. These steps often go unmentioned in articles but they can constitute the most significant barrier. Systems ignoring them in their design eventually face a data flood problem. Another problem lies at an institutional level. Technology designed independent of public health procedures and even at times by public health workers themselves, seldom influences public health decision-making processes. The most advanced technology used for surveillance purposes will be useless if it cannot access the communication lines required for vector control. The INOVEC network will have an ideal vantage point from which to engage with such issues due to the consortium's inherent ability to involve all the necessary institutions and actors involved in both the research and implementation of vector surveillance. Perhaps the most useful impact of the INOVEC consortium on AI-powered vector surveillance might not necessarily come in the form of yet another pilot test of concepts, but could arise in the form of data standards, an imaging repository, and integration protocols.

Spatiotemporal dynamics of *Aedes aegypti* populations in three squared in Bobo-Dioulasso city from 2021-2025. perspectives for Sterile Insect Technique Implementation to control dengue in Burkina Faso

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Between 2013 and 2020, Burkina Faso experienced a series of dengue outbreaks involving all four serotypes of the dengue virus. Recent studies have shown that *Aedes aegypti*, the main vector of arboviruses, is resistant to conventional insecticides. This calls for alternative and/or complementary strategies, such as the Sterile Insect Technique (SIT). Longitudinal entomological surveys were conducted to monitor the dynamics of the *Ae. aegypti* population in Bobo-Dioulasso in preparation for SIT pilot interventions. Entomological surveys were conducted at three sites selected as pilot sites for SIT purposes. From September 2021 to May 2025, adult mosquitoes were collected monthly. Larvae of household mosquitoes were collected from water-holding containers and reared to adulthood in the insectary in 2022. The main entomological indices for arbovirus risk were estimated according to World Health Organization criteria. A total of 49,652 adult mosquitoes were collected. *Culex quinquefasciatus* and *Aedes aegypti* were the most abundant species, accounting for 82.73% and 15.58% of the total, respectively. The *Ae. aegypti* population increased in abundance during the rainy season, in line with rainfall intensity. A total of 5,955 *Ae. aegypti* larvae were collected from 775 containers. The house and container indices were higher during the rainy season, reaching 20 and 40, respectively, for all sites. These results provide the basic entomological information before the SIT implementation in the field. Our next challenge will be the mass rearing, mark release recapture of male *Ae. aegypti*, followed by the acceptability of SIT strategy by stakeholders such as government and the population

Evaluation of eDNA qPCR for *Aedes albobictus* surveillance in tropical larval habitats

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Mosquito vector surveillance is a major public health priority in tropical regions. Environmental DNA, a promising approach for larval detection, remains poorly documented under tropical conditions with high DNA degradation and PCR inhibition. This study evaluated a qPCR assay targeting *Aedes albopictus* eDNA in larval breeding sites, compared its performance with conventional larval surveillance, and identified factors influencing detection and signal intensity. We conducted field validation at 28 breeding sites on La Réunion island over five months, from November to March, totaling 102 site visits. At each visit, for each breeding site, we filtered (Sterivex, 0.45 µm) 120 mL water samples and extracted DNA using a Macherey-Nagel NucleoSpin eDNA Water Kit. We amplified DNA by qPCR using Environmental Master Mix in triplicate, alongside larval dipping. A site was considered eDNA-positive if at least two out of three replicates amplified beyond the detection limit, which was established from a standard curve. We assessed predictors of detection and signal intensity using mixed models. In the field, eDNA-qPCR detected *Ae. albopictus* in 64.7% of site visits, significantly more than larval surveys (39.2%; McNemar's test, $X2(1) = 16.45$, $p < 0.001$). Agreement was fair (Cohen's Kappa=0.30, 95%CI [0.14-0.46]), reflecting their differing temporal sensitivity rather than assay unreliability. Positive and Negative percentage agreement were 85% and 48.4%, respectively. Larval density was negatively correlated with Ct values (rho=-0.46, p=0.007), confirming a dose-dependent relationship between larval abundance and eDNA signal. Detection probability was not affected by sun exposure, but signal intensity was reduced under full sun exposure independently of larval density. eDNA-qPCR significantly outperformed conventional larval dipping for *Ae. albopictus* detection under tropical field conditions. These findings support eDNA-qPCR as a sensitive complementary tool for mosquito surveillance, with potential applications to early detection of invasive vectors and the monitoring of vector-control interventions.

Review of a 2026 trapping season using the I-NEST PRO trap for urban mosquito management

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The proliferation of the invasive mosquito species, *Aedes albopictus*, leads local authorities to test new solutions to monitor populations in sensitive areas (educational institutions, public parks and gardens). Effective control strategies require targeted tools capable of disrupting the mosquito life cycle at critical stages. The Invascience Company is a French company founded in 2021 to control invasive insect species, particularly mosquitoes. The company designs environmentally friendly and scientifically validated trapping solutions targeting different stages of the mosquito life cycle. Its portfolio includes automated smart CO_2 traps for host-seeking female mosquitoes and oviposition traps for gravid females. These solutions are marketed under two specialized brands. INYO, for professional service providers and certified networks, and WILIV, for retail distribution. In 2025, a new product specifically designed for municipalities and local authorities was developed to target gravid females. The I-NEST PRO trap. This presentation evaluates the field performance of the I-NEST PRO, a sustainable trap specifically engineered for municipal use, targeting gravid female mosquitoes. It provides an analysis of the field monitoring results and population data collected throughout the 2026 mosquito summer season.

Insecticidal activity of *Sargassum* extracts against *Aedes albopictus* mosquitoes. Towards the development of sustainable bioinsecticides

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Introduction. The control of *Aedes* mosquitoes, vectors of dengue, chikungunya and Zika, relies heavily on synthetic insecticides, whose efficacy is increasingly compromised by resistance and whose environmental impact is a growing concern. There is therefore an urgent need to develop new bioinsecticides derived from natural sources. Massive strandings of *Sargassum fluitans* and *Sargassum natans* generate abundant marine biomass that could be valorized as a source of bioactive compounds. Methods.This study evaluated the larvicidal activity of dichloromethane (DCM) and ethyl acetate (EtOAc) extracts of *S. fluitans* and *S. natans* against *Aedes albopictus* larvae. Methods. Third- and fourth-instar *Ae. albopictus* larvae were exposed for 72 h to DCM and EtOAc extracts at 100–500 mg/L, with a 0 mg/L control (pooled data. 200 larvae per concentration for DCM, 300 for EtOAc). Mortality was recorded at 72 h, and probit regression was used to estimate LC_{50}, LC_{90} and LC_{95} with 95% confidence intervals (CI). Results. Larvicidal activity of both extracts generally increased with concentration. For EtOAc, mortality was 6.3%, 37.3%, 58.3%, 72.0% and 84.3% at 100, 200, 300, 400 and 500 mg/L, respectively; the LC_{50} was 260.7 mg/L (95% CI. 248.5–273.5), while the LC_{90} (609.1 mg/L; 557.1–666.0) and LC_{95} (774.7 mg/L; 694.2–864.6) exceeded the tested range. For DCM, mortality reached 47.0%, 89.0%, 91.0%, 92.5% and 92.5% at the same concentrations, with an LC_{50} of 91.4 mg/L (77.4–108.0), an LC_{90} of 316.0 mg/L (280.4–356.0) and an LC_{95} of 449.1 mg/L (382.3–527.6). DCM thus yielded lower lethal concentrations than EtOAc, with nearly 90% mortality at 200 mg/L. Conclusion. *Sargassum fluitans* and *Sargassum natans* organic extracts showed larvicidal activity against *Ae. albopictus* larvae, the DCM extract being the most active. These findings support bioassay-guided fractionation of the DCM extract, coupled with chromatographic and spectrometric analyses, to identify the active compounds and assess their potential as bioinsecticides for vector control