RESOURCE HUB *Correspondents*

# 8th PAMCA Annual Conference and Exhibition: *"Harnessing local institutional and community support for the elimination of vector-borne diseases (VBDs)"*

## Complete series

*MESA Correspondents bring you cutting-edge coverage from the 8th PAMCA Annual Conference and Exhibition*

*26 - 28 September 2022*

*The MESA Alliance would like to thank Jessy Goupeyou-Youmsi (WIVC Regional Coordinator for West Africa) and Idelphonse Bonaventure Ahogni (Centre for Research in Entomology of Cotonou - CREC, Ministry of Health, Benin, for providing senior editorial support.*

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RESOURCE HUB Correspondents

M E S A

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**8th PAMCA Annual Conference and Exhibition**

The #PAMCA2022 Annual Conference & Exhibition is being held at the Kigali Convention Centre (KCC), Rwanda, between 26th - 28th September 2022. This year's event marks the 8th annual edition and it is themed "*Harnessing local institutional & community support for the elimination of Vector-Borne Diseases (VBDs)*".

Prior to the start of the 3-day conference, seven short trainings/meetings were held:

1. A closed **FNIH meeting** was held on September 23rd, where participants (mostly decision-makers) have been trained to appreciate modelling and how models can be used to support the decision-making process.
2. A **Gene Drive Beta course** held on September 23rd, targeted people with little knowledge and background about gene drive as preliminary to the standard Gene Drive course.
3. A **3-day training course on gene drive** (September 23rd - 25th), "*Novel Genetic Vector Control strategies: From research to acceptance and implementation*" took place to provide the basic technical understanding of gene drive technologies with the action plan to disseminate that knowledge in the participants' home countries and institutions.
4. A **3-day workshop specific for women-themed** (September 23rd - 25th), "*Effective communication in leadership and professional development course*" to improve the leadership and communication skills of women in vector control (WIVC) in Africa. This workshop featured 25 women from 17 African countries.
5. A **3-day professional development workshop** (September 23rd - 25th) on Strengthening Vector Control Decision-Making in Africa, targeting researchers and professionals based in Africa who are interested in using modelling information to make informed decisions within public health.
6. The **Anopheles Genomics Hackathon workshop** was held on September 25th, for trainees and trainers of the *PAMCA-MalariaGEN training programme on data analysis for genomic surveillance of African malaria vectors* was delivered virtually and that provided participants with a great opportunity to meet, interact, and network with each other.
7. The **Wekre Initiative workshop** was held on September 25th, where National Malaria Control Programmes (NMCPs) from 16 countries met with three PAMCA centres of excellence (the Centre for Research in Infectious Diseases in Cameroon, Ifakara Health Institute in Tanzania and the Research Institute of Health Sciences - IRSS in Burkina Faso) to discuss the path forward for system-wide evidence-based decision-making for malaria elimination.

**Opening Ceremony**

The opening ceremony was moderated by **Dr. Damaris Matoke-Muhia**, Programme Manager for Capacity Building & Gender Mainstreaming at PAMCA, and **Dr. Jessy Goupeyou-Youmsi**, WIVC Regional Coordinator for West Africa at PAMCA, who co-MC the entire conference. Six hundred practitioners, researchers, program managers, policymakers, partners, and members of civil society from across Africa, Asia, Europe and America attended this year's edition. The Executive Director of PAMCA, **Dr. Prosper Chaki**; the president of PAMCA, **Prof. Charles Mbogo**; the President of AMCA, **Dr. Mark Breidenbaugh**; the PAMCA-Rwanda president, **Dr. Emmanuel Hakizimana**; the Director General of KEMRI, **Prof. Sam Kariuki**, the interim CEO of the Roll Back Malaria, **Dr. Corine Karema**; the Bill & Melinda Gates Foundation representative, **Dr. Seynudé J-F Dagnon**, and the Rwanda Minister of Health, **Dr. Daniel Ngamije**, gave their opening remarks. The opening highlighted the participation of 16 National Malaria Control Programme (NMCP) representatives sponsored by PAMCA which marks

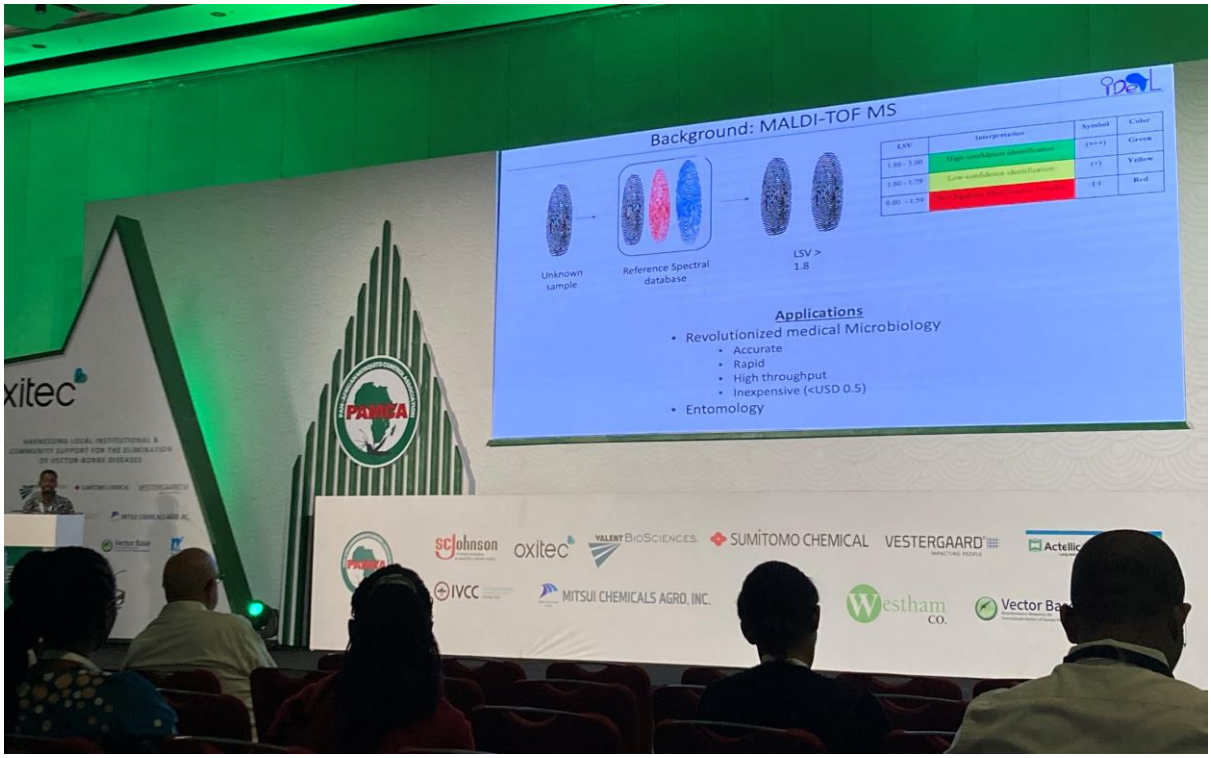
the first time PAMCA integrates programs and researchers, in a context where malaria is increasing with a child dying every minute of malaria in Africa, a preventable and treatable disease. During the opening, the President of AMCA informed about the updated resources on “Best Practices for Integrated Mosquito Management”. It was also mentioned by the panel for the opening remarks that gender-skewed efforts are still needed to improve.


**Keynote Speaker**

The keynote address was given by **Prof. Sheila Tlou** (African Leaders Malaria Alliance - ALMA) from Botswana. She highlighted the work that has been done in reducing malaria in Africa and the problems faced. Indeed, there has been an increase in vector control interventions in Africa. However, due to challenges in the implementation of vector control, supply chain management, limited resources, limited capacity, and lack of accountability and mobilization, the gains have been minimal. She highlighted the importance of political and local community engagement, especially with women and the youth, and also setting systems to involve local stakeholders in joining forces in implementing vector control and taking ownership of vector control activities. Prof. Tlou also highlighted the need to advocate for malaria to remain a priority at a political level. She recognized the important work PAMCA plays in capacity building, and local and political mobilization.

**Parallel Scientific Session 1: Vector surveillance, epidemiology, disease control programs and global health**

**Jonathan Karisa** (KEMRI - Wellcome Trust, Kenya) introduced a novel use of the Matrix-Assigned Laser Desorption Ionization-Time of Flight (MALDI-TOF) technique for determining entomological parameters including vector species diversity, infection status, feeding behaviors, age grading and insecticide resistance level which overcomes the challenges of cost and throughput from current techniques. The efficiency and cost-effectiveness of MALDI-TOF over currently gold standard methods (microscopy, ELISA and PCR-based) was proven in the field, on the Kenyan coast, thus positioning MALDI-TOF as a potential tool to improve vector surveillance for species and blood meal identification.




**Yvonne Kamau** (KEMRI - Wellcome Trust, Kenya) highlighted that there is no clear dose regimen recommended for ivermectin mass drug administration (MDA) for malaria control. The study evaluated two dose regimens: 300mcg/Kg (administered for 3 days) and 400mcg/Kg (administered once) for Killing *An. gambiae* mosquitoes. Venus blood and capillary samples were taken to analyze pharmacokinetics and pharmacodynamics (PK/PD). The study results showed that the killing effect lasted the same time for both regimens, with 400mcg/Kg administered once showing a slightly higher killing effect in *An. gambiae*.

**Caroline Wanjiku Kung'u** (KEMRI - Wellcome Trust, Kenya) recalled the limited utility of current conventional vector control tools, long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS), against outdoor mosquitoes which contribute to residual malaria transmission and questioned how to cover these gaps. To demonstrate the mosquitocidal effect of ivermectin, a mass drug administration (MDA) three-arm cluster randomised controlled trial was performed in Mopeia, Mozambique. Ivermectin was administrated to humans only, and to humans and livestock. In the control arm albendazole was administered to humans. Findings suggested that repeated administration of ivermectin to humans and livestock at the community level could result in a decrease in mosquito populations and malaria transmission.

**Limonty Simubali** (Johns Hopkins Bloomberg School of Public Health - JHSPH, USA) brought the focus on how understudied malaria vectors such as *Anopheles rufipes*, a primarily zoophilic species, could exacerbate malaria risk and supplement malaria transmission to humans. The study involved twenty-five clusters of 12 households each, along the transect from Mutama River to Kariba Dam in Southern Zambia, with mosquitoes being collected indoors and outdoors. Specimens of *Anopheles rufipes* caught from animal enclosures showed positivity with circumsporozoite protein (CSP) through ELISA. This raises the need for enhanced vector surveillance to understand the behaviour (feeding, resting, etc) of understudied vectors.

**Parallel Scientific Session 2: Precision public health and innovations for VBD elimination: AI, entomological databases, modelling and genomic surveillance**

**Halfan Ngowo** (University of Glasgow, UK) presented on using the state-space model to study and predict the population dynamics of *An. funestus*. There is scarce information on *An. funestus* ecology and it poses a challenge in rearing in the laboratory. At the Ifakara health institute, they have a nearly stable colony which has been used to test many entomological parameters of *An. funestus*. This has enabled them to generate their survivorship and fecundity. They have been able to accurately reconstruct seasonal population dynamics in different settings. The next step is to simulate the response of *An. funestus* to different interventions.

**Issa Mshani** (University of Glasgow, UK) on behalf of Bazoumana Sow, narrated the challenges associated with predicting the age of mosquitoes and proposed the use of an infrared spectrometer combined with a machine model. An online platform - Vector Predict - whose requirements are minimal, a computer, operating system, registration, and other details like location, the wavelength of machinery used, and bioassay information, was created to optimize results. Along with meta form completion, spectra are uploaded by the end user to predict age, infectivity and species of mosquitoes. Error is mitigated through filtering. The advantages of this innovation include ease of use as well as cost-effectiveness.

**Andrea Kipingu** (Ifakara Institute of Health - IHI, Tanzania) presented on using stage-structured population models to understand factors affecting population and the presence of malaria in places with a low density of vectors. The model followed the mosquito's life stages and was able to determine that density is a predictor of larval stage survivorship and allele effects a predictor of the fecundity of adult mosquitoes. These factors are able to predict population density taking into account the presence of interventions and their duration. Increasing vector control efficacy, like extensive larvicidal control, in combination with density dependence and allee effects, has decreased the population of vectors.

**Mauro Pazmino** (University of Glasgow, UK) addressed the limitations of mid-infrared spectrometers used in mosquito surveillance and how they can be improved using quantum cascade lasers (QCL). These lasers can produce high-power mid-infrared light which allows the use of non-destructive methods to collect infrared data from mosquitoes and measure small tissues (legs or wings) which can contain important biological information. His team built a QCL-based spectrometer prototype entirely with off-the-shelf components. The prototype is tiny and cheaper than most spectrometers, with similar performance compared to commercial equipment. Thus, QCLs have the potential to develop more efficient and cost-effective spectrometers.

**Givemore Munhenga** (Wits University, South Africa) has been working on sterile insect technique (SIT) for the last ten years in order to reduce the burden of malaria in South Africa. It involves mass-rearing mosquitoes, separation on the basis of sex, irradiation of males and eventual release to the wild. Density reduction of *Anopheles* population was achieved when mating between irradiated males and wild females occurred, which caused sterility. For this study, the conditional phase approach has been deployed with only one phase left -field trial- to complete. The challenges faced include; the appearance of new vector species, difficulties in developing an irradiation canister and the tedious sexing system.

**Parallel Scientific Session 4: Social sciences and gender inclusivity for VBDs**

**Gerry F. Killeen** (University College Cork, Republic of Ireland) began his presentation by demonstrating that independent leadership includes policymakers and technical expertise. He emphasizes that PhD

candidates which come from a variety of institutions, each with its own set of policies and many African institutes, need to build capacity. The risk arises when the institute produces a poor PhD with limited capacity. As a result, you struggle for many years with implementation. Killeen emphasized the need of being proactive in recruiting and training people who can provide solutions to the current problems, quality control during the recruitment process, the need for people with diverse skills for malaria elimination and collaboration among African institutions. Currently, it is difficult to find a well-trained individual at the right time.

**Sarah Moore** (Ifakara Health Institute - IHI, Tanzania) began her presentation by emphasizing the importance of vector control, noting that there are numerous tools available to control vectors, such as IRS and ITN, mentioned that there are two types of repellents, passive and non-passive. They tested repellent efficacy for 32 nights using the experimental hut and human landing catches (HLC). Efficacy was 67% in HLC and 73% in the experimental hut. She concluded that mortality increased when spatial repellent (SR) product remains in the same location an HLC showed to be a practicable method

**Lina Heltsche** (Swiss Tropical and Public Health Institute - Swiss TPH, Switzerland) began her presentation by asking a question about how gender plays a role in malaria elimination. She recalled that global malaria death was 12% higher in 2020, with 14 million more cases than in 2019 and all dependent on various factors such as climate change and resistance. She searched published articles, and only 24 texts matched gender roles in malaria and vector control. Results showed that during an intervention survey, the questions are asked tomen as the house headers, whereas females are more likely to face challenges, and the only message females receive from the media is to sleep under treated bed nets. She concluded that more women should be included in malaria elimination and vector control decision-making, and also maintain equity in malaria control.

**Frederick Tripet** (University of Keele, UK) presented 50 years of mosquito control research based on unstructured data analysis published between 1971 and 2020. He worked on most of the 20 diseases, including vector-borne diseases like chikungunya, Brugia malayi, yellow fever, filariasis, and the West Nile fever virus. Later research output revealed that there was a significant increase in malaria cases in various regions over time, most mosquito research focused on *Aedes aegypti*, and females are disproportionately affected in Africa due to their biological behavior. In a nutshell, gender balance and access to collaborative grant leadership and research development will lead to a reduction in malaria.

**Luzungu Kayira** (Malaria Alert Centre, Malawi) conducted research on different pathways to reduce malaria exposure when members in the Malawi-Chikwawa district were outside at night. She stated that insecticide residual spray (IRS) is the most popular tool used to control vectors in Malawi and that the root cause of malaria exposure is activities such as playing, chores, religious events and burial, which have contributed to the rise in malaria in the Chikwawa district. Children aged 5 to 10 years and pregnant women are particularly vulnerable to malaria. Measures to reduce malaria exposure include smoke from the burning of animal waste and reem leaves, physical protection like trousers, and community support interventions. She concludes that pursuing active preventive strategies for daily interventions will reduce the number of people exposed.

**Caroline Monteh** (University of Buea, Cameroon) presented her work on the prevalence and associated factors of malaria among internally displaced children in Ntouessong and the central region of Cameroon. She narrated the findings of this study, in which *Plasmodium falciparum* is the most prevalent species in Cameroon, accounting for approximately 13% of malaria-related deaths in children and pregnant women in 2017. Furthermore, currently, malaria infection recorded in children (5 - 10 years) and women were 67.2% and 1.9% among them are treated by hospitals while 14% use self-medication. Her study showed that pregnant women and children under 5 - 10 years old are prone

to malaria. To close up, she pointed out that malaria control should include children over the age of five and pregnant women.

**Parallel Symposium 2: Gene drive mosquitoes: New approaches for community engagement and agreement in vector control**

Effective community engagement has long been recognized as important to the success of vector control programmes. This is even more of a prerequisite when it concerns gene drive mosquitoes which represent nowadays a promising novel tool for vector control. However, the adoption of such ground-breaking interventions by community actors relies firstly on their good understanding of the gene drive concepts as a whole.

This symposium was therefore opened by a talk by **Greg Lanzaro** (University of California, Davis, USA) on "*Why is gene drive different? … in the context stakeholder engagement*". He did mention the various considerations (changes in human behaviours) and potential advantages (no direct implication of human populations for complex activities, long-term sustainability of the tools, etc…) which are gained with gene drive as compared to current malaria control methods. Conventional methods imply interactions between the tool and the stakeholder, whereas gene drive does not require human behavior modifications and it has a lower cost.

**Anna Kormos** (University of California Malaria Initiative - UCMI, USA) proposed a relationship-based model as a form of guidance on ethics and co-development regarding gene drive technology for mosquito control. Using the UCMI framework, stakeholders and end users take active roles in determining the strategy that is used for engagement. The model is weaved around six core concepts including a commitment from project leaders, built on existing strength and resources as well as establishing a supportive environment where engagement is led by a local team. She gave specific examples from their field experience and how trust and sustainability have been built.

In 2016, the first genetically modified mosquitoes arrived in Burkina Faso in the hands of **Lea Pare Toe** (Research Institute of Health Sciences - IRSS, Burkina Faso) who received sterile and non-gene drive male mosquitoes from her partners at Target Malaria. The aim was to release the sterile mosquitoes into a community after a process of engagement with it. This engagement started six years ahead of receiving the mosquitoes and three years prior to its release in 2019. The engagement strategy was based on three principles: step-by-step progress, inclusive engagement and transparency in research. In conclusion, there is a need to better understand the pathway of the release of the mosquitoes as well as strong political support as backup and clear mapping of the stakeholders.

In addition, **Naima Skyes** (Target Malaria, UK) gave a picture of what stakeholder engagement might look like. Individual consent for community decisions is necessary and must be sought before and after mosquito release. She also emphasized flexibility, especially with dialogue and maintained that the community actors remain the centre of the research. The instauration of a direct communication approach that sidelines a middle man/third party is a way of building trust. Early engagement and updates were also crucial as the project develops. In conclusion, guidelines and frameworks recommended to an international level should always be adapted in a case-by-case community approach.

**Parallel Symposium 3: Supporting improved insect resistance management strategies - a new mode of action for the Indoor Residual Spraying (IRS) programs**

Chaired by Maezawa Takeo from Mitsui Chemicals Agro, Inc. and Dr. Graham Small from the Innovative Vector Control Consortium (IVCC).

**Janneke Snetselaar** (Innovative Vector Control Consortium - IVCC, UK), the first speaker, presented the importance of insecticide resistance management. Countries have reported mosquitoes being susceptible to more than one type of insecticide class. Insecticide resistance management (IRM) could reverse the insecticide resistance trends by rotating insecticides with different modes of action. Thus, there is a need for novel tools with different modes of action for effective IRM. The question raised, deciphers the feasibility of an IRM plan in a country. She ended her talk by introducing Vectron ™ T500, a new insecticide under review by the World Health Organization (WHO).

**Ayumi Kawasa** (Mitsui Chemicals Agro Inc., Japan) introduced Vectron™ T500, a novel broflanilide-based insecticide designed, for indoor residual spraying (IRS). It is a new generation of insecticide formulation containing new chemicals that provide improved and prolonged control of insecticide-resistant malaria vector populations. Trials conducted showed that the insecticide causes convulsions and death in mosquitoes. *An. gambiae* has shown to be more susceptible to this insecticide than other *Anopheles* species. The insecticide has a long residual activity, low mammalian toxicity, and is environmentally friendly. She mentioned that Vectron™ T500 is a good candidate for IRM.

**Samuel Dadzie** (Noguchi Memorial Institute for Medical Research - NMIMR, Ghana) presented the results of a field trial assessing Vectron™ T500 in Ghana. Testing was conducted through the exposure of wild-caught mosquitoes and Kisumu susceptible strain to treated mud and concrete walls, using WHO cone bioassays. Vectron™ T500 performed similarly to Sumishield®50WG, which was the reference product for IRS. Both insecticides achieved high mortality after 72 hours. However, Vectron™ T500 had a prolonged efficacy compared to Sumishield®50WG, which was the reference product. There was reduced efficacy on mud surfaces treated by Vectron™ T500 than on concrete walls.

**Steven Gowelo** (University of Malawi, Malawi) presented the results of a field trial describing the efficacy and residual effect of Vectron™ T500 on mud and brick wall surfaces. WHO wall cone bioassays were conducted in a southeastern district of Malawi using *An. gambiae* Kisumu strain. After seven months of trial, high mortality was recorded at 48 hours. Vectron™ T500 and Fludora fusion performed similarly. The insecticide showed potential in controlling pyrethroid-resistant mosquitoes on all wall types.

**Bayili Koama** (Research Institute of Health Sciences - IRSS, Burkina Faso) presented results on the efficacy of Vectron™ T500 on mud, concrete and cement walls. WHO wall cone bioassays were performed using field-caught and insectary-reared mosquitoes. The trial recorded high mortality from both field and susceptible strain for 12 months at 72 hours. The residual efficacy of the insecticide is longer than for the reference product, and it has higher efficacy on entomological parameters. No adverse effect was recorded from the use of Vectron™ T500 and the product was accepted by users.

**Parallel Symposium 4: The mosquito abatement district learning exchanges - Lessons from the American mosquito control model**

The session was co-chaired by Elijah Juma (PAMCA) and Samuel Rund (University of Notre Dame, USA).

**Elijah Juma** (PAMCA) explained that the exchange of knowledge on mosquito abatement in certain districts in the United States, with some African countries, resulted in the implementation of similar strategies within the African context. The differences and similarities between the two programs were mentioned, the main ones being the model of funding, and districts having dedicated taxpayer-funded budgets for mosquito control.

**Dereje Alemayehu** (Alameda County Mosquito Abatement District, USA) presented a brief history of the mosquito districts in America and emphasized how one of the first mosquito control districts saw women coming together to fund and clear breeding sites within their district.

**Ary Fraji** (Salt Lake Mosquito Abatement District, USA), presented on the Salt Lake abatement district program. The main intervention was larviciding using different products, tools and equipment with a robust surveillance system.

A panel discussion with **Dereje Alemayehu**, **Prosper Chaki** (PAMCA), **Ary Fraji**, **Mark Breidenbaugh** (Northwest Mosquito and Vector Control District, USA), **Charles Mwalimu** (Vector Control, Tanzania) and **Otubea Owusu Akrofi** (National Malaria Control Programme, Ghana) ensued. The discussion highlighted the need for African countries to see vector control as a community-led approach and so have communities find ways to fund these interventions, not relying on external funding which tends to dictate what you can do or not do. In addition, WHO guidance restricts vector control interventions such as larviciding which has been shown to work, and was used in the model of the mosquito abatement districts. A change in WHO guidance will also allow countries to obtain funding from institutions like Global Fund and PMI for interventions such as larviciding.

*This report is brought to you by the MESA Correspondents Nzungize Lambert, Eggrey Aisha Kambewa, Oyinkansola Fadiji and Jean Claude Ngirimana, with the support of the past correspondents Leslie Diane Nkahe, Mauro Pazmino Betancourth, Doumbe Belisse Patricia and Nathalie Amvongo-Adjia, and other volunteers Otubea Owusu Akrofi and Caroline Kiuru. Senior editorial support has been facilitated by Jessy Goupeyou-Youmsi and Idelphonse Bonaventure Ahogni.*

# Day 2: 27th September 2022

**Plenary talks 1 to 4:**

**Corine Karema** (Roll Back Malaria - RBM) began her presentation by pointing out the importance of data in decision-making and collaboration among different entities. For example, she mentioned that RBM has collaborations with governments, NGOs and donors. According to WHO, Africa has the majority of malaria cases. The challenges are low malaria intervention coverage during the pandemic, insecticide resistance, funding gap, Ebola, and flooding among others. She then pondered what was required to get back on track. Around 10 billion USD per year, new tools, and sharing experience. In terms of data decision-making, she asks herself, "Why does malaria response require the use of data?". To answer this, she gave two clear examples where data is used, in health management information systems (HMIS) and district health information software (DHS2). In the end, Krema emphasized the role of PAMCA in demonstrating the type of insecticide required, the use of data for decision-making, data sharing, and empowering women in vector control.

**Heather Ferguson** (Glasgow University, UK) presented the effects of climate change on malaria vector control. Africa is the most vulnerable continent as it is warming faster than the rest of the world. Climate change might cause the re-emergence of malaria, increased transmission at higher altitudes, changes in vector ecology and human behavior. This will test the efficacy of current interventions and the question will be on how to adapt interventions to changes. Outbreaks of various diseases might limit the funding for malaria research. There is a need to identify the environmental determinants of intervention efficacy and feasibility and investment in climate robust strategies.

**Mark Latham** (PAMCA and IVCC) initiated his presentation on larval source management (LMS) in operational mosquito control programs: lessons from the past and tools for the future. He began by demonstrating how vector control programs in the USA are mostly at the local level, but never one size fits all. Vector control programs' decentralization increased their complexity and capability. Furthermore, vector control in the United States focuses heavily on nuisance species. As a result of targeting multiple mosquito species, the success is based on entomological evidence. He also stated that the vector control program in the United States focuses on larval and adult surveillance, larvicide, and biological control. The advantage of larva surveillance helps to identify species, habitats, bionomics, seasonality, and flight range. Thus, it is preferable, to begin with, boots on the ground to assess larva presence density, then use a GIS database to identify existing larva sites, record them, and save them for future intervention. Many tools are available, including Google Earth, imagery, and LIDAR. He explained that in the selection of larvicide products, previous evidence can help to make a choice of the right larvicide, searching in published articles, knowledge exchange, keep communicating with neighbors, wing beats (magazine), after all, you can select your larvicide product, and the cost is also an important factor. The application also necessitates careful consideration because not all sizes fit all, whether done by hand, by vehicle, with a coarse droplet of larvicide, a tank sprayer, or by aerial such as drones or helicopters. As a result, the quality of the application is critical; otherwise, you're wasting money and time. Therefore, post-application monitoring and evaluation provide evidence to support the next application strategy. He concluded that accurate surveillance requires a lot of attention.

**Marion Law** (WHO, Switzerland) introduced us to the steps, committees and working groups involved in the evaluation of vector control products. Emphasis was on safety, quality and efficacy to which she added timely access as part of lessons learnt. Further down in her presentation, she expressed how they needed to build infrastructures in order to properly manage data and how they came up with a consistent evaluation approach. According to her, “the primary output of the evaluation process is

good, robust decision making". To conclude, emphasis was made on equality as regards the importance of all aspects which is provided in the assessment report.


**Parallel Scientific Session 5: Larval source management and integrated vector management**

**Antonio-Nkondjio Christophe** (Organization for coordination for the fight against endemic diseases in Central Africa - OCEAC, Cameroon) highlighted that WHO promotes the use of interventions alone or in combination in order to efficiently manage insecticide resistance and control vector-borne diseases (VBDs). The study was conducted for 2 years in the city of Yaoundé, Cameroon, on behalf of its characteristics suitable for practicing larviciding. The baseline data helped to separate the 13 intervention areas from the 13 non-intervention areas. Larval and adult collections were performed before and during the larviciding to assess the mosquito distribution. The biolarvicide VectoMax G has been applied according to the manufacturer's instructions every 14 days. This study showed a monthly variation in breeding sites and adult mosquitos' distribution across the city following the implementation of larviciding. The malaria prevalence in intervention sites was reduced.

**Nkahe Diane** (University of Yaoundé I, Cameroon) started by mentioning that the impact of larviciding on insecticide resistance prevalence remains unknown. The insecticide resistance level of *An. coluzzii* to deltamethrin and the fitness parameters were assessed before and after larviciding using bioassays, qPCR and Multiplex detox assays, in order to check some insecticide resistance reversal patterns both in the field and in laboratory strains. Despite the significant increase in the susceptibility to deltamethrin in laboratory strains, the resistance level remained high in the field mosquitoes. The frequency of the kdr gene (L1014F) and the expression level of GsTe2 and Cyp6P3 remained high

irrespective of the generation, and selection regime. The life traits were very different from one strain to another.


**Jubilate Mina** (National Malaria Control Program - Tanzania) stated that the Tanzanian government prioritized the control of mosquitoes' aquatic stages since it reduces larval density and adult mosquitoes, hence, contributing to the reduction of malaria transmission. The biolarvicide BACTIVEC and GRISELESF locally manufactured have been applied since February 2022 based on the rainfall pattern and malaria risk strata. Six larval source management (LSM) SOPs have been developed, and six types of training on biolarvicing have been organized at the Ward village at the community level. A baseline larval habitat has been established and the quantity of larvicide/surface was defined. The project by the Swiss Development Cooperation in Tanzania will last 4 years and is still ongoing.

**Doumbe Belisse** (University of Yaoundé I, Cameroon) talked about the impact of a biolarvicide (VectoMax G) on malaria prevalence in the city of Yaoundé. Parasitological survey was conducted to get parasitological indicators, mostly malaria prevalence in 26 areas. Before that, cluster randomization was performed to select intervention and non-intervention areas. Then malaria prevalence was recorded in both types of areas and compared according to population characteristics. The study highlighted a high prevalence in non-intervention areas compared to intervention areas whatever the age range, sex, the frequency of long-lasting insecticide-treated nets (LLINs) usage and the diagnostic tools (RDTs, microscopy or PCR).

**Carmène Ngadjeu** (University of Yaoundé I, Cameroon) talked about the influence of house characteristics on mosquito distribution and malaria transmission during a larviciding trial in the city of Yaoundé, Cameroon. She demonstrated that non-protective features of houses like the absence of screens on windows, and the presence of holes in the wall and opened eaves, increased the risk of exposure to mosquito bites contrary to close eaves and ceilings at an instance. The study also highlighted a high risk of malaria infection in traditional houses compared to modern homes.

**Steven Gowelo** (University of Malawi, Malawi) highlighted the masked contribution of LSM in malaria control in the context of high insecticide-treated bed nets (ITNs) use. LSM's intervention used in the study as draining, filing and spraying Bti coupled with house improvement, affects the outdoor

densities of *Anopheles arabiensis*, a major malaria vector in Malawi. He also stated that there was a high coverage of mosquito nets in the area but there were challenges around the LSM implementation and house improvement.

**Parallel Scientific Session 6 - LLINS, IRS and Insecticide Resistance Management**

**Maria Pondja** (National Malaria Control Programme - NMCP, Mozambique) presented the results of a study monitoring insecticide resistance in the main malaria vectors across Mozambique. The study reported resistance to deltamethrin, alphacypermethrin, permethrin, lambda-cyhalothrin, DDT and bendiocarb. Furthermore, that pre-exposure to piperonyl butoxide (PBO) restored susceptibility to deltamethrin confirming the involvement of metabolic resistance. She concluded the talk by highlighting that the widespread insecticide resistance observed in malaria vectors in Mozambique poses a huge threat to malaria control and elimination efforts.

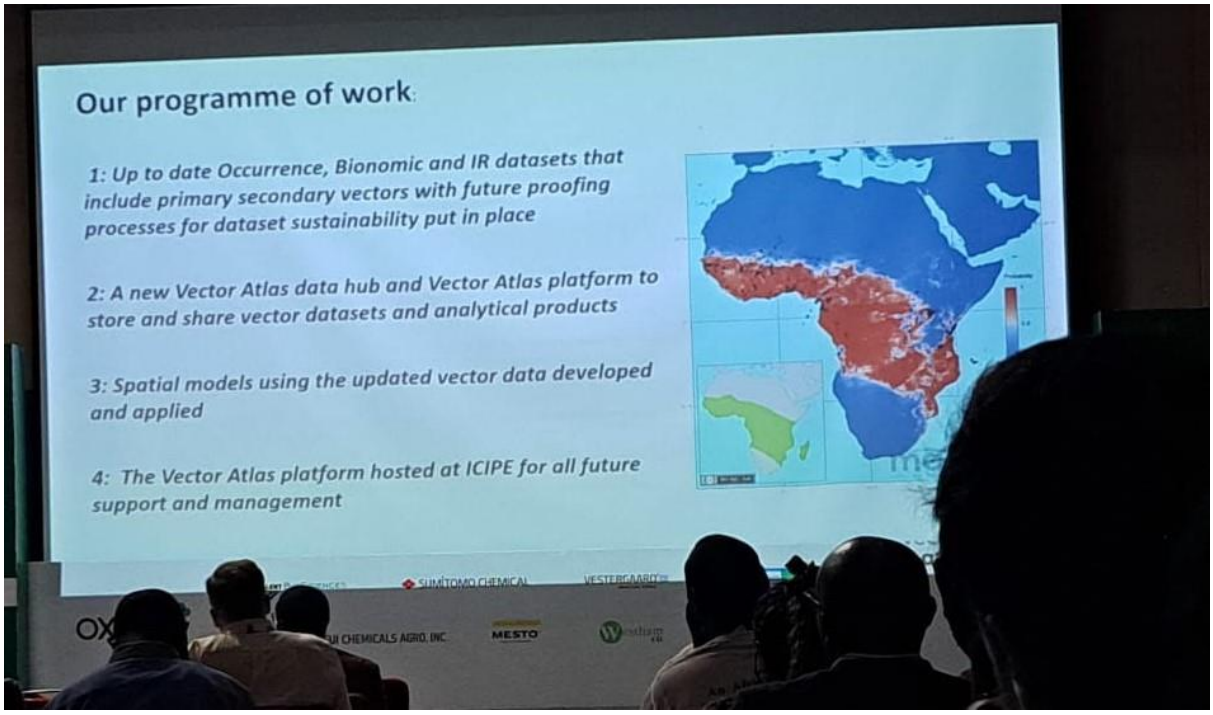
**Parallel Scientific Session 7: New and re-emerging arthropod-borne viruses, climate change, NTDs and One Health**

**Remy Hoek Spaans** (Liverpool School of Tropical Medicine - LSTM, UK) et. al researched the differences among various models and the impact on malaria using climate simulation data. To achieve this, collaboration was forged between South Africa and the UK institutions leaning on the knowledge of climate scientists, and malaria knowledge from her team. Results showed that conversion permitting climate data simulation (CP4) has better agreement with observed data. However, some things are still considered a work in progress owing largely to the parameters used which were skewed. To conclude, she emphasised the need to continue entomological research on the climate suitability of different mosquito species.

**Parallel Scientific Session 8: Vector biology, ecology, taxonomy and population genetics**

**Diego Ayala** (Institute of Research for Development - IRD, France) started his presentation by asking how we can predict the urban adaptation of *Anopheles gambiae* and *An. coluzzii*, vectors in Central Africa. Malaria cases have been higher in rural areas since 2000, however, after 20 years, there were malaria cases also recorded in urban regions. In this study, he characterized 380 breeding sites and genotyped 2427 mosquitoes in Douala, Bangui, Libreville and Brazzavill. The study revealed high variability in physical-chemical parameters across breeding sites, but they are similar across the cities. *Anopheles coluzzii* is predominant in coastal cities and it is adapted to high ammonium concentration. However, *An. gambiae*, which is predominant in savanna, is tolerant to high salt concentrations. Both species showed high levels of adaptation to urban settings. Due to the high levels of urbanization that Africa will experience by 2035, malaria-related deaths will increase if there are no control measures taken in cities.

**Marianne Sinka** (University of Oxford, UK) presented to us the international project called "*Vector Atlas*". She explained how occurrence data for malaria vectors was hard to find. Data is scattered in the scientific literature, and it is not always available. The aim of Vector Atlas is to have all this information about principal and secondary malaria vectors in one place. Moreover, *Vector Atlas* includes information such as bionomics, house type and fauna/ flora which is useful to understand the ecology of *Anopheles* mosquitoes. The website interface allows us to select what type of map we want, download it, and submit data as well. Current work is focused on updating maps and transforming the data into useful formats. The project will help researchers and policymakers by making data easy to access.




**Roundtable Discussion 1 & 2:**

**Harnessing the capacity of the African institution for strengthened response against vector-borne diseases (VBDs)**

This session was chaired by Prosper Chaki (PAMCA) and Emma Orefuwa (PAMCA).

**Diabate Abdoulaye** (Research Institute of Health Sciences - IRSS, Burkina Faso) opined on the standard of living and infrastructure as part of the factors for brain drain experienced across Africa. Speaking on inclusive leadership, he strongly believes it begins with hiring candidates with the most passion for science. He also narrated how he prefers to take a passenger role in leading in order that individual excellence may shine.

**Jewelna Akorli** (Noguchi Memorial Institute for Medical Research - NMIMR, University of Ghana) returned to her home after her studies abroad to make an impact. For takeaways directed at women researchers, she surmised on mentoring and collaboration

**Sam Kariuki** (KEMRI, Kenya) responded to the question of funding and relevance by asking, "Who sets our research agenda?" He warned against the use of technologies that do not optimize local solutions and described how his institution has benefited from an approved collaboration and publishing policy when asked about collaborations.

**Noella Bigirimana** (Rwanda Biomedical Center - RBC, Rwanda) explained the importance of setting an in-house pace, impact-wise, prior to collaborations as a means of filtering parasitic collaborations. For takeaways, she put the responsibility of levelling the playing field on male researchers.

**Gerry Killeen** (University of Cork, Ireland) speaking on inclusive leadership added that motivation and value cannot be taught at the individual level and gave insights as to how no one has all the answers

and how patriarchy stifles growth in research. He ended by warning about the pseudo capacity building where half-baked graduates are presented to the world.

**Corine Karema** (Roll back Malaria) talked about finding your support system and intentionality across the board in answering questions about motivation and navigating the murky waters.

**The development journeys of global women leaders in vectors control and men allies**

This session was chaired by Damaris Matoke, Jessy Goupeyou-Youmsi, Rosalia Joseph and Christina Sudi.

The panellists included **Sheila Tlou** (African Leaders Malaria Alliance - ALMA, Botswana), **Corine Karema** (Roll Back Malaria - RBM, Rwanda), **Corine Ngufor** (London School of Hygiene and Tropical Medicine - LSHTM, UK), **Heather Ferguson** (University of Glasgow, UK), **Evelyn Olanga** (PMI Kinga Malaria, Kenya) and **Francesco Baldini** (University of Glasgow, UK). The discussion covered two topics: people who played significant roles in women's career and personal development and defining the term male ally and the role they play in helping women in spaces occupied majorly by men.


*Q) What are the differences in leadership in different contexts?*

Leadership can be inborn, being able to naturally take charge of any situation due to one's ability to work and collaborate with other people. Leadership can also be a process a person can learn over time. This can be done by gaining knowledge and being a mentor to colleagues. Knowledge is power and how you use that power sets you apart. To be a leader, you need to be able to define yourself and have confidence in decision-making.

*Q) How have women been able to reconcile to always prove themselves in places occupied by men?*

It is difficult to be a leader in an area mainly occupied by men as they tend to second guess women's decisions, look at their male counterparts for decision making and be challenged by superiors. It is important for women to network and empowers other women in similar situations.

*Q) What helped women succeed in a male-dominated field?*

First of all, misconceptions that certain fields of work are disliked by women need to be removed. For one to succeed in anything, passion is needed. Communication skills are important in enhancing careers. It is important for people to treat themselves as a brand so that they can be able to sell their skills.

*Q) Who played important roles in your career development?*

Families have played a huge role in encouraging women to achieve their goals, in not putting ceilings on their career goals. Female and male supervisors have provided mentorship and given opportunities to their mentees to achieve their goals. Opportunities given to women in the global North and South differ, women from the global North are given more opportunities, resources and support than women from the global South. There are still systematic biases that need to be tackled so all women are given the same opportunities.

*Q) Why is it important to engage young people in decision-making?*

Young people are the consumables of all decisions to be made therefore, they deserve a seat at the table. Youth have a lot of growth and act as role models in their communities and evidence shows that the more people at the decision-making table, the better and more inclusive the decisions are.

*Q) What does it mean to be a male ally?*

Being a male ally is to first acknowledge male privilege and the challenge women face in spaces majorly occupied by men. Acknowledging and having empathy for the plight of women is not enough, action, such as capacity building, mentorship, giving opportunities and creating positions for deserving women are needed.

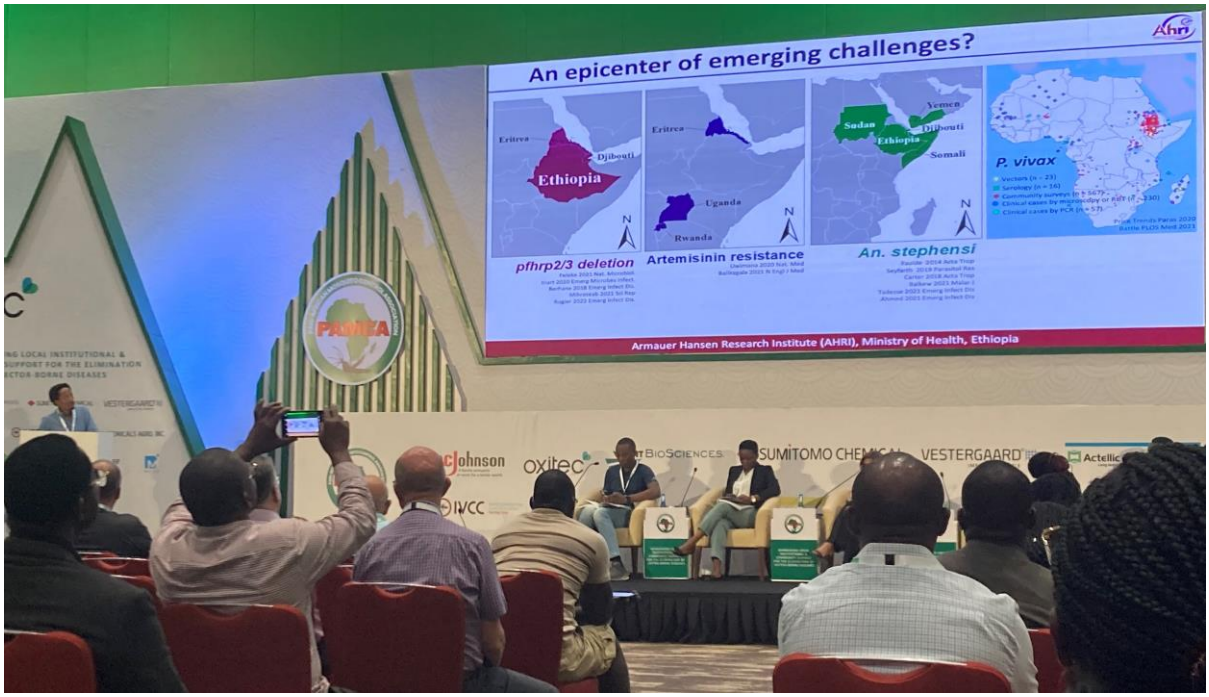
*This report is brought to you by the MESA Correspondents Nzungize Lambert, Eggrey Aisha Kambewa, Oyinkansola Fadiji and Jean Claude Ngirimana, with the support of the past correspondents Leslie Diane Nkahe, Mauro Pazmino Betancourth, Doumbe Belisse Patricia and Nathalie Amvongo-Adjia, and other volunteers Otubea Owusu Akrofi and Caroline Kiuru. Senior editorial support has been facilitated by Jessy Goupeyou-Youmsi and Idelphonse Bonaventure Ahogni.*

# Day 3: 28th September 2022

**Plenary talks 5 to 7:**

**Jaishree Raman** (Laboratory for Antimalarial Resistance Monitoring and Malaria Operational Research - ARMMOR, South Africa) pointed out that existing interventions are not sufficient, therefore investing in genomic surveillance could help get closer to malaria elimination. As it allows early detection of resistance (diagnostic, antimalarial, insecticide) and resistance gene flow. This technique has been proven in other infectious diseases with the determination of transmission networks, foci and parasite flow. However, the fear of victimization over novel findings and data ownership are some concerns limiting the prompt sharing of outcomes. Therefore, National Malaria Control Programmes (NMCPs) and policy-makers should get more involved to achieve sustainable genomic surveillance.

**Fitsum Girma** (Armauer Hansen Research Institute - AHRI, Ethiopia) introduced the threats related to the invasion of *An. stephensi* in Ethiopia. He presented the distribution of this species in the horn of Africa. Many facts about *An. stephensi* were highlighted, namely its ability to transmit *P. falciparum* and *P. vivax*, preference for man-made water storage containers, and behavioral plasticity. He showed the role of *An. stephensi* in the transmission of malaria. Bioecology studies of this vector in the city of Dire Dawa, Ethiopia, reveal its predominance across the study site with most of them resting in animal shelters although they could rest both indoors and outdoors. In general, malaria incidence in this city is alarmingly increasing and linked to *An. stephensi*.

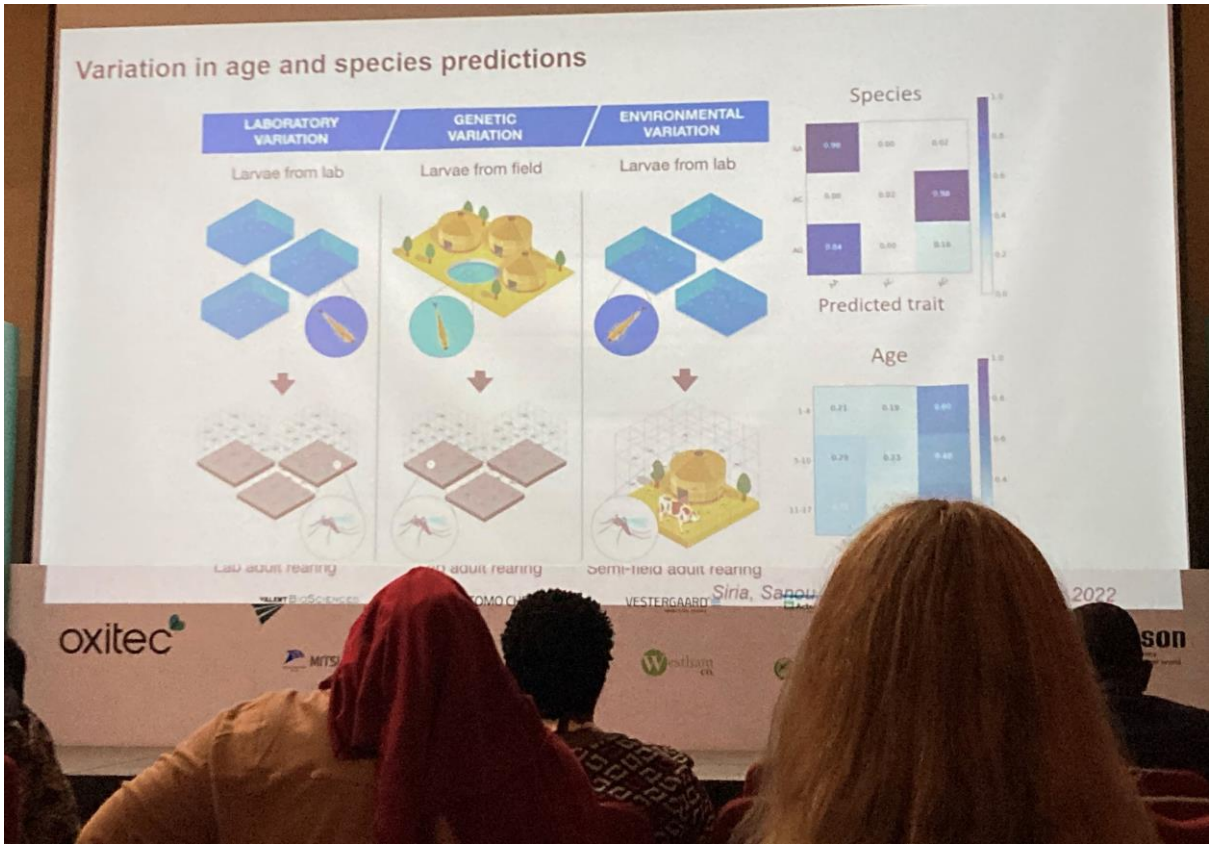



**Abdoulaye Diabate** (Research Institute of Health Sciences - IRSS, Burkina Faso) at the onset of his talk presented the rich research pipeline of vector control. Despite the recent success of vector control efforts and the great support provided by funders such as the Innovative Vector Control Consortium (IVCC), malaria is still a great concern. Several teams have come together through the Scientists Against Malaria (SAM) Consortium to address the knowledge gap concerning ecological and physiological parameters related to mating behavior, hence helping to control population growth. Diabate and collaborators developed a growth regulator to control mosquitoes. It is an ongoing study

which needs more effort to be deployed and currently, genetic engineering is used to improve its efficacy.

**Parallel Scientific Session 9: Vector surveillance, epidemiology, disease control programs and global health**

**Roger Damon** and **Doreen Siria** (Ifakara Health Institute - IHI, Tanzania) believe understanding the age structure of mosquitoes, especially *"Anopheles gambiae"*, is important because it can be used to assess the risk of infection vis-a-vis and the impact of interventions. Current tools to measure age structure are limited, the reason why Roger, Doreen and collaborators. carried out this study. The use of mini infrared spectroscopy (MIRS) was proposed based on factors like; robustness and greater accuracy. To enhance the quality of the results, there was a need to combine MIS with a convolutional neural network (CNN). They ended the talk by pointing out the need to develop more effective spectrometers and accelerate the uptake by end-users.




Malaria in Mozambique is endemic throughout the year although it peaks during the rainy season. Therefore, **Dulcisária Marrenjo** (National Malaria Control Program, Mozambique) and colleagues decided to study the vector feeding behaviour using human baits in order to identify interventions that can be adopted "where or for what?". Results showed *An. funestus* and *An. gambiae* to be the predominant species, biting occurred both indoors and outdoors with *An. funestus* feeding more indoors and *An. gambiae* more outdoors. The outdoors biting behaviour could jeopardise the impact of insecticide residual spraying (IRS) and insecticide-treated nets (ITNs) since the majority of the current interventions are designed to attack mosquitoes in an indoor setting.

**Mercy Opiyo** (The University of California, USA) highlighted the lack of operational guidance to perform certain interventions in Mozambique, reason why she involved herself with the Entomology

Adaptive Sampling Framework (EASF) project which has two sides, Mozambique and Ghana. The EASF plan to provide information on the cost of interventions, the user experience and future surveillance frameworks. Opiyo pointed out the need to take vector control decisions based on entomological data. In Mozambique, the project is more advanced and data has been already collected from four villages already after a process of downsampling. Opinions from the community were gathered through questionnaires. In Ghana, data collection hasn't started yet. The pilot EASF in Mozambique helped National Malaria Control Programmes (NMCPs) to improve the monitoring and evaluation of issues related to surveillance and also improve the model for Ghana.

**Adeogun Adedayo** (Nigeria Institute for Medical Research - NIMR, Nigeria) presented the progress of malaria vector surveillance in relation to the fight against insecticide resistance in Nigeria, a country that in 2012 encountered approximately 26% of the total malaria cases. These numbers made the President Malaria Initiative (PMI) to invest heavily in the country by 2012. A few years later, the Global Fund invested too making the vector control program in the country to be extended to 29 out of 36 states in total. Surveillance and entomological data were available for the 29 states. Modelling studies are evaluating how to cover the rest of the states. The current challenge is that despite the huge amount of information collected on epidemiological aspects of the vector in the country, there is still a lack of data on the route of transmission.

**Parallel Scientific Session 10: Vector biology, ecology, taxonomy and population genetics**

**Victor Balyesima** (Uganda Virus Research Institute - UVRI and Target Malaria, Uganda) highlighted the fact that Arthropod Containment Level 2 (ACL2) facilities are needed for the support of genetically modified mosquito containment studies. To test ACL2's facilities team's ability to handle transgenic mosquitoes, wild types pigmented and non-pigmented *An. gambiae* population were selected and maintained in a heterozygous state by backcrossing generations. The team also measured some life traits. The study showed no significant difference in hatching rates, average larval development time and sex ratio, between the pigmented and non-pigmented at each backcross. Successful maintenance of the two phenotypes under ACL2 standards was obtained with no significant differences in the developmental parameters.

**Gift Mwanga** (Macha Research Trust, Zambia) began his presentation by recalling the primary tools used in vector control. His research aims to assess species diversity in Zambia through an entomological cross-sectional survey. As a result, 13 mosquito species were identified. Morphological studies showed that *An. gambiae* sensus lato (s.l) was abundant. Molecular studies showed that *An. gambiae* sensus stricto (s.s) was abundant, and for parasite infection, *Plasmodium falciparum* was highly presented in *An. gambiae* s.l. Gift concluded that more efforts in vector control are required.

**Rosine Z. Wolie** (University of Félix Houphouët-Boigny - UFHB, Ivory Coast) presented eave tubes as an innovative delivery system with a high dose of insecticide capable of killing insecticide-resistant mosquitoes. The evaluation of the efficacy of eaves at the community level involved 40 villages (20 control and 20 intervention) in Ivory Coast, from May 2017 to April 2019. Mosquitoes were collected, identified, screened for *Plasmodium spp.* infection and compared between control and treated sites. *Anopheles gambiae* s.I. had the highest infective bites compared to *An. funestus* in the control group. Parity and entomological inoculation rates by the intervention were higher in the control as well. The use of eave tubes decreased vector density and malaria transmission indicators.

**Parallel Scientific Session 11: Precision public health and innovations for VBD elimination: AI, entomological databases, modelling and genomic surveillance**

**Tristan Ford** (Vectech, USA) started his talk by showing a device capable of taking mosquito pictures and morphologically identifying species with an accuracy of over 90%. The device aimed at reducing the time for morphological identification, as well as helping with the digitalization of the information using deep learning models. The device has been tested with species from the USA such as *Aedes aegypti* and *An*. *albopictus* or *Culex pipiens,* but also with *An. gambiae* and *An. funestus*. Its current database consists of 39 mosquito species and it requires around 100 photographs of a new species to be able to morphologically identify the species with high accuracy. Current work is focused on making the device compact and sturdy for fieldwork.

**Lakamy Sylla** (Malaria Research and Training Center, University of Sciences, Techniques and Technologies of Bamako - USTTB, Mali) showed the work of the Target Malaria project on capacity building in the development of genetically modified mosquitoes in Mali. Target Malaria is a non-profit organization that focuses on the development of cost-effective technologies, in this case, transgenic mosquitoes and capacity building to reduce mosquito populations. The process started with the creation of male sterile mosquitoes. Then, as the technologic evolved, it continued with the transfer of the transgene into local mosquitoes and the evaluation of the strains in terms of longevity, mating competitiveness and sexual sterility. This also included the construction of a contained laboratory for testing. Lakamy concluded his talk by showing the importance of building local facilities for the development of this technology and the need of training local scientists and technicians.

**Parallel Scientific Session 12: LLINs, IRS and Insecticide Resistance management**

**Jackline Martin** (Kilimanjaro Christian Medical University College - KCMUCo, Tanzania) presented the bio-efficacy of three different classes of bed nets; Olyset plus, Interceptor G2 and Royal Guard. High sterility of *An. gambiae* was observed after exposure to Royal Guard, however, sterility decreased over time. Olyset plus nets and Interceptor G2 nets failed to meet WHO criteria of 80% mortality after 24 hours at 12 and 24 months. However, interceptor G2 performed better than standard interceptor nets. Olyset plus nets were discarded faster than the other nets with it having the poorest textile durability.

**Eliud Lukole** (National Institute for Medical Research - NIMR, Tanzania) compared the survival, physical durability and efficacy of permethrin Long-lasting insecticidal nets (LLINs), Olyset®, and permethrin plus piperonyl butoxide (PBO) LLIN, Olyset®Plus, in Northwest Tanzania. The study reported that for both LLINs, almost 50% of the nets were lost by 24 months' post distribution and over 70% after 36 months post distribution. The study observed that fewer nets were lost in arms that received indoor residual spraying. Further, the study reported that aged pyrethroid-PBO LLINs offered better protection compared to pyrethroid-only LLINs (standard LLINs) in their second year of use. Lukole concluded by recommending adjustment of the 3-year LLINs replacement strategies to a shorter time or the manufacturing of LLINs with up to 3 years of durability.

**Leon Mugenzi** (Centre for Research in Infectious Diseases - CRID, Cameroon) pointed out that to manage insecticide resistance, it is important to understand the resistance mechanisms, the origin of the resistance and how spreads within the mosquito populations. The study investigated the contribution of a 4.3kb structural variant (SV) inserted in the promoter region of CYP6P9b to resistance phenotypes. The study found the SV to be occurring in near fixation frequencies in Cameroon and Uganda. The frequency increased over the years and was associated with the deltamethrin resistance phenotype. Further, the SV was found to be associated with increased expression of CYP6P9a/b. The study findings highlighted the role of SVs in the evolution of insecticide resistance and proposed the use of SVs as an additional tool for molecular surveillance of insecticide resistance.

**Josue Zanga** (University of Kinshasa, Democratic Republic of the Congo) presented on finding pragmatic ways in conducting a comparative performance study of nets. The effectiveness of pyrethroid-treated bed nets has been limited due to pyrethroid resistance. Synergist PBO is able to reverse resistance and thereby improve the effectiveness of the pyrethroid. A cluster randomized control trial linked to the 2020 distribution of standard bed nets and PBO co-treated nets in DRC was performed. Comparative performance of the two nets was conducted by comparing malaria prevalence in pregnant women. Over 18 months, malaria prevalence was reduced in the PBO co-treated study arm compared to pyrethroid-only nets. This study has highlighted an inexpensive way of conducting a comparative performance study of bed nets.

**Emmanuel Menze** (Liverpool School of Tropical Medicine - LSTM, UK) presented on the need to assess the impact of metabolic resistance on the effectiveness of pyrethroid-only bed nets compared to a PBO-based pyrethroid net experiments were conducted to assess the exophilic, mortality and blood feeding of insecticide-resistant mosquitoes when exposed to the two types of nets. The presence of resistance alleles in mosquitoes increased their ability to blood feed and survive. Resistant mosquitoes survived and blood fed more when exposed to pyrethroid-only Olyset nets compared to PBO-based Olyset nets. This study showed the importance of using PBO-based Olyset plus nets in areas of pyrethroid resistance.

**Parallel symposium 5: Strengthening the nexus between parasite and vector genomics to accelerate malaria elimination in Africa**

**Paballo Chauke** (Sanger, UK) began his presentation by discussing the success of the genomic data analysis training course, where trainees learned how to identify insecticide resistance. He also mentioned the first cohort of the training program in partnership with PAMCA and MalariaGenin 2022, delivered virtually, with about 50 participants from all over Africa. In addition, Chauke stated that two candidates were chosen for the PAMCA bioinformatics fellowship program in 2022.

**Alistair Miles** (Wellcome Sanger Institute, UK) started his presentation by asking what role PAMCA and MalariaGen should play in the future. As a short answer, the only way both should work is together as a community to accelerate malaria genomics surveillance in Africa.

**Lucas Amenga** (University of Ghana, Ghana) initiated his talk by reminding us that malaria transmission remains heterogeneous but relatively high in Ghana. His study had two main objectives: assessment of the abundance of malaria vectors and assessment of the level of insecticide resistance in Ghana. For sample collection, CDC light traps and human landing catches were used. As a result, *An. gambiae* was abundant and copy number variation (CNV) revealed that the CYP9K1 gene conferred insecticide resistance in Ghana. The kdr west was discovered to be fixed throughout the country. The CYP6aap/1 cluster in *An. culuzzi* confers resistance in the north of Ghana. As a result of comparing sample sizes, no structure was identified in the north, whereas structure between samples was identified in the south.

**Deus Ishengoma** (National Institute for Medical Research, Tanzania) reported the outcomes from a malaria molecular surveillance (MMS) project in Tanzania. He explained the objectives of the project, such as identifying the parasite population, drug resistance, training the students, and developing testing models using data. The samples were collected from the community in partnership with health centers across the country, and all samples were RDT-positive. Therefore, qPCR was used on random samples to confirm *Plasmodium spp.*. Results identified artemisinin resistance in one district only, which is closer to Rwanda. Thus, suggesting that the migration of artemisinin resistance may have originated in Rwanda. The hrp2/3 gene deletion has been tested and found to be spread across

Tanzania. Deus concluded that in the future, the deep sampling should be based on the school and initiate genomics sites in the East Africa region.

**Parallel symposium 6: Presenting the ATSB® (Attractive Targeted Sugar Bait); a novel outdoor intervention**

**Woody Foster** (The Ohio State University, USA) started the presentation by highlighting that while males need only sugar to survive, females need both sugar and blood meal to produce eggs. Mosquitoes are attracted by some volatile chemical detected by their antenna. A Baited Trap test in screen houses was performed to know which chemicals make the odour attractive to them and the factors that help females to choose between a blood meal or sugar taken. The choices were influenced by phenylacetalldehyde, 1-hexanol and linalool, depending on internal and external stimuli. Female and male were human and sugar feeder dependent respectively. Since female insemination depends on male feeding and survival, feeding knowledge could help population surveillance.

**Michal Elias Gez** (Westham CO., Israel) mentioned that attractive target sugar baits (ATSBs) are a newly developed product, based on the "Attract and Kill" approach, to control outdoor malaria transmission in peri-domestic areas. A successful large-scale field trial took place in Mali (2016-2017), showing a significant impact on mosquito density and survival. Bait formulation and bait station are the two components of ATSB. It targets outdoor vectors and is oral delivering, which allows it to bypass resistance mechanisms. The product is safe for humans and the environment. In addition to Mali, epidemiological trials are in progress in Zambia and Kenya are on track.

**Nick Yalla** (KEMRI, Kenya) evaluated the attractiveness of *An. gambiae* and *An. arabiensis* to the ATSBs compared to natural sugar sources. He conducted semi-field experiments using the glue-netted trapping method. Several plants were used such as *Mangifera indica* and *Crotalaria pallida*. Yalla's results highlighted that ATSBs are highly attractive compared to the most attractive plants suggesting that *Anopheles* mosquitoes are attracted to feed on ATSBs despite the availability of natural sugar sources. ATSBs in bait stations placed outdoors are ideal for the control of outdoor biting mosquitoes and may inadvertently attract and kill indoor-bound mosquitoes.

**Mohamad Traore** (Bamako University, Mali) focuses his speech on the paradigm of attractive toxic sugar bait from concept to clinical trials. It is a bi-dimensional bait station which can be simply hung on walls and can be protected from the adverse environment. Randomized entomological trials were conducted in 14 southern villages of Mali. Results showed that the daily feeding rate exceeds the 2.5% threshold which corresponds to a 30% reduction in malaria incidence.

**Eric Ochomo** (KEMRI, Kenya) shared the results of an epidemiological evaluation of ATSBs in Kenya, Mali and Zambia. Prior to the results, he presented ATSBs as a tool to address outdoor transmission. Ochomo went through different steps required to set ATSBs as a WHO-qualified product. He compared the efficacy of ATSBs combined with LLINs to LLINs alone in reducing the case burden of clinical malaria. This efficacy could be assessed through epidemiology, entomology, social science and cost-effectiveness studies. ATSBs epidemiology and entomological trials were launched in three countries: Zambia, Kenya and Mali. The study is still ongoing and aims to assess community insights about ATSBs.

**Javan Chanda** (PATH, Zambia) focused his speech on the acceptance of ATSBs by the population in Zambia. Work was conducted by a team of community engagement. Teams were well-trained in their role of supporting community engagement and door-to-door sensitization to orient households in their communities. Following his talk, communities are presenting concerns about ATSBs used in populations like suspicion and mistrust, side-effects. To address these concerns, community health workers (CHWs) conducted door-to-door follow-up and community meetings for information. Chanda

concluded that community engagement is a critical component of the ATSB intervention. Close monitoring, continuous communication with communities and rapid response to community concerns are needed to ensure high coverage. ATSB refusals and removals occurred throughout the study area directly following installation.

**Parallel Symposium 7: Regulating the use of genetically modified mosquitoes for malaria control in Africa**

**Charles Mbogo** (KEMRI-Wellcome Trust, Kenya) presented novel tools under development for controlling malaria vectors. These are; 1) Attractive toxic sugar baits (ATSBs) which are adulticides and target mosquitoes' need to feed on energy. Field studies are occurring in Mali, Kenya and Zambia. 2) Widespread use of ivermectin in humans and cattle as a control tool against residual transmission. Large-scale ivermectin field trails are occurring in Burkina Faso and Ivory Cost. 3) Gene drive technologies to render vector populations incompetent to transmit diseases or to reduce the prevalence of the vector. Ongoing field studies are occurring in Burkina Faso, Ghana, Mali and Uganda.

**Dorington Ogoyi** (University of Kenya, Kenya) presented on steps Kenya took in regulating research on genetically modified mosquitoes (GMMs). Regulatory boards are there to provide pathways for GMMs and to make sure adverse effects of genetically modified organisms (GMOs) are addressed so human health and the environment are protected when conducting experiments. GMMs are expected to be regulated throughout biosafety and environmental pathways. Biosafety and ethical committees are heavily involved in all stages of research and act as oversight on GMMs research and development.

There is the question of what to regulate also, product or process? **Hennie Groenewald** (Biosafety, South Africa) puts forward a strong case as to why regulating the process can delay the product hence, it is the product that should be regulated. However, regulation is necessary in order to take genetic modification to the field once everything is correct as everything that was done wrong in crop biotechnology can be averted. Biosafety of the environment is important when talking about gene drive because of its impact and this is where responsible governance comes into play. Regulation is important because of the new risk category genetically modified mosquitoes fall within.

**Agha Ukpai Agha** on behalf of Rufus Ebegba (Nigeria Biosafety Management Agency - NBMA, Nigeria) started the presentation by pointing out that the NBMA was established in 2015 to reflect modern biotechnology, and ensure its safety for human health, biodiversity and the environment. This mandate was expanded in 2019 to include the regulation of gene editing, gene drive, biosafety and some others. There is a committee that looks into applications, which must be made before products are accepted in the country. There are also well-trained technical staff who have been supported by the agency in the area of capacity development abroad. Presently, genetically modified mosquito guidelines are being developed.

**Closing Remarks**

To begin the closing remarks, **Dr. Emmanuel Hakizimana** (President, PAMCA - Rwanda) expressed his gratitude to all; attendees, presenters, organisers, partners, donors, sponsors and funders as well as the government and people of Rwanda. He encouraged everyone to continue to work on addressing vector-borne diseases (VBDs) and not lose the network built in the course of the conference. He encouraged everyone working on VBDs to align research agendas based on our local challenges and optimise the use of available tools.


**Dr. Prosper Chaki** (Executive Director, PAMCA) gave a follow-up remark narrating the challenges brought by the COVID-19 pandemic resulting in the adoption of the virtual conference last year. He acknowledged receiving support from the Gates Foundation and Bayer. He is attuned to how despite the language barrier, the impact has been made gathering from remarks from attendees. He solicited for further donations to support most affected communities, women, early career researchers and students. Prosper also mentioned that over 600 participants registered for this year's event and that Ethiopia will be hosting the 9th PAMCA Annual Conference & Exhibition in 2023. He threw open a challenge of 800 participants for next year.

To conclude the closing remarks, **Prof. Charles Mbogo** (President, PAMCA) was called upon who was elated about the turnout at this year's event and specially thanked Dr. Damaris (Programme Manager for Capacity Building & Gender Mainstreaming at PAMCA) for bringing the women together. He further challenged the secretariat to begin a young investigator award.

*This report is brought to you by the MESA Correspondents Nzungize Lambert, Eggrey Aisha Kambewa, Oyinkansola Fadiji and Jean Claude Ngirimana, with the support of the past correspondents Leslie Diane Nkahe, Mauro Pazmino Betancourth, Doumbe Belisse Patricia and Nathalie Amvongo-Adjia, and other volunteers Otubea Owusu Akrofi and Caroline Kiuru. Senior editorial support has been facilitated by Jessy Goupeyou-Youmsi and Idelphonse Bonaventure Ahogni.*

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