CONFERENCE PROGRAMME

# Virtual 7th PAMCA

## Annual Conference and Exhibition

20-22 September 2021

Hosted by PAMCA Ghana Chapter

**Theme:**

Empowering local institutions to set the agenda for the elimination of vector-borne diseases

#PAMCA2021 pamca.org

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# Table of Contents



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# ACKNOWLEDGMENTS


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| | NAME | MEMBERSHIP |
|---|---|---|
| 1 | Dr Samuel Kweku Dadzie | Chair, LOC |
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| 3 | Dr Fred Aboagye-Antwi | Scientific committee |
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| | | |
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| Dr. Billy Tene | CRID | Cameroon |
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| Dr. Givemore Munhenga | WITS/NICD | South Africa |
| Dr. Jewelna Akorli | Noguchi Memorial Institute for Medical Research | Ghana |
| Dr. Joseph Chabi | Abt Associate -PMI VectorLink | Cote d'Ivoire |
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| Prof. Lizette Koekemoer | WITS | South Africa |

# WELCOME ADDRESS

**Prof. Charles Mbogo | PAMCA President**

It is my distinguished honor to welcome you all to the 7th edition of the PAMCA Annual Conference and Exhibition which is being hosted for the first time virtually from September 20-22, 2021, due to the prevailing pandemic situation which precludes our ability to meet face-to-face. This 7th edition of the PAMCA Annual Conference & Exhibition is being hosted by our PAMCA Ghana Chapter in collaboration with PAMCA Secretariat, coming after the postponement of the planned face-to-face convening in Accra, Ghana in 2020 at the height of the COVID-19 pandemic. Whereas this year's conference is going fully virtual, we hope that you will still feel the local Ghanian hospitality and ambience throughout the duration of the conference.

The PAMCA Annual Conference & Exhibition continues to provide a premier platform bringing together diverse actors in the disease vector control sphere to share experiences and lessons on arthropod-borne diseases, and to provide the necessary synergy towards control and elimination of arthropod-borne diseases in Africa. Conferences such as this provide a valuable opportunity for research scientists, industry specialists and decision-makers to share experiences. I am grateful to the many experts who have come to share their knowledge this week. I also welcome the many representatives of governments, industry associations and NGOs who have joined us.

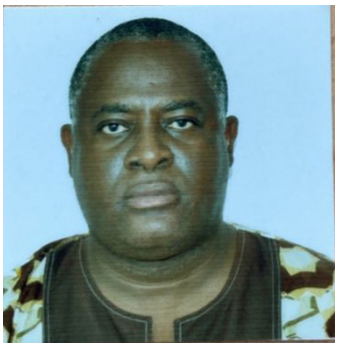
The theme of this year's conference is, "***Empowering local institutions to set the agenda for the elimination of vector-borne diseases.***" This year's conference features a rich and diverse menu of scientific content, plenary discussions on topical issues in vectorborne disease control, hosted symposia, round table discussions with major financing partners in global health, and an award ceremony supported by one of our partners. Besides this, there will be diverse opportunities to network with colleagues, form new acquaintances, and forge long-term partnerships with colleagues, new and old from the virtual interactive platform.

All this would not be possible without the hard work of the organizers co-led by PAMCA Secretariat and the local organizing committee (LOC) of the PAMCA Ghana Chapter, as well as the financial and material support we have received from our sponsors and partners. I therefore heartily thank all the LOC team lead by the President of PAMCA Ghana Chapter, Dr. Samuel Dadzie. I also thank the PAMCA Secretariat for providing leadership and coordination of the entire planning and organizing process. We are also grateful to the international scientific team for the work they have done to ensure that all abstracts accepted for presentation at the conference meet the necessary rigour and scientific merit.

I continue to encourage you to join the growing network of PAMCA members from every part of the globe to contribute in a concerted manner to the efforts to alleviate humans of the scourge of vector-borne diseases.

I am sure you will have a fruitful and rewarding exchanges in the next few days. I wish you every success with this important conference and I look forward to learning about the outcome.

**Dr. Samuel Dadzie | Chair, Local Organizing Committee**



It is with great pleasure that I welcome you to the virtual 7th annual PAMCA conference and Exhibition.

Although, the COVID-19 pandemic did not allow us to meet physically last year in Accra, Ghana, I am of the hope that this virtual meeting will afford us the opportunity to meet, strategize and continue our fight against the menace of vector-borne diseases in Africa and beyond. Mosquitoes and vector-borne diseases continue to pose a grave public health challenge to many communities globally. Controlling the diseases that they transmit requires a well-coordinated, highly trained workforce and integrated approach that meets international standards. The recent COVID-19 pandemic has taught us many lessons that should guide us as a continent in our preparedness to contain future disease outbreaks. Dengue outbreaks and other mosquito-borne diseases has seen a rise in many countries including our neighboring countries. This calls for a more technically sound concerted approach that requires the support of all. The theme of this year's conference ` Empowering local institutions to set the agenda for the elimination of vector-borne diseases in Africa' emphasizes the role of local institutions in the agenda of disease elimination. I hope that at the end of this conference, we can take home some ideas that should guide the way forward in our fight against the common enemy. Together we can build many bridges in science, academia and industry in the days and years ahead for the benefit of our communities. I would like to on behalf of the members of the LOC extend my gratitude to the PAMCA, HQ, sponsors and all members of the LOC for their support in organizing the conference. As we say in Ghanaian language, AKWABAA!!!, meaning welcome to the historic event of the 1st virtual PAMCA conference and I wish you all a successful conference.

**Dr Samuel Kweku Dadzie**
PAMCA-GHANA President and Chair, LOC

# KEYNOTE SPEAKER

Dr. Agyepong Dadzie, PhD

Title of the talk: **Empowering local institutions to set the agenda for the elimination of vector-borne diseases**

**Dr Joseph Siaw Agyepong**

Dr. Joseph Siaw Agyepong, founder and Executive Chairman of the Jospong Group of Companies can best be described as an entrepreneur with a penchant for identifying business opportunities across various industries. He presently owns over 60 companies in Ghana, and in other African and Asian countries with operations in over 14 sectors of the economy, clustered into Environment & Sanitation, Financial Services, ICT, Technical & Logistics and Commercial and Allied Services. In 2006 he revolutionized waste management in Ghana with the introduction of Zoomlion Ghana Limited which currently is the leading waste management company in Ghana and West Africa. For his immense contribution to capacity building in Waste and Environmental Sanitation, the Kwame Nkrumah University of Science and Technology (KNUST) conferred on him a doctorate degree. Dr. Agyepong is a member of the Governing Council of the Ghanaian Hungarian Business Council, a member of The Advisory Board of the Centre for African Studies of Harvard University, President of the Environmental Service Providers Association (ESPA) in Ghana, a Council member of the Association of Ghana Industries (AGI) and a member of other Boards. He is currently the President of the Pest and Vector Control Association of Ghana (PEVAG) and runs the National Mosquito Control Programme (NAMCOP) in Ghana. His sterling leadership and contribution to national and continental development have been duly recognized over the years by governments and other institutions. He has won several awards including Lifetime African Achievement Prize in Sustainable Development in Africa, African Achievers Awards in Business Innovation; Order of the Star of Volta-the highest award of the nation Ghana.

**Abstract**

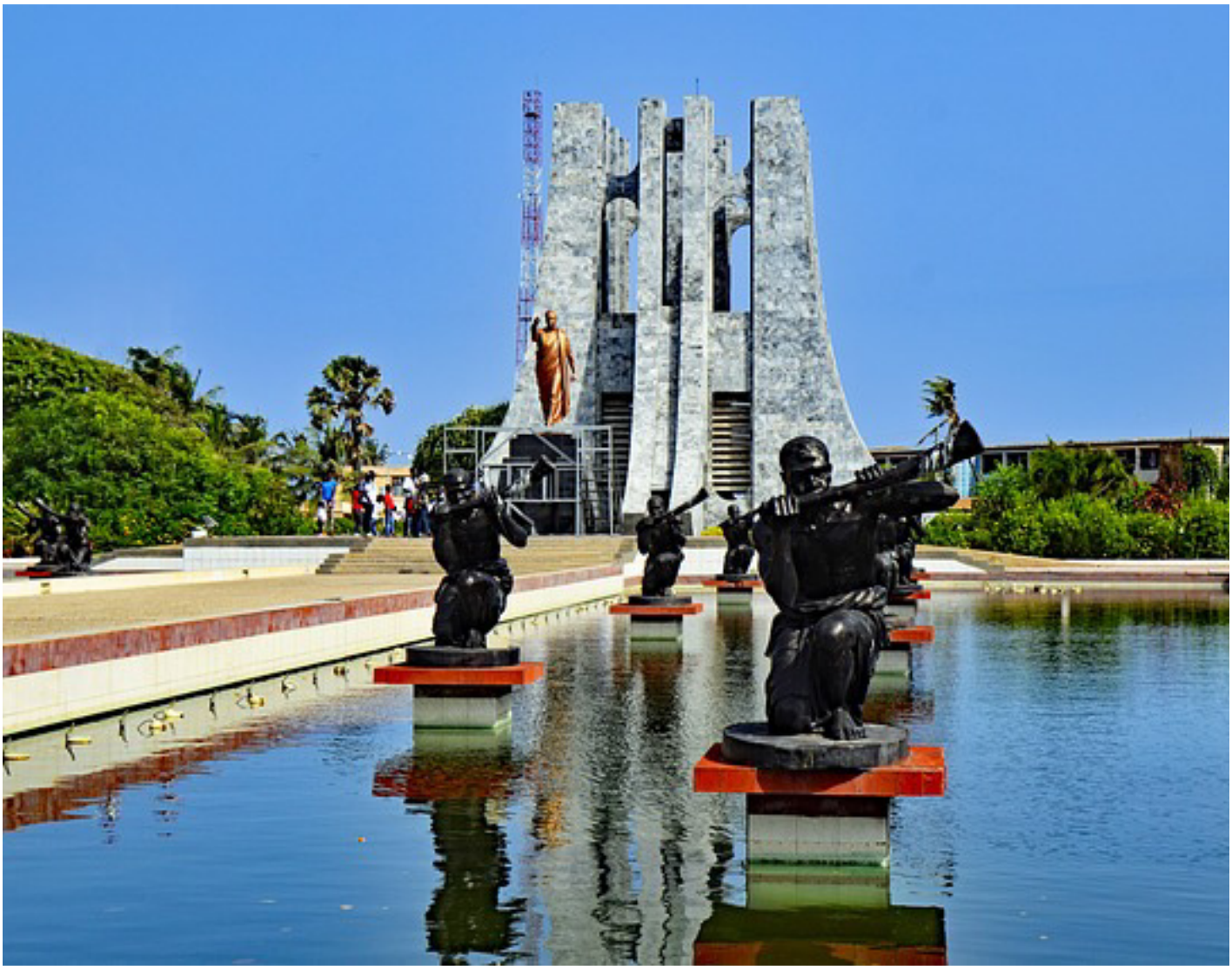
Vector-borne diseases (VBDs) account for around 17% of the estimated global burden of communicable diseases and disproportionately affect poorer populations. Over 80% of the world's population is at risk of one of more of VBDs. Most vector-borne diseases can be prevented by vector control, if it is implemented well. Recent data indicates that there has been a reduction in the prevalence and deaths due to VBDs due to some vector control interventions such as the use of insecticide-treated long-lasting nets and indoor residual spraying of surfaces with insecticides. Recent data indicates that there has been over 20% decrease in the number of deaths from malaria worldwide in the past decade. Many countries are aiming to eliminate VBDs. Empowering local institutions and communities is indispensable for successful vector control programs as demonstrated in the elimination of diseases such as Guinea worm in Ghana and malaria in North America. Although, it is known that strong and dynamic local institutions and national disease control programs that are participatory to the community level are required for success in disease elimination, the empowerment has not always been accompanied by an adequate level of autonomy, capacity development and financial resources. This keynote speech will discuss the role of local institutions in contributing to the continental agenda for control and elimination of vector-borne diseases.

# REMARKS

from Dr Franklin Asiedu-Bekoe, Director of Public Health, Ghana Health Service.

I am most honored to be asked to give some opening remarks at first virtual 7th annual PAMCA conference and Exhibition.

Firstly, Ghana is very honored to host this first virtual conference. Although, we would have liked you to physically join us and share the hospitality of the Ghanaian people, it is gratifying to know that a bit of the culture of the Ghanaian people will be showcased during the conference. Secondly, Ghana has started the process of enhancing vector surveillance and control strategies within the context of some emerging threats of the invasion of An. stephensi into many areas in Africa and the emergence of arboviral diseases in Africa. We have to get ourselves prepared for these emerging threats. In order to be able to do this, we will need to empower our local institutions through training and capacity building, resource mobilization and strategic investment in human resource. That is why the theme of the conference `Empowering local institutions to set the agenda for the elimination of vector-borne diseases in Africa' is very apt and emphasizes the role policy makers should play in achieving the objective of eliminating vector-borne diseases in Africa. Ghana is proud to be part of this important meeting and I hope that at the end of this conference, we can all work together in achieving the aim of controlling and most importantly eliminating the burden of vector-borne diseases in Africa. On behalf of the Director General of the Ghana Health Service, I wish you a successful conference.



# PLENARY SPEAKERS

Presentation title: **Strengthening National Malaria Control Programs capacity for vector surveillance for malaria elimination**

**Dr Keziah L. Malm** MBCHB, MPH, PHD, FGCP, (Program Manager, Ghana Malaria Control Program)

Dr. Keziah L. Malm is the Programme Manager of the National Malaria Control Programme, Ghana Health Service. A public health physician specialized in epidemiology with a distinguished career in malaria. As the Programme Manager, Dr. Malm leads the strategic direction and planning for all malaria control interventions in Ghana. She was the first female Fellow by Examination of the Ghana College of Physicians College, Faculty of Public Health.

Dr. Malm occupies vital roles in academia and research from her engagements in public health. At the School of Public Health, University of Ghana, she served as Academic Coordinator for the Workshop on M&E for Malaria Planning since its inception in 2010 till 2016 and currently facilitates the coursework. She also lectures part-time at the School of Public Health in malaria planning, field epidemiology, outbreak investigation, and surveillance. Her supervision of academic thesis and field internships of several students at the Masters of Public Health (MPH) and Masters of Philosophy (MPhil) level speaks to her immeasurable contribution to raising the next generation of public health scientists.

At the global level, Dr. Malm has contributed to the fight against malaria by serving as a consultant to different organizations and countries, sitting on WHO committees, and contributing immensely to international technical meetings. She just ended her term as one of the Co-Chairs of the RBM Vector Control Working Group.
An author of several articles in public health and disease control, Dr. Malm has been instrumental in the development of several national guidelines and plans for malaria control in the African region.

**Abstract**

Vector surveillance is fundamental for providing critical data for decision-making to ensure that malaria control programmes are, and remain, effective in the face of increasing insecticide resistance and limited resources. The fight against malaria continues to be multi-faceted requiring great attention to the various strategic interventions. Vector control remains a very important component of malaria control since transmission of the disease is dependent of the availability of competent vectors. Many national control programs across the continent have the capacity to implement control strategies such as distribution and monitoring use of insecticide bed-net, indoor residual spraying and larval source management. However, there is a general challenge in the implementation of optimal vector surveillance to guide and support the implementation of these key vector control interventions. One of the factors accounting for this gap is the lack of the needed capacity to carry out effective vector surveillance.

The absence of this capacity impacts negatively on malaria control in countries. This session is to highlight some of the gaps which exists in programs, how they affect countries as well as elaborate on how these challenges/ gaps could be mitigated to help strengthen the capacity of NMCPs to generate vector data within the context of enhancing strategies for malaria elimination.

Topic: **Challenges of vector control in the wake of COVID-19 pandemic in Africa: innovating new solutions for vector-borne disease elimination**

**Audrey Lenhart**, PhD MPH

Chief, Entomology Branch
Center for Global Health/Division of Parasitic Diseases and Malaria

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. She is based in the Division of Parasitic Diseases and Malaria in the Center for Global Health, where she serves as the senior agency expert on public health entomology. The Entomology Branch provides technical assistance throughout the Americas, Asia, and Africa regarding vector surveillance and control, including co-implementing the U.S. President's Malaria Initiative (PMI) across its 27 partner countries. Dr. Lenhart also coordinates the entomology activities in the USAID-funded Latin America and Caribbean Regional Malaria Program and serves as a senior advisor to PMI. She previously managed CDC's portfolio of international vector-related activities for Zika and led the Entomology Branch's Insecticide Resistance and Vector Control Team, which includes 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. Dr. Lenhart is a founding member of PAHO's Technical Advisory Group for Public Health Entomology in the Americas, and is a member of the WHO Vector Control Advisory Group. 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.

**Abstract**

Vector-borne diseases represent a major global public health burden. In the wake of the COVID-19 pandemic, this burden remains a top public health priority. In Africa, mosquito-borne diseases are of primary importance, with malaria continuing to contribute significantly to the public health burden and Aedes-borne arboviruses increasingly emerging across the continent. Innovation in the vector control space comes in many forms, ranging from high-tech genetic modification strategies to novel approaches of community engagement. As data continues to be generated regarding the efficacy of these innovations, determining which tools will yield the greatest impact should be guided by local characteristics and led by local stakeholders. Examples of vector control innovations will be presented, and gaps will be highlighted where novel solutions are needed. In addition to novel tools and vector control strategies, innovation is also needed regarding how interventions are developed, operationalized and implemented, with local institutions providing the leadership and oversight. Factors that can enable these structural and institutional innovations will also be proposed.

**Title: Global health and the emerging challenges of arthropod-borne diseases in Africa**

**Florence Fouque, Ph.D.,**

Scientist, Focal Point for Vectors,
Research For Implementation Unit,
The Special Programme for Research and Training
in Tropical Diseases World Health Organization

The professional experience and personal involvement of Florence Fouque are on the broad knowledge on insects vector of diseases, vector-borne diseases (VBDs) in particular against the vectors of malaria, arboviral diseases and leishmaniasis and on the development and implementation of new approaches and strategies for the control of the diseases and theirs vectors.

Her first position was as an assistant at the Polytechnic School of Zurich to work on the biological control of insects vectors and pests. Then, she joined the Pasteur Institute and its International Network for more than 20 years to work in/for different countries affected by Tropical Diseases and Poverty. She had the opportunity to participate and lead several research projects on different vectors and vector-borne diseases acquiring experience and knowledge on both the vector biology and the project management in different ecological, socio-economics and political environments. The research programs she was involved in were not only providing new findings but also contributing actively to regional and country efforts to develop sustainable local research capacity and successful partnerships and collaborations. During her different positions within the Pasteur network she also contributed to strengthening capacity building at different levels (from technical to post-doc) in those fields.

Since 2014, she joined WHO Special Programme for research and training on Tropical Diseases (TDR), first as the Team Lead for the Vector Environment and Society Unit and then as a Scientist within the Implementation Research Unit. Their activities are looking at the broader issues that affect the transmission of pathogens through vectors. An interdisciplinary approach is used, including water, agriculture, meteorology, and sociology and the work with community members to develop new approaches and strong capacity building to improve the health of the most vulnerable. Among the research projects supported at TDR which she had the opportunity to manage, a strong emphasis was on residual malaria, multisectoral approaches for prevention and control of VBDs, insecticide resistance of vectors of arboviral diseases and innovative vector tools. These activities include also the support to the development of Networks (both regional and worldwide) to facilitate the exchange of knowledge and build up capacity.

## Abstract

Global Health is a new approach to Public Health extended at the worldwide level, which was developed by the United Nations after the turn of the century. However, the definition of global health encompasses so many aspects that a universal definition is not yet available. Nevertheless, some general understanding has been reached to focus the global health perspectives on population-centered health in which the health of very small communities can affect the health of the worldwide population as this has been demonstrated by the recent pandemics. The place and challenges of the vector-borne diseases (VBDs) within this global health approach is very specific due to the indirect transmission modes with the need of vectors which are closely environmental dependent. The main challenges are thus linked not only to the common factors of globalization such as demographics, climate change, urbanization and others, but also to specific and contextual factors and risks such as the geographic distribution of the vectors. Through examples, some challenges for malaria,

arboviral diseases and vector-borne neglected tropical diseases will be given for VBDs and emerging VBDs in the African Region. The global health challenges are requiring multidisciplinary and multisectoral approaches, which are currently investigated by TDR through case studies in several African countries. Although, the work is in progress some findings, recommendations and lesson learned can already being extracted.

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# CONFERENCE PROGRAMME

**Day One: Monday September 20, 2021**

| Time (UTC) | Activity | |
|---|---|---|
| **10:00 – 11:20** | **Opening Ceremony** | |
| 10:05 – 10:15 | MC: Silas Majambere, PhD | Welcoming of guests |
| 10:15 - 10:20 | Country Chapter President | Welcome address |
| 10:20 – 10:25 | Executive Director | Opening remarks |
| 10:25 – 10:30 | PAMCA President | Opening remarks |
| 10:30 – 10:40 | Minister from host country | Remarks and Official opening of the conference |
| 10:40 – 10:45 | Group Entertainment | Cultural animation |
| 10:45 – 11:15 | Keynote Address:<br>Speaker: Dr. Joseph Siaw Agyepong, PhD<br>Chair: Prosper Chaki, PhD | Topic: **Empowering local institutions to set the agenda for the elimination of vector-borne diseases** |
| 11:15 – 11:20 | MC: Silas Majambere, PhD | Overview of conference and recognition of sponsors |
| **11:20 - 12:10** | **Break/Exhibition Hall/Networking** | |

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|---|---|
| 12:10 – 12:30 | **Plenary session 1**<br>Speaker: Keziah Malm, PhD, Programme Manager, NMCP, Ghana<br>Presentation title: **Strengthening National Malaria Control Programs capacity for vector surveillance for malaria elimination**<br>Chair: MC: Samson Kiware, PhD & Jewelna Akorli, PhD |
| 12:30 – 12: 45 | Presentations on PAMCA Program Initiatives & Future Outlook (Recorded)<br>Prosper Chaki, PhD, Executive Director, PAMCA |
| 12:30 – 2:00 | **Symposia Session 1** |
| 12:30 – 2:00 | **Parallel symposium 1**: Strengthening entomological surveillance capacity towards malaria elimination in sub-Saharan Africa<br>Organizer: PAMCA; Co-organizer: IHI, CRID, IRSS<br>**Speakers:**<br>Silas Majambere, PhD, PAMCA, Kenya<br>Abdoulaye Diabate, PhD, IRSS, Burkina Faso<br>Fredros Okumu, PhD, IHI, Tanzania<br>Charles Wondji, PhD, CRID, Cameroon<br>Samson Kiware, PhD, PAMCA, Kenya<br>Ghislaine O Ametchie, PhD, PAMCA, Kenya |

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|---|---|---|---|
| 12:30 – 2:00 | **Parallel symposium 2**: Vector surveillance during the New Nets Project pilot evaluations: Estimating the entomological impact of next-generation insecticide-treated nets in high-transmission malaria endemic countries<br>Organizer: Okefu Oyale Okoko, PhD, National Malaria Elimination Programme,<br>Co-organizer: Wamdaogo Moussa Guelbeogo, PhD, Centre National de Recherche et de Formation sur le Paludisme, BURKINA FASO<br>**Speakers**<br>Emmanuel Hakizimana, PhD, Rwanda Biomedical Center, Ministry of Health<br>Kigali, RWANDA, ehakizimana@gmail.com<br>Dulcisaria Jotamo, Programa Nacional de Controlo da Malária, Ministério da Saúde<br>Maputo, MOZAMBIQUE, djotamo15@gmail.com<br>Adedapo Adeogun, Nigerian Institute of Medical Research, NIGERIA, dapoadeogun@hotmail.com | | |
| 2:00 – 3:00 | **Break/Virtual Exhibition Hall open/ Poster session 1 (39 posters) Poster # 1-39** | | |
| **Scientific session** | | | |
| **3:00 – 4:00 (Live Q&A)** | **Parallel session 1: Vector surveillance, entomological capacity and National Malaria Program support** | | |
| | **Session chair:** Mrs. Delia Doreen Djuicy; **Session co-chair:** Dr. Amegee Quach J | | |
| **Time** | **Abstract N°** | **Speaker** | **Abstract Title** |
| 3:00 – 4:00 | ABS-74 | Amegee Quach J | Developing postdoctoral expertise in vector control research within sub-Saharan African research institutions: The experience of the 'Partnership for Increasing the Impact of Vector Control |
| 3:00 – 4:00 | ABS-81 | Prof. Charles S Wondji | The Partnership for Increasing the Impact of Vector Control (PIIVeC) consortium: a model to maximise the impact of vector control |
| 3:00 – 4:00 | ABS-62 | Tchoumbou Melanie Adele | Effect of deforestation on prevalence of avian malaria parasites and mosquito abundance in a tropical rainforest of Cameroon |
| 3:00 – 4:00 | ABS-166 | Dr. Christopher Jones | The Shire Valley Transformation Project in southern Malawi: an opportunity to address the delicate interaction between emerging agricultural systems and vector-borne disease |
| 3:00 – 4:00 | ABS-202 | Prof. Nicodem James Govella | Heritability and phenotypic plasticity of biting time behaviors in the major African malaria vector *Anopheles arabiensis* |
| 3:00 – 4:00 | ABS-39 | Dr. Aramu Makuwaza | A comparison of wild adult Anophelines collection by four capture methods in Burma Valley, Zimbabwe |
| 3:00 – 4:00 | ABS-72 | Mr Alex K Musiime | Can housing improvements for malaria control also reduce acute respiratory infection and non-malaria fever? A cohort study in Uganda |

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|---|---|---|---|
| 3:00 – 4:00 | ABS-44 | Dr. Marie Paul Audrey MAYI | Habitat and seasonality affect mosquito community composition in the west region of Cameroon |
| **3:00 – 4:00 (Live Q&A)** | **Parallel session 2: Vector surveillance, entomological capacity and National Malaria Program support** | | |
| | **Session chair:** Miss Nellie Chikondi Kaunde; **Session co-chair:** Dr. Michael Osae | | |
| **Time** | **Abstract N°** | **Speaker** | **Abstract Title** |
| 3:00 – 4:00 | ABS-136 | Dr. Francis Wat'senga | Longitudinal monitoring of malaria vector populations in three sites in the democratic republic of Congo to determine vector dynamics and annual malaria risk |
| 3:00 – 4:00 | ABS-171 | Miss Nellie Chikondi Kaunde | Malaria vector surveillance in Central and Southern Malawi |
| 3:00 – 4:00 | ABS-98 | Dr. Rosemary Susan Lees | Validating entomological methods for evaluation of vector control tools |
| 3:00 – 4:00 | ABS-99 | M Moussa M. DIALLO | Three consecutive years monitoring of malaria vector transmission in Kénieroba rural village in Mali. |
| 3:00 – 4:00 | ABS-236 | Dr. Jeanne Lemant | Estimating the variability of Anopheles bionomics and its impact on malaria transmission with a Bayesian hierarchical model |
| 3:00 – 4:00 | ABS-91 | Dr. Emily Dantzer | Key findings of a global landscape analysis on entomological surveillance best practices |
| **3:00 – 4:00 (Live Q&A)** | **Parallel session 3: LLINS, IRS and Insecticide Resistance Management** | | |
| | **Session chair:** Alistair Miles**; Session co-chair:** Dr. Evelyne Olanga | | |
| **Time (UTC)** | **Abstract N°** | **Speaker** | **Abstract Title** |
| 3:00 – 4:00 | ABS-131 | Alistair Miles | Insecticide resistance in the Anopheles gambiae complex - analysis of whole-genome sequence data from 19 countries and three mosquito species |
| 3:00 – 4:00 | ABS-177 | Dr. Chifundo Kadangwe | Entomological impact of indoor residual spraying with clothianidin in Balaka district, Malawi |
| 3:00 – 4:00 | ABS-164 | Dr. Evelyne Olanga | Human-biting activity and human exposure indices of major malaria vectors in Malawi |
| 3:00 – 4:00 | ABS-182 | Mr. Alidu Iddrisu | Maintaining *Anopheles gambie* s.l mosquitoes using an artificial membrane feeding technique at Vestergaard-NMIMR Vector Labs, Ghana. |
| 3:00 – 4:00 | ABS-200 | Dr. Sonhafouo-Chiana N | High insecticide resistance in the main Malaria Vector *An. gambiae* s.l. is challenging vectors control in Yaoundé Cameroon before and during larval control intervention and its relevance future malaria control. |

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|---|---|---|---|
| 3:00 – 4:00 | ABS-90 | Dr. Francesco Baldini | Transgenerational effects in life history traits and malaria susceptibility induced by insecticide sub-lethal exposure in the mosquito Anopheles gambiae |
| 3:00 – 4:00 | ABS-125 | Dr. Priscille Barreaux | Exposure to pyrethroid nets reduces blood feeding efficiency and longevity in resistant mosquitoes. |
| 3:00 – 4:00 | ABS-232 | Dr. Renaud Govoetchan | VECTRON T500 (broflanilide) a new meta-diamide insecticide for indoor residual spraying, shows prolonged efficacy against pyrethroid-resistant malaria vectors |
| | **Day One Ends** | | |

## Day Two: Tuesday September 21, 2021

| Time (UTC) | Activity | | |
|---|---|---|---|
| 10:00- 10:10 | **Welcome and Announcements**<br>MC: Silas Majambere, PhD | | |
| 10:10 – 10:30 | **Plenary session 2**<br>Speaker: **Audrey Lenhart, PhD**<br>Presentation title: **Challenges of vector control in the wake of COVID-19 pandemic in Africa: innovating new solutions for vector-borne disease elimination**<br>Chair: Samson Kiware, PhD & Jewelna Akorli, PhD | | |
| 10:30 – 12:00 | **Symposia Session 2** | | |
| 10:30 – 12:00 | **Parallel symposium 3**: Data Sharing in the African Context - Opportunities to Reshape the Conversation<br>Organizer: Samuel Rund, PhD; Co-organizer: Elijah Juma, PhD<br>**Speakers:**<br>Jane Wyngaard, PhD - University of Cape Town, South Africa<br>Louise Bezuidenhout, PhD - University of Cape Town, South Africa<br>Duncan Athinya - Vestergaard/IR Mapper<br>Samuel Rund, PhD: University of Notre Dame, USA | | |
| **12:00 – 1:00 UTC (Live Q & A)** | **Parallel session 4: LLINS, IRS and Insecticide Resistance Management** | | |
| | **Session chair:** Dr. Fotso Toguem Yvan Gaétan**; Session co-chair:** Dr. Amelie Wamba Ndongmo Regine | | |
| **Time (UTC)** | **Abstract N°** | **Speaker** | **Abstract Title** |
| 12:00 – 1: 00 | ABS-77 | Dr. Fotso Toguem Yvan Gaétan | Polymorphism analysis of CYP6M2, a main metabolic resistance gene in *Anopheles gambiae* from Yaoundé, Cameroon |
| 12:00 – 1: 00 | ABS-152 | Mrs. Delia Doreen Djuicy | CYP6P9-Driven Signatures of Selective Sweep of Metabolic Resistance to Pyrethroids in the Malaria Vector *Anopheles funestus* Reveal Contemporary Barriers to Gene Flow |
| 12:00 – 1: 00 | ABS-45 | Dr. Tchouakui Magellan | A 6.5kb intergenic structural variation exacerbates fitness cost of P450- metabolic resistance in the major African malaria vector *Anopheles funestus* |
| 12:00 – 1: 00 | ABS-267 | Mrs. Christabelle Gba SADIA | Short-term metabolic resistance inductive effect of different agrochemical groups on *Anopheles gambiae* mosquitoes |
| 12:00 – 1: 00 | ABS-183 | Mr. Assogba Adandé MEDJIGBODO | Putative pleiotropic effects of the knock-down resistance (L1014F) allele on the life-history traits in *Anopheles gambiae* |

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| 12:00 – 1: 00 | ABS-278 | Dr. Nathalie AMVONGO ADJIA | Exploring the spread of metabolic (GSTe2) and target-site (Rdl) insecticide resistance alleles in *Anopheles funestus* vector populations across a major mountainous landscape (the Mount Cameroon |
| 12:00 – 1: 00 | ABS-173 | M. Jerome Achille BINYANG | Nationwide distribution of Acetylcholinesterase (Ace-1R) target site mutation G119S and resistance to carbamates and organophosphates in *Anopheles gambiae* s.l populations in Cameroon |
| 12:00 – 1: 00 | ABS-259 | Dr. Amelie Wamba Ndongmo Regine | The Cytochrome P450 CYP325A is a major driver of pyrethroid resistance in the major malaria vector *Anopheles funestus* in Central Africa |
| **12:00 – 1: 00 (Live Q & A)** | **Parallel session 5: LLINS, IRS and Insecticide Resistance Management** | | |
| **Time (UTC)** | **Session chair:** Mr. Duncan Kobia Athinya**; Session co-chair:** Miss Rosalia Nghitalesheni Joseph | | |
| 12:00 – 1: 00 | **Abstract N°** | **Speaker** | **Abstract Title** |
| 12:00 – 1: 00 | ABS-185 | Mr. Duncan Kobia Athinya | Understanding the long-term efficacy of Perma Net® 3.0 through post market surveillance |
| 12:00 – 1: 00 | ABS-58 | Miss Rosalia Nghitalesheni Joseph | Potential efficacy of Piperonyl Butoxide (PBO) synergist on deltamethrin resistant Anopheles mosquitoes in Namibia |
| 12:00 – 1: 00 | ABS-79 | Mr. William Syme | Pyrethroid-piperonyl butoxide (PBO) nets reduce the efficacy of indoor residual spraying with pirimiphos-methyl: an experimental hut evaluation in southern Benin |
| 12:00 – 1: 00 | ABS-281 | Dr**.** Elizabeth Bandason | Interceptor G2 net has Multiple effects on Anopheles mosquitoes |
| 12:00 – 1: 00 | ABS-239 | Dr. Barnabas Zogo | Meeting the challenge of insecticide resistance |
| 12:00 – 1: 00 | ABS-87 | Mr. Borel Djiappi Tchamen | Analyses of Insecticide Resistance Genes in *Aedes aegypti* and *Aedes albopictus* Mosquito Populations from Cameroon |
| **12:00 – 1: 00 (Live Q & A)** | **Parallel session 6: Larval source management, IVM, Global Health, and public engagement** | | |
| **Time (UTC)** | **Session chair:** Dr. Seydou YABRE**; Session co-chair:** Mr. Mark Ntangeki Lwakatare | | |
| 12:00 – 1: 00 | ABS-67 | Dr. Emmanuel Hakwia Kooma | Implementing Quality; a missing piece with a need for process of behavior change: A case for implementing Quality Community Based Indoor Residual Spraying Delivery Model in Zambia. |
| 12:00 – 1: 00 | ABS-110 | Dr. Seydou YABRE | Analysis of the impact of malaria on the labour productivity of cotton farmers in Burkina Faso. |
| 12:00 – 1: 00 | ABS-120 | Miss Carmène Sandra NGADJEU | Perceptions and practices of communities during a larviciding trial in the city of Yaounde, Cameroon |

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| 12:00 – 1: 00 | ABS-181 | Dr. Mphatso Dennis Phiri | Larval source management for malaria control in Africa: divergence in policy, funding and adoption; a 'funding-evidence' catch-22 |
| 12:00 – 1: 00 | ABS-66 | Ms Patricia Lucie Vanessa Doumbe Belisse | Assessing malaria transmission and vector dynamic in a context of larviciding trial in the city of Yaoundé, Cameroon. |
| 12:00 – 1: 00 | ABS-64 | Mr. Mark Ntangeki Lwakatare | Achieving improvements in malaria behaviors and behavioral determinants through integrated social and behavior change activities in Tanzania Mainland. |
| 1:00 – 2:30 | **Symposia session 3** | | |
| 1:00 – 2:30 | **Parallel symposium 5**: Using entomological surveillance data and programmatic tools for evidence-based planning and selection of vector control interventions<br>Organizer: Sheila Ogoma, PhD; Co-organizer: Joseph Zvoushoma<br>**Speakers**:<br>Elodie Vadja and Neil Lobo**;** University of California, San Francisco, Global Health Group Malaria Elimination Initiative, and University of Notre Dame<br>Charles Ntege; Principal Entomologist NMCD-MOH, Malaria Consortium<br>Stark Katokele; Namibia Ministry of Health and Social Services/National Vector-Borne Disease Control Programme, Namibia<br>Bernard Kouassi**;** Entomologist PMI VectorLink, Cote d'Ivoire<br>Tom Burkot and Tanya Russell**;** Australian Institute of Tropical Health and Medicine, James Cook University, Cairns, Australia<br>Ellie Sherrard-Smith; Imperial College, UK | | |
| 1:00 – 2:30 | **Roundtable discussion**: A conversation between funders and implementers of malaria control and elimination in Africa<br>Organizer: Prosper Chaki, PhD; Co-Organizer: Silas Majambere, PhD<br>**Speakers:**<br>Perpetua Uhomoibhi, Director, NMEP Nigeria<br>Rick Steketee, Deputy Malaria Coordinator, PMI<br>Yacine Djibo, Executive Director, Speak Up Africa<br>Scott Filler, Head of Malaria, The Global Fund<br>Helen Jamet, Deputy Director, Vector Control, Malaria, BMGF<br>Aimable Mbituyumuremyi, Division Manager, Malaria & NTDs, RBC - Rwanda | | |
| 2:30– 3:30 | **Break/Virtual Exhibition Hall open/ Poster session 2 (38 posters) Poster # 40-78** | | |
| | **Symposium session 3** | | |

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| 3:30 – 5:00 | **Parallel symposium 4:** PAMCA WIVC professional development<br>Organizer: Dr. Damaris Matoke-Muhia; Co-organizer: Emma Orefuwa & Ghislaine Ouedraogo-Ametchie<br>**Speakers:**<br>Helen Jamet, PhD, Deputy Director, Vector Control, Malaria, BMGF<br>Mwele Ntuli, PhD – WHO Afro Director WHO Afro<br>Keziah Malm, PhD – Programme Manager, NMCP, Ghana<br>Emma Orefuwa – Co-founder PAMCA |
| **Day Two Ends** | |

**Day Three: Wednesday September 22, 2021**

| Time (UTC) | Activity |
|---|---|
| 10:00 – 10: 10 | Welcome and announcement<br>MC: Silas Majambere, PhD |
| 10:10 – 10:30 | Plenary session 3<br>**Speaker: Florence Fouque, PhD**<br>Topic: **Global health and the emerging challenges of arthropod-borne diseases in Africa**<br>Session chair: MC: Brian Tarimo, PhD & Jewelna Akorli, PhD |
| 10:30 – 11:45 | Sponsor presentations |
| **Time (UTC)** | **Activity** |
| 11:45-1:15 | **Symposium session 4** |
| 11:45-1:15 | **Parallel symposium 6:** How is GPIRM going? Generating the evidence to inform insecticide resistance management<br>Organizer: Raphael N'Guessan, PhD<br>Co-organizer: Sian Clarke, PhD; Louisa Messenger (moderator),<br>**Speakers:**<br>Jo Lines, PhD, LSHTM, UK<br>Natacha Protopopoff, PhD, LSHTM, UK<br>Charles Wondji, PhD, LSHTM/CRID, UK/Cameroon<br>Raphael N'Guessan, PhD, IPR, Cote d'Ivoire<br>Tom Churcher, Imperial College, UK |

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| 11:45-1:45 | **Parallel symposium 7 & Launch of African Gene Drive Network & Outreach:** Who keeps gene drive research safe? Engaging African researchers and experts in governance of gene drive research<br>Organizer: Benjamin Robinson, PhD; Co-organizer: TBD<br>**Speakers:**<br>Fredros Okumu, PhD, IHI, Tanzania<br>Emma Orefuwa, PAMCA<br>Damaris Matoke – Muhia, PAMCA, Kenya<br>Willy Tonui, PhD, Africa Genetic Biocontrol Consortium (TBC), Kenya | | |
| 11:45-12:45 | Health Tech Satellite Event: Eliminating Vector-Borne Diseases in Africa: Introducing the Platform for Dialogue and Action on Health Technologies in Africa<br>Organizer: Ernest Tambo, PhD; Co-organizer: Rose Oronje, PhD<br>**Speakers:**<br>Ernest Tambo, PhD; Health tech Project Manager, African Institute for Development Policy (AFIDEP)<br>Rose Oronje, PhD; Director – Public Policy & Communication, AFIDEP | | |
| 1:45– 2:45 | **Break/Virtual Exhibition Hall open/ Poster session 3 (39 posters) Poster # 79-117** | | |
| **Scientific session** | | | |
| 2:45 – 3:45<br>(Live Q&A) | **Parallel session 7: Innovation and new tools for mosquito surveillance and control** | | |
| | **Session chair:** Dr. Yacouba Poumachu**; Session co-chair:** Dr. Corine Ngufor | | |
| **Time** | **Abstract N°** | **Speaker** | **Abstract Title** |
| 2:45 – 3:45 | ABS-275 | Ms Tracy Wanjiku Maina | Horizontal transmission of the symbiont Microsporidia MB in *Anopheles arabiensis* |
| 2:45 – 3:45 | ABS-144 | Dr. Simon Péguédwindé Sawadogo | Assessing the microbiome in *Anopheles coluzzii* and Anopheles gambiae from natural swarm |
| 2:45 – 3:45 | ABS-145 | Miss Grâce maffo Tatsinkou | Molecular detection and maternal transmission of a bacterial symbiont *Asaia* species in the field-caught *Anopheles* mosquitoes from Cameroon |
| 2:45 – 3:45 | ABS-142 | Dr. Delphine Thizy | The road to the elaboration of a community agreement model for gene drive mosquito releases in Africa |
| 2:45 – 3:45 | ABS-227 | Dr. Yacouba Poumachu | Prospects on the development of physical methods of females limination in *Anopheles arabiensis* for an sterile insect technique program |
| 2:45 – 3:45 | ABS-73 | Mrs. Jennifer Kay McCaw | Collection performance of the new BG-pro mosquito traps in various locations around the world |

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| 2:45 – 3:45 | ABS-165 | Dr. Corine Ngufor | The impact of Good Laboratory Practice certification on vector control product evaluation at a GLP-Compliant Facility (CREC/ LSHTM/PAMVERC) in Benin, West Africa |
| 2:45 – 3:45 | ABS-279 | Dr. Pare Toe | Productive collaboration between scientists and community in genetics research: case of Target Malaria research in Burkina Faso |
| 2:45 – 3:45 (Live Q&A) | **Parallel session 8: Innovation and new tools for mosquito surveillance and control** | | |
| | **Session chair:** Dr. Michelle C Stanton**; Session co-chair:** Dr. Frederik Seelig | | |
| **Time (UTC)** | **Abstract N°** | **Speaker** | **Abstract Title** |
| 2:45 – 3:45 | ABS-223 | Dr. Michelle C Stanton | Using high-resolution drone imagery to understand the impact of human-made larval habitat on dry season malaria transmission in rural Malawi |
| 2:45 – 3:45 | ABS-254 | Dr. Andreas Maria Rose | Electric fields can be used to repel mosquitoes: laboratory experiments and use cases. |
| 2:45 – 3:45 | ABS-187 | Dr. Dari Frédéric DA | Detection of Plasmodium falciparum in laboratory-reared and naturally infected wild mosquitoes using near-infrared spectroscopy |
| 2:45 – 3:45 | ABS-102 | Dr. Mark Thomas Fowler | Tensorflow and vector fertility: the automatic classification of pyriproxyfen-damaged mosquito ovaries |
| 2:45 – 3:45 | ABS-124 | Dr. Laban Njoroge | A larval mosquito rearing robot inspired by the Covid-19 induced lockdowns |
| 2:45 – 3:45 | ABS-89 | Mr. Bazoumana Bala Danouma Sow | An Online Platform for Malaria Vector Surveillance in Africa using artificial Intelligence and mosquito Infrared Spectroscopy |
| 2:45 – 3:45 | ABS-245 | Dr. Frederik Seelig | The Global Vector Hub - building entomological capacity worldwide and improving epidemic preparedness |
| 2:45 – 3:45 (Live Q&A) | **Parallel session 9: Arthropod-borne viruses, control of arboviral vectors, NTDs, One Health** | | |
| | **Session chair:** Dr. Basile Kamgang**; Session co-chair:** Mr. Hyacinthe Kobié Toe | | |
| 2:45 – 3:45 | ABS-201 | Dr. Basile Kamgang | Risk of dengue in Central Africa: vector competence studies with *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) populations and dengue 2 virus. |
| 2:45 – 3:45 | ABS-96 | Dr. Lassane Koala | Efficient traps for xenomonitoring onchocerciasis vectors: optimising visual cues for host seeking *Simulium damnosum*. |
| 2:45 – 3:45 | ABS-100 | Mr. Hyacinthe Kobié TOE | Multiple insecticide resistance and first evidence of V410L kdr mutation in *Aedes aegypti* from Burkina Faso |

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| 2:45 – 3:45 | ABS-158 | Ms Nukunu Etornam Akyea-Bobi | *Aedes* mosquitoes in Ghana: risk of transmission of arboviral diseases in an urban forest and community |
| 2:45 – 3:45 | ABS-137 | Dr. Huguette SIMO TCHETGNA | Concurrent circulation of dengue serotype 1, 2 and 3 among acute febrile patients in Cameroon |
| 2:45 – 3:45 | ABS-263 | Miss Owusu Ntim | Transmission of cutaneous leishmaniasis and bacterial co-infection of cutaneous lesions in the Nkwanta south district of Ghana |
| 2:45 – 3:45 | ABS-82 | Fatma Saleh | Epidemic risk of arboviral diseases: determining the habitats, spatial-temporal distribution, and abundance of immature *Aedes aegypti* in the urban and rural areas of Zanzibar, Tanzania |
| 3:45 - 4:35 | **Closing ceremony: MC: Silas Majambere, PhD; Brian Tarimo, PhD** | | |
| 3:45 - 4:20 | Program Manager, Capacity Building, Gender Mainstreaming & Career Progression, PAMCA | WIVC Awards Ceremony | |
| 4:20– 4:25 | Ghana LOC Chair & PAMCA Ghana President | Closing remarks | |
| 4:25 – 4:30 | Executive Director, PAMCA | Closing remarks | |
| 4:30 – 4:35 | PAMCA President | Closing remarks and Announcement of next conference host | |
| 4:35 | **Conference Ends** | | |

# SYMPOSIA

## SYMPOSIUM 1

**Strengthening local capacity for malaria surveillance and elimination in Africa Principal organizer**
Pan-African Mosquito Control Association (PAMCA). KEMRI Headquarters, Off Mbagathi Way, P. O. Box 44455 -00100, Nairobi, Kenya; info@pamca.org

**Co-organizers**: Ifakara Health Institute (IHI), Tanzania; Centre for Research in Infectious Diseases (CRID), Cameroon; Institut de Recherche en Sciences de la Sante (IRSS), Burkina Faso

**Speakers**

Silas Majambere; Pan-African Mosquito Control Association (PAMCA). KEMRI Headquarters, Off Mbagathi Way, P. O. Box 44455 -00100, Nairobi, Kenya; silas.majambere@pamca.org

**Presentation title: Strengthening local capacity for malaria surveillance and elimination in Africa.**

Fredros Okumu; Ifakara Health Institute (IHI). Off Mlabani Passage, P.O. Box 53, Ifakara, Tanzania; fredros@ihi.or.tz

**Presentation title: Strengthening local capacity for malaria surveillance and elimination in Africa; Tanzania Case Study**

Samson Kiware; Pan-African Mosquito Control Association (PAMCA). KEMRI Headquarters, Off Mbagathi Way, P. O. Box 44455 -00100, Nairobi, Kenya; samson.kiware@pamca.org

**Presentation title: Strengthening entomological data management capacity in Africa**

Charles Wondji; Centre for Research in Infectious Diseases (CRID). Rue 1.606 Yaoundé 5, Cameroon; P.O. Box 13591; Charles.Wondji@lstmed.ac.uk

**Presentation title: Strengthening local capacity for malaria surveillance and elimination in Africa; Cameroon-Case Study**

Diabate Abdoulaye; Research Institute Science Health Regional Directorate L'ouest (IRSS); 399 Avenue de la Liberté, 20981880, Bobo-Dioulasso, Burkina Faso. npiediab@gmail.com

**Presentation title: Strengthening local capacity for malaria surveillance and elimination in Africa; Burkina Faso-Case Study**

Ghislaine Ouedraogo-Ametchie; Social Science Consultant, PAMCA. KEMRI Headquarters, Off Mbagathi Way, P. O. Box 44455 -00100, Nairobi, Kenya; oghislaine@gmail.com

**Presentation title: Landscaping of malaria vector control and surveillance systems in Burkina Faso, Cameroon and Tanzania.**

**Description** : Vector-borne diseases (VBD) disproportionately affect the communities in the low-income countries (LIC), especially in sub-Saharan Africa (SSA). To effectively address the burden of VBDs in the endemic settings in SSA require putting in place vector-borne disease surveillance systems that address practical barriers to their control and elimination. Vector control has been the gold standard method for prevention and control of VBDs for over 100 years and remains highly effective, when applied comprehensively and sustainably. However, for most VBD-endemic countries in SSA, vector control is generally under-funded with limited resources allocated to support building adequate capacity for effective entomological surveillance at national vector-borne disease programs. Vector surveillance systems remain weak, fragmented, and lack proper coordination mechanisms at the national vector-borne disease control programs where such systems are urgently needed.

**Justification:** The SSA countries require a growing pool of adequately trained, entomology professionals at all levels; from the entomology technicians at the district unit, to the highest level policy formulators and disease control implementers. This critical mass of entomologists should be equipped with the technical capacity to study vector biology, conduct entomological surveillance, process, analyse and interpret entomological data to guide planning, targeting and implementation of vector control and elimination interventions. Although in the recent years there has been progress in increasing the pool of well-trained entomologists within research and academic institutions in SSA countries, their skills and research outputs have not been adequately harnessed

to the direct benefit of the national vector-borne disease programs. Additionally, a lot of training focus has been at the higher graduate levels (master and PhDs) and this has created a gap in skills development at the low- to mid-levels of the district entomology technicians which is a critical capacity for supporting evidence-based decision making on effective vector control interventions.

**Objective:** The main objective of this symposium will be to give an update on the progress made with the PAMCA's plans to strengthen entomology capacity at national VBD programs and invite contributions to building strong partnerships and alliances to strengthen vector-borne disease control and elimination in SSA.

## SYMPOSIUM 2

Vector surveillance during the New Nets Project pilot evaluations: Estimating the entomological impact of next-generation insecticide-treated nets in high-transmission malaria endemic countries

**Principal organizer:**

Okefu Oyale Okoko
Deputy Director, Integrated Vector Management Branch
National Malaria Elimination Programme
Public Health Department, Federal Ministry of Health
Abuja, NIGERIA
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**Speakers:**

Wamdaogo Moussa Guelbeogo, PhD
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Research Fellow
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**Description:** To help address the spread of pyrethroid resistance in key malaria vector populations across sub-Saharan Africa, several countries are piloting the distribution of next-generation insecticide-treated nets (ITNs) in collaboration with the New Nets Project (NNP). Next-generation ITNs are designed to be effective at killing pyrethroid-resistant mosquitoes and contain mixtures of pyrethroids and either the insecticide synergist piperonyl butoxide or a second active ingredient, such as the pyrrole insecticide chlorfenapyr (Interceptor G2®) or the insect growth regulator pyriproxyfen (Royal Guard®). Accompanying several of these pilot distributions are observational studies designed to measure the epidemiological and entomological impact, and estimate the incremental cost effectiveness, of new ITN types relative to standard, pyrethroid-only ITNs. Here, baseline vector surveillance results and preliminary data from four NNP pilot evaluations across Burkina Faso, Rwanda, Mozambique, and Nigeria will be summarized. A facilitated group discussion will highlight the diverse vector bionomics within and across the different evaluation settings and begin to discuss how this diversity and variability will guide the interpretation of NNP pilot evaluation results and improve our understanding of where and when next-generation ITN types can be utilized most effectively within the context of locally tailored, integrated malaria control strategies.

**Justification:** In light of the expanding and intensifying pyrethroid resistance in key malaria vector populations, next-generation ITNs are frequently cited as key components of the kinds of integrated malaria control approaches needed to maintain and accelerate progress in the global fight against malaria. However, in order to better understand how to maximize the impact of these newer and more expensive tools, they must be evaluated in a variety of transmission settings. The NNP is aiming to do this through the use of two cluster-randomized controlled trials and several observational pilot studies in sub-Saharan Africa. This symposium will discuss the entomological surveillance components of the pilot evaluations, with a focus on the diverse vector bionomics encountered across the study settings. Discussions will highlight early lessons learned and will set the stage for further interpretation of results in the near future.

**PAMCA sub-theme**: LLINS, IRS and Insecticide Resistance Management

SYMPOSIUM 3

## Data Sharing in the African Context - Opportunities to Reshape the Conversation

- Principal organizer: Samuel Rund, University of Notre Dame / VectorBase: srund@nd.edu
- Co-organizer/Moderator: Elijah Juma, PAMCA: elijah.juma@pamca.org

**Speakers**

- Jane Wyngaard - University of Cape Town: jane.wyngaard@uct.ac.za (Data Technologist (tools, storage, compute), OpenData advocate, Engineer)
- Louise Bezuidenhout- University of Cape Town: lm.bezuidenhout@uct.ac.za (data ethicist)
- Duncan Athinya - Vestergaard/IR Mapper: dka@vestergaard.com (African-led aggregated entomological data resources & repositories and recent advances in entomological data sharing: are we making progress?)
- Samuel Rund: (Examples of different entomological data sharing systems and outcomes)

**Introduction:** Data is a valuable currency for scientific research and evidence-based decision making in operational intervention contexts. Current scientific research and surveillance operations generate large volumes of data that exist in different depths, formats, and stored in multiple repositories. The reuse and/or aggregation of such data can multiply the societal benefits of the collected and analyzed data (aggregated data is more than the sum of its parts); however, sharing can disadvantage the original data collector. Numerous examples of misalignments in benefits between original data collectors and reusers (often based in the global north), has highlighted a long list of things *not to do* regarding use of LMIC data, but offered very restricted views of what *should be done*.

**Objectives:**

1. Encourage open conversation that increases understanding regarding the various perspectives on data sharing - its utility, pitfalls, prospects, costs, opportunities and limitations
2. Discuss existing or potential resources (human and digital) and gaps to ensure "best practices," guidelines, tools, and infrastructures, that could be adopted
3. Explore how the entomological community could be a leader on what not to do and expand in what to do with regards to data sharing and reuse in the wider context of African scientific data.

**Justification:** There is a need to have the conversation on data sharing to balance the competing trends in science toward greater equity and more open science. However, this leads to a natural conflict when research is done between high- and low-resource settings. There is also the underlying need to delicately balance academic pursuits versus the timely use of surveillance data to guide timely operational intervention in disease control settings. Symposium speakers are experts in data ethics, research data management, data curation, and use of aggregated data.

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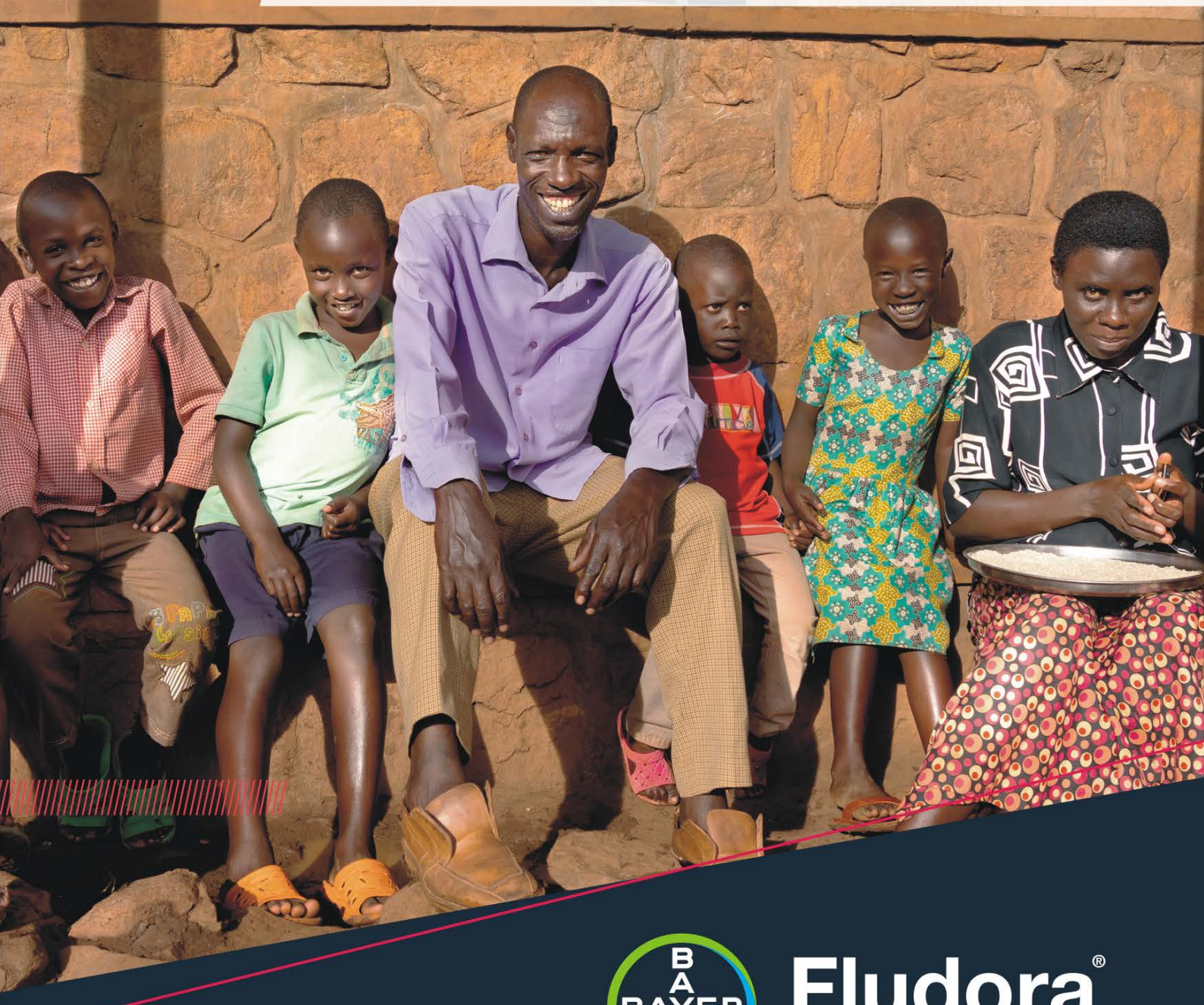

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SYMPOSIUM 4

**Title: PAMCA WIVC professional development**

Organizers: Damaris Matoke-Muhia, Emma Orefuwa & Ghislaine Ouedraogo-Ametchie

**Background:** Gender equality and women's rights are critical drivers of health, well-being, and socioeconomic development. The complexity of global health problems demands leadership that represents the pluralism in society. In 2017, the World Health Assembly approved The *Global vector control response (GVCR) 2017–2030* strategy that advocates the urgent need to strengthen vector control activities in preventing disease outbreaks (WHO, 2017). The strategy recommended re-alignment of vector control programs with increased technical capacity support, improved infrastructure, strengthened monitoring and surveillance systems, and greater community mobilization. Implementation of a comprehensive approach to vector control will enable achievement of disease-specific national and global goals and contribute to achievement of the Sustainable Development Goals (SDGs) and Universal Health Coverage (UHC).

**Justification:** In recognition of the critical role women play in achieving parity in health and well-being of the society, PAMCA is committed to building the capacity of women leaders in the vector-borne disease (VBD) control in Africa. Specifically, PAMCA aims to achieve these goals through specific action plans including: strengthening the role of women in VBD control through policy and advocacy; promoting gender equality in women in the field of VBD control; building women's capacity through targeted training programs, effective science communication, and confidence building initiatives; advancing women's role in VBD leadership through structured mentorship; and promoting the active engagement of non-professional women within grassroot communities in VBD control and elimination efforts.

Riding on the wings of the first successful WIVC workshop held during the 6th PAMCA Annual Conference & Exhibition in Cameroon, PAMCA proposes to host a round table discussion symposium that focusses on professional development of WIVC in Africa.

**Objectives:** The overall objective is to share and learn from experiences, insights, and development journeys of global women leaders in to support of career development of women professional in vector borne disease control

The specific objectives are:

1. To discuss the strategies of confidence building as part of personal development
2. To highlight leadership and organizational skills through personal experiences

**Expected outcomes:**

- Shared information on leadership and confidence
- More women in managerial positions in Vector control activities

**Discussion Areas**

- Leadership skills and competencies
- Strategic thinking in leadership
- Confidence building measures
- Self-regulation and management tools/practices

**Benefits of attending**

By the end of the symposium, participants should understand the strategies and approaches for building confidence and the need for transformative leadership in order to offer strategic guidance in dynamic environments not only VBDs

## Tentative Programme

| | Activity | Facilitator |
|---|---|---|
| 10min | Welcome remarks, PAMCA WIVC overview and workshop objectives & expectations | Damaris Matoke-Muhia |
| 50Min | Strategic thinking and confidence building in leadership: the experiences (successes and Challenges) | Helen Jamet - Deputy Director, Vector Control, Malaria, BMGF |
| | | Emma Orefuwa – Co-founder, PAMCA |
| | | African Women leaders<br>Mwele Ntuli – Director WHO Afro<br>Keziah Malm, Programme Manager, NMCP, Ghana |
| 30 min | Panel discussion | Damaris Matoke-Muhia<br>Ghislaine Ouedraogo-Ametchie |
| 20 min | Participants Q&A | |
| 10min | Wrap up | Damaris Matoke-Muhia |
| END | | |

SYMPOSIUM 5

Using entomological surveillance data and programmatic tools for evidence-based planning and selection of vector control interventions

**Principal organizer**: Sheila Ogoma, Clinton Health Access Initiative, **sbarasa@clintonhealthaccess.org**

**Co-organizers:** Joseph Zvoushoma, Clinton Health Access Initiative, **jzvoushoma@clintonhealthaccess.org**

Speakers:

- **Elodie Vadja** and **Neil Lobo;** University of California, San Francisco, Global Health Group Malaria Elimination Initiative, and University of Notre Dame; **Elodie.Vajda@ucsf.edu**, **nlobo@nd.edu**; Applications of the Entomological Surveillance Planning Tool in High Burden High Impact National Malaria Control Programs
- **Charles Ntege**; Principal Entomologist NMCD-MOH, Malaria Consortium; **c.ntege@malariaconsortium.org** ; Using entomological and insecticide resistance data to inform vector control decisions in Uganda
- **Stark Katokele**; Namibia Ministry of Health and Social Services/National Vector-Borne Disease Control Programme; **katokeles@nacop.net**; Using entomological and insecticide resistance data to inform vector control decisions in Namibia
- **Bernard Kouassi;** Entomologist PMI VectorLink, Cote d'Ivoire; **Bernard_Kouassi@pmivectorlink.com**; Using entomological and insecticide resistance data to inform vector control decisions in Cote d'Ivoire
- **Tom Burkot** and **Tanya Russell;** Australian Institute of Tropical Health and Medicine, James Cook University, Cairns, Australia; **tom.burkot@jcu.edu.au**, **tanya.russell@jcu.edu.au**; Capacity of National Malaria Control Programmes to implement vector surveillance: a global analysis
- **Ellie Sherrard-Smith**; Imperial College, UK; **e.sherrard-smith@imperial.ac.uk**; Tool to optimize cost effective deployment of new vector control tools against malaria

**Description**: In line with the sub-theme: "Vector surveillance, entomological capacity and National Malaria Program support", this symposium will focus on how malaria programs and partners use entomological and insecticide resistance data for evidence-based planning in sub-Saharan Africa. The symposium will include presentations from National Malaria Control Programs (NMPCs) and local partners sharing their experiences collecting, analyzing, and using entomological data to inform their vector control strategies in three countries. The symposium will also provide an overview of two tools to guide programmatic decisions: the first tool is being used by NMCPs to guide planning of entomological surveillance activities aimed at informing vector control strategies, and the second tool is aimed at helping NMCPs explore the most cost-effective option of deploying current World Health Organization (WHO) recommended classical and next generation long lasting insecticidal nets and indoor residual spraying products for malaria control. In addition, results of a global analysis on the capacity of NMCPs to conduct entomological surveillance will be presented. We propose six talks, each 15 minutes in length, followed by a moderated panel discussion of 30 minutes with all speakers.

**Justification:** There is need to ensure that NMCPs collect usable and relevant entomological data that can be used to inform selection of effective vector control interventions and ensure that the tools are used in the right places and at the right time. The first objective is to provide evidence from NMCPs highlighting the successes, challenges and lessons learned during collection and use of entomological data. Secondly, this symposium will make visible decision making tools that can be used to streamline entomological surveillance activities as well as enhance selection and deployment of vector control tools. These presentations and discussions will provide an opportunity for other NMCPs and local partners to leverage existing efforts and solutions from other stakeholders to inform programmatic and strategic planning and operations in their countries

## Round table discussion: A conversation between funders and implementers of malaria control and elimination in Africa.

**Principal organizer**: Prosper Chaki, PhD

**Co-organizer:** Silas Majambere, PhD

Over the past decade, efforts have been made to strengthen the capacity of national malaria control programs to develop "National Strategic Plans" that should set country priorities and guide funding decisions for the control and elimination of malaria in Africa. However, different funders have their own internal mechanisms and targets that are considered before making funding decisions.

In line with the theme of this year's conference "Empowering local institutions to set the agenda for the elimination of vector-borne diseases" the aim of the round table is to generate an open discussion between funders and implementers of malaria control and elimination to review opportunities and challenges each partner faces in prioritizing interventions, operational research and ultimately agenda setting for malaria elimination.

**Discussion topics:**

- What is the role of funders and local national programs in setting the agenda for the control and elimination of malaria in Africa?
- Is the current funding mechanism sustainable and fit for malaria elimination? (i.e. the Zanzibar perspective)
- What drives the selection of primary recipients of funding: the choice between national programs, local NGOs and international NGOs

**Panelists:**

- Perpetua Uhomoibhi, Director, NMEP Nigeria
- Rick Steketee, Deputy Malaria Coordinator, PMI
- Yacine Djibo, Executive Director, Speak Up Africa
- Scott Filler, Head of Malaria, The Global Fund
- Helen Jamet, Deputy Director, Vector Control, Malaria, BMGF
- Aimable Mbituyumuremyi, Division Manager, Malaria & NTDs, RBC, Rwanda

**Moderators:**

- Silas Majambere
- Ghislaine O. Ametchie

SYMPOSIUM 6

## How is GPIRM going? Generating the evidence to inform insecticide resistance management

**Principal organizer :** Raphael N'Guessan

Vector Control Product Evaluation Centre, Institut Pierre Richet (IPR), Côte d'Ivoire; and London School of Hygiene & Tropical Medicine, UK. **raphael.n'guessan@lshtm.ac.uk**

**Co-organizers**

- Louisa Messenger (moderator), London School of Hygiene & Tropical Medicine, UK. **louisa.messenger@lshtm.ac.uk**
- Sian Clarke, London School of Hygiene & Tropical Medicine, UK. **sian.clarke@lshtm.ac.uk**

### Description

The Global Plan for Insecticide Resistance Management in malaria vectors (GPIRM) was launched by WHO in 2012, with the aim of maintaining the effectiveness of modern malaria vector control interventions, especially LLINs. It is particularly important in Sub-Saharan Africa, not only because the intensity of insecticide resistance can be stronger and more widespread than in other regions, but also because in many countries, malaria transmission has been greatly suppressed for more than a decade, leaving people with reduced immunity and vulnerable to resurgent transmission if vector control were to be withdrawn or lose its effectiveness. In order to implement these resistance management strategies, LLINs with new active ingredients are needed. It has taken nearly a decade of investment, but now at last such products are becoming available. With the arrival of these products, the question of "which LLIN to buy" has suddenly become much more complicated and more consequential. In this Symposium we will look at some of the work generating the evidence needed to implement the GPIRM, after the process of product development.

### Justification

This symposium aims to provide an overview of the research evidence needed to inform the development of insecticide resistance management plans; and deepen understanding of how insecticide resistance can be considered when formulating future malaria control and public health policy. The talks and following panel discussion aim to highlight the evidence needs of national programmes and identify priorities for future work. Our chosen speakers are all internationally acknowledged experts in this field. Additionally, given the urgency of this concern for malaria control in many countries in Sub-Saharan Africa, we would expect this symposium to have broad spectrum appeal, and generate a large audience.

**Speakers (Names, affiliations, emails, and tentative titles or topic areas).**

| | Speaker | Title |
|---|---|---|
| 1. | Jo Lines,<br>LSHTM, UK<br>jo.lines@lshtm.ac.uk | **Insecticide resistance (IR) and malaria: Why we cannot afford to lose the arms race** |
| 2. | Charles Wondji,<br>CRID, Cameroon/LSTM, UK<br>charles.wondji@lstmed.ac.uk | **The evolution of IR in mosquitoes: What have we learnt?** |
| 3. | Natacha Protopopoff<br>LSHTM, UK<br>natacha.protopopoff@lshtm.ac.uk | **Effectiveness of three dual active ITNs in preventing malaria: Results from a cluster-randomized trial in Tanzania** |
| 4. | Raphael N'Guessan,<br>IPR, Cote d'Ivoire/LSHTM, UK<br>raphael.n'guessan@lshtm.ac.uk | **IR research in Africa to inform LLIN procurement decision and distribution: Experience from Cote d'Ivoire** |
| 5. | Tom Churcher,<br>Imperial College, UK<br>thomas.churcher@imperial.ac.uk | **A decision support tool for IR management** |
| 6. | **Moderated round table discussion and Q&A from audience**. (30 mins)<br>Our panel will include the speakers listed above, together with two programme managers (names TBC) to provide a practical perspective on the IR challenge facing national malaria control programs in Africa. | |

SYMPOSIUM 7

**Who keeps gene drive research safe? Engaging African researchers and experts in governance of gene drive research**

**Principal organizer:** African Gene Drive for Vector Control Network

**Chair:** Margaret Karembu, ISAAA AfriCenter

**Speakers:**

- 10 min - The gene drive "landscape": who's researching what? (Tony Nolan, LSTM)
- 15 min - Overview of the debates on gene drive governance and what's at stake (Outreach Network for Gene Drive Research speaker)
- Speakers Panel: Raising Africa's voice in gene drive policy debates: where can African researchers come in?
    - Fredros Okumu, Ifakara Health Institute
    - Emma Orefuwa, PAMCA
    - Damaris Matoke-Muhia, KEMRI
    - Willy Tonui, Africa Genetic Biocontrol Consortium

**Description:** Gene drive technologies are increasingly being recognized as a tool with significant potential to address global challenges such as vector-borne diseases and invasive alien species, with some of the most advanced research being conducted on mosquito-borne diseases, including malaria. As this research progresses towards possible field evaluations, policymakers are considering whether existing governance frameworks are adequate for the risk assessment and management of gene drives technologies, and how they can be permitted to move forward safely and responsibly.

This symposium will allow gene drive researchers to present an overview of current policy debates about gene drive research governance, and how these are important for African researchers. The two introductory presentations will be followed by a panel discussion with experts to discuss how scientists, policymakers, and other stakeholders from the continent can become more actively and effectively involved in these policy debates.

**Justification:** Gene drives have notable potential as an innovative approach to controlling vector-borne diseases and invasive alien species. Recent policy developments, such as WHO's issuing of a position statement on genetically modified mosquitoes or discussions on synthetic biology under the Convention on Biological Diversity, will have significant effects on how research into these approaches is conducted, under what conditions, and by whom. Understanding these new public policy developments will therefore provide crucial context and insight into the medium-term development of new malaria control technologies. This symposium will provide an accessible overview of relevant policy-making processes, explore how African stakeholders can be more involved, and help situate them with regards to the current state of gene drive research and ongoing debates about its potential impacts. It will foreground the insights of African scientists from local research institutions working to control vector-borne diseases, in accordance with the theme of the meeting.

Health Tech Satellite Event: **Eliminating Vector-Borne Diseases in Africa: Introducing the Platform for Dialogue and Action on Health Technologies in Africa**

Organizer: Ernest Tambo, PhD; Co-organizer: Rose Oronje, PhD

**Speakers:**

Ernest Tambo, PhD; Health tech Project Manager, African Institute for Development Policy (AFIDEP)

Rose Oronje, PhD; Director – Public Policy & Communication, AFIDEP

**Description**

The African Union (AU)'s development road map, Agenda 2063, recognises the critical role of technology as a catalyst for growth on the continent. The AU, through its Development Agency (AUDA-NEPAD), has gone further to prioritise technologies that have potential to contribute to changing the continent's disease trajectory. However, the development and testing of health technologies in Africa is undermined by an interaction of various factors including: opposition to the development of some of the technologies (such as gene drives for Malaria elimination); limited African voices and engagement in the development of these technologies; limited knowledge among many Africans on these technologies; and low priority and inadequate investments by African governments in the development of these technologies. To respond to this challenge, the *Platform for Dialogue and Action on Health Technologies in Africa* (Health Tech Platform) has been established to promote and facilitate informed, objective, open and balanced discussions on development and use of emerging transformative tools and technologies to address health challenges in Africa.

Justification: The session will introduce the *Platform for Dialogue and Action on Health Technologies in Africa* to PAMCA scientists in order to create awareness among the scientists on how they can use the Platform to advance their research and innovation efforts for the elimination of vector-borne diseases in Africa. Further, the session will discuss the results of a recent landscape and political economy analysis of emerging health technologies in sub-Saharan Africa. Among others, the results offer insights on how PAMCA scientists can expand the involvement of a wider range of stakeholders in their efforts to eliminate vector-borne diseases on the continent.

**ABS-74**

## Developing postdoctoral expertise in vector control research within sub-Saharan African research institutions: The experience of the 'Partnership for Increasing the Impact of Vector Control (PIIVeC)' consortium


Amegee Quach J., Pulford J., Bates I.

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**Background**: Maintaining a critical mass of highly skilled researchers is essential to further research capacity in Sub-Saharan Africa. Supporting career and leadership development among vector control postdoctoral researchers is needed to generate local evidence, apply, and disseminate new knowledge to address vector-borne diseases (VBDs). Vector control plays a pivotal role in breaking disease transmission and reaching global elimination targets. Yet, current technologies and approaches need adaptation to thwart the insecticide resistance threat in the region, holding the highest burden of VBDs worldwide. In this context, the PIIVeC programme supported and nurtured a cohort of 10 Research Career Development Fellows (RCDFs) in Malawi, Burkina Faso, and Cameroon, to generate reliable evidence for vector control decision-making. This study examines how PIIVeC strengthened RCDFs' expertise in vector control and explored what factors played a role in their career development.

**Methods**: This is a qualitative longitudinal study. A total of 28 individuals involved in the programme were interviewed, of which 10 RCDFs interviewed multiple times from 2018-2021. Data were collected through semi-structured interviews, focus group discussions and from project documentation at key stages of the programme. Data were analysed using a content analysis approach.

**Results**: Views/perspectives were collected from 10 RCDFs multiple times, 5 primary advisors based in their home institutions, 6 UK-based secondary advisors, 4 support team members, 3 project management team members. Factors influencing RCDFs' research capacity include a structured mentoring framework, diversity of support offered, accessibility and engagement into networks, and inclusiveness. Individual attributes and past experiences also played a role in RCDFs' performance.

**Conclusion**: PIIVeC demonstrated substantial enhancement of the knowledge and skills required to generate quality research evidence. Success of the next generation of researchers in vector control will be shaped by research programme attributes, individual trajectories and significant and sustained investment from local research institutions and national stakeholders.


**ABS-81**

## The Partnership for Increasing the Impact of Vector Control (PIIVeC) consortium: a model to maximise the impact of vector control


Charles Wondji, Roch Dabire, Themba Mzilahowa, Justin Pulford, Imelda Bates, Innocent Valea, Eve Worral, Nfale Sagnon, Edward Thomsen, Phil McCall, Rose Oronje, Hilary Ranson



Vector-borne diseases are pervasive, causing massive morbidity and mortality and severely retarding economic development across the developing world. Many of our current tools are inadequate, outdated, or failing due to insecticide resistance. The evidence base for newer interventions remains weak. Moreover, there is a critical shortage of researchers developing and evaluating innovative new approaches to control these diseases.

The Partnership for Increasing the Impact of Vector Control (PIIVeC) consortium, funded by the Research Councils UK Global Challenges Research Fund (GCRF), was established in 2017 to address this gap. PIIVeC brought together leading research institutes and national disease control programmes from three African countries with high burdens of vector-borne disease, Burkina Faso, Cameroon and Malawi, to develop evidence-based solutions for integrated vector control. The Partnership has generated new knowledge and tools through translational research activities across several vector-borne diseases to develop and evaluate new control tools and approaches, strengthen research capacity by training over 25 African early-career research fellows and investing in the research institutes in which they work. Furthermore, PIIVeC has reinforced links between researchers and policymakers with the establishment of technical vector control advisory groups (TVCAG) in the three countries, and the publication of policy briefs. TVCAGs provide a platform to identify major research gaps, commissioning operational research to respond to implementation challenges encountered by national control programmes with findings translated into policies.

PIIVeC has set a model of collaboration, capacity training, engagement with stakeholders, that should help to maximise the impact of vector control if sustained and replicated across the continent leading to reduced disease burden and increased resilience for responding to outbreaks.

**ABS-62**

## Effect of deforestation on prevalence of avian malaria parasites and mosquito abundance in a tropical rainforest of Cameroon

Tchoumbou Melanie Adele[1]*, Mayi Marie Audrey[1], Malange N.F. Elikwo[2], Foncha David[2], Kowo Cyril[2], Fru-cho Jerome[2], Tchuinkam Timoleon[1], Awah-Ndukum Julius[3], Robert Dorazio[5], Anong Damian[2], Anthony John Cornel[4], Ravinder Sehgal[5]

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Anthropogenic land-use change is considered a key driver of disease emergence; it usually modifies the interactions of many biotic and abiotic factors and can alter the pattern of diseases in wildlife birds. Whether land-use changes increase directly or indirectly the prevalence of avian malaria parasites through the effect on hosts and/or vectors is still not well understood. We sampled understory bird communities and mosquitoes in three habitat types (Unlogged forest, selectively logged forest, and young palm plantation) to assess the effects of habitat type on avian *Plasmodium* prevalence and its relationship with mosquito abundance. Blood samples of 845 bird individuals belonging to 86 species and 26 families were collected and screened using microscopy and PCR. *Plasmodium* infections were detected in 136 individuals (16.09%) and varied significantly between forest types. The intensity of *Plasmodium* infection was low in general and did not differ significantly according forest types. We also observed that, the prevalence of *Plasmodium* varied significantly according to bird feeding groups. Nectarivorous birds had the highest *Plasmodium* prevalence while the lowest prevalence was recorded in granivorous birds. The abundance of mosquito varied significantly according to forest types and the highest mosquito abundance was recorded in the selectively logged forest while young palm plantation had the lowest abundance. Also, the prevalence of *Plasmodium* significantly and positively correlated with mosquito abundance and this correlation was associated to selectively logged forest. This study highlights the importance of biotic and abiotic factors in the transmission dynamic of avian malaria. Habitat type affects the abundance of mosquito and play determinant role in the prevalence of avian *Plasmodium* parasites. Species feeding behavior is also important for a better understanding and prediction of patterns of parasite infections in a changing environment.

**Keywords**: Selective logging, palm oil plantation, mosquito abundance, bird feeding groups, avian malaria.

**ABS-166**

## The Shire Valley Transformation Project in southern Malawi: an opportunity to address the delicate interaction between emerging agricultural systems and vector-borne disease

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Food production will need to keep pace with rapid population growth during the 21st century and this will be an acute challenge for countries such as Malawi. Large scale irrigation offers potential food security and significant health benefits, but at the same time can increase the risk of vector-borne diseases such as malaria and schistosomiasis. Furthermore, drastically altered landscapes disturb the relationship between insect vectors, hosts and wildlife and can lead to emerging infectious zoonotic diseases. Here, we present our current knowledge of vector-borne diseases in the Shire Valley in southern Malawi in the context of the development of a new large-scale canal-based irrigation programme; the Shire Valley Transformation Project (SVTP). The SVTP will permanently change the landscape of the lower Shire Valley offering a real-time natural longitudinal experiment to determine (i) the impact of land-use transformation on vector-borne diseases, (ii) how local smallholder farming practices will be affected on the ground and how this influences the risk of vector-borne infection and (iii) practical vector control solutions which can integrated across both public health and agriculture. We will present the plans of a new four-year project which aims to reduce the transmission and burden from vector-borne disease while maintaining the socio-economic benefits of expanding agricultural development in southern Malawi.

**ABS-202**

## Heritability and phenotypic plasticity of biting time behaviours in the major African malaria vector *Anopheles arabiensis*

Nicodem J. Govella[1,2,3*,] Paul C. D. Johnson[2], Gerry F. Killeen[1,4,5] & Heather M. Ferguson[2]

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Use of Insecticide Treated Nets for malaria control has been associated with shifts in mosquito vector feeding behavior including earlier and outdoor biting on humans. The relative contribution of phenotypic plasticity and heritability to these behavioural shifts is unknown. Elucidation of the mechanisms behind these shifts is crucial for anticipating impacts on vector control. We used a novel portable semi-field system (PSFS) to experimentally measure heritability of biting time in the malaria vector *Anopheles arabiensis* in Tanzania. In PSFS assays, the biting time of F2 offspring (early: 18:00-21:00, mid: 22:00-04:00 or late: 05:00-07:00) was significantly associated with that of their wild-caught F0 grandmothers, corresponding to an estimated heritability of 0.30 (95% CI:

0.20, 0.41). F2 from early-biting F0 were more likely to bite early than F2 from mid or late-biting F0. Similarly, the probability of biting late was higher in F2 derived from mid and late-biting F0 than from early-biting F0. Our results indicate that variation in biting time is attributable to additive genetic variation. Selection can therefore act efficiently on mosquito biting times, highlighting the need for control methods that target early and outdoor biting mosquitoes.

Key words: Feeding behaviour, malaria vector, heritability, phenotypic plasticity, *Anopheles arabiensis*

**ABS-39**

## A comparison of wild adult Anophelines collection by four capture methods in Burma Valley, Zimbabwe

[1]Aramu Makuwaza, [2]David Nyasvisvo, [1]Nobert Mudare, [1]Tanatswa Gara, [2]Tafadzwa Mazhambe [1]Charmaine Matimba, [3]Munyaradzi Mukuzunga, [3]Amon Nyadundu, [4]Andrew Tangwena, [4]Wilson Chauke, [4]Joseph Mberikunashe, [2]Carmen Vilanova de Denys, [2]Hieronymo T. Masendu, [5]Nicholas Midzi & [1]Sungano Mharakurwa,

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There are various mosquito collection techniques to monitor and evaluate the impact of vector control measures in malaria prone areas. The present study compared entomology indicators from mosquitoes collected in Burma Valley between 2016 – 2019. Burma valley is under routine indoor residual spraying. The aim was to compare number of vectors collected fed or not and parasite infected over time. Four collection methods assessed were: indoor/outdoor CDC light traps, prokopack aspirations (PPA), pyrethrum spray catches (PSC) and human baited CDC light trap (HLC proxy). Parasite infections and vertebrate host blood-meal identities were determined per collection method. A total of 934 adult anophelines were collected comprising 84.6% (790) from CDC (in/out), 7.9% (74) HLC proxy (in/out), 4.8% (45) PPA and 2.7% (25) PSC. Major vectors collected were 4.6% (43/934) *An. funestus* s.s., 6.9 % (64/934) *An. arabiensis* and 0.1 % (1/934) *An. gambiae* s.s. Other species collected in high numbers included *An. leesoni* (243/934), *An. parensis* (125/934), *An. pretoriensis* (64/934), *An. rufipes* (50/934) and some whose species could not be determined by current polymerase chain reaction protocols (*Anopheles* unknown 210/934). The results show association of indoor collection methods and presence of human host blood meal $p<0.001$. 0.43% (4/934) *Anopheles* vectors were found to be infected after polymerase chain reaction test and these were 2 *An. funestus* s.s., 1 *An. rivulorum* and 1 *Anopheles* unknown. Collection densities were high with CDC light traps (in/out) compared to other collection methods. CDC light traps appeared more effective method for mosquito surveillance in this endemic area and an alternative method for human-landing catches. Presence of parasites in mosquitoes was associated with indoor capturing ($p=0.015$). Engorged mosquitoes were higher in PSC and PPA. For vector sampling the CDC light traps (in/out) are recommended as they caught diverse mosquitoes species in the Valley. Vector mosquitoes caught infected suggests interaction with host and longevity contrary to intervention objectives and a pointer for need to improve IRS coverage or investigate insecticide susceptibility.

**ABS-72**

## Can housing improvements for malaria control also reduce acute respiratory infection and non-malaria fever? A cohort study in Uganda.

Alex Musiime

Housing improvements may support malaria control and elimination in sub-Saharan Africa by reducing house entry by malaria vectors, but concurrent effects on other causes of child morbidity and mortality are poorly understood. We tested the hypothesis that improved housing is associated with reductions in malaria, acute

respiratory infection (ARI), non-malaria fever and diarrhea disease in Nagongera, Uganda. Data were analysed from a cohort study that followed all residents (n=531) of 80 randomly selected households for 24 months from October 2017 to October 2019.Houses were classified as modern (cement, wood, or metal walls, tiled or metal roof, and closed eaves) or traditional (all other homes). Associations will be presented between house type and human biting rate(HBR) and proportion of blood fed *Anopheles*(BFA) (measured every two weeks using CDC light traps in all rooms where participants slept),and between house type and malaria parasitemia, incidence of ARI, incidence of non-malaria fever and incidence of diarrhea disease (measured every four weeks using active surveillance for all enrolled participants).The findings of this study will provide important insight into the potential health benefits of housing improvements beyond reductions in malaria in rural Sub-Saharan Africa.

**ABS-44**

## Habitat and seasonality affect mosquito community composition in the west region of Cameroon

Marie Paul Audrey Mayi [1,*] , Roland Bamou [1,2] , Borel Djiappi-Tchamen [1,2], Albin Fontaine [3,4,5], Claire L. Je_ries [6], Thomas Walker [6], Christophe Antonio-Nkondjio [2], Anthony John Cornel [7] and Timoléon Tchuinkam [1]

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**Background & Objective:** Given the lack of studies looking at the mosquito composition after urbanisation in western Cameroon, we undertook an entomological survey to identify potential sylvatic, urban and bridge-vector species that could potentially play a role in current or future virus spillover from wild to more urbanised areas.

**Materials & Method:** Entomological field surveys were conducted in rural, peri-urban and urban areas spanning the rainy and dry seasons in western Cameroon, by collecting immature stages in available breeding sites and using sweep nets to catch mosquito adults resting on vegetation. Immature stages were reared to adults before identification. Morphological identification of mosquito adults was done using stereomicroscopes and morphological identification keys of Edwards (1941) and Jupp (1996).

**Results & Discussion:** A total of 2650 mosquitoes belonging to 37 species and eight genera were collected. Mosquito species richness was significantly influenced by the specific combination of the habitat type and the season. The highest species richness was found in the peri-urban area (S = 30, Chao1 = 121±50.63, ACE = 51.97±3.88) during the dry season (S = 28, Chao1 = 64±25.7, ACE = 38.33 ±3.1). *Aedes (Ae.) africanus* and *Culex (Cx.) moucheti* were only found in the rural and peri-urban areas, while *Cx. pipiens* s.l. and *Ae. aegypti* were only found in the urban area. *Cx. (Culiciomyia)* spp., *Cx. duttoni* and *Ae. albopictus* were caught in the three habitat

types. Importantly, approximately 52% of the mosquito species collected in this study have been implicated in the transmission of diverse arboviruses.

**Conclusion & Recommendation:** This entomological survey provides a catalogue of the different mosquito species that may be involved in the transmission of arboviruses. Further investigations are needed to study the vectorial capacity of each mosquito species in arbovirus transmission.

**Keywords:** emerging vector-borne diseases; arboviruses; mosquito-vectors; urbanisation; Dschang; Cameroon

**ABS-136**

## Longitudinal monitoring of malaria vector populations in three sites in the democratic republic of congo to determine vector dynamics and annual malaria risk.

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The U.S. President's Malaria Initiative (PMI) VectorLink Project conducted entomological monitoring in the Democratic Republic of Congo (DRC) from January to December 2020. The project conducted monthly longitudinal monitoring of malaria vector biting rates, resting densities, and entomological inoculation rates (EIRs) in three sites (Lodja, Kimpese, and Inongo). Indoor resting densities were determined using pyrethrum spray catch (PSC) collections, and human landing catches (HLC) were undertaken indoors and outdoors to determine malaria vector biting rates. Further, molecular analyses were conducted at the Institut National de Recherche Biomedicale (INRB) to determine the composition of *Anopheles* species collected by HLCs. To support the generation and use of high quality entomological data, the DHIS2-based VectorLink Collect programs for entomological data management were developed and used in DRC for the first time in 2020.

All entomological data collected in DRC in 2020 was managed within VectorLink Collect. The platform includes comprehensive dashboards to synthesize vector bionomics and insecticide resistance summary results. In 2021, stakeholders including the National Malaria Control Program (NMCP), INRB and PMI, will have ongoing access to these results dashboards to support timely decision-making.

*Anopheles gambiae* s.l. was the predominant malaria vector throughout the year in Lodja and Inongo, with *An. funestus* the predominant species collected in Kimpese. The abundance in all sites of *Anopheles* species was greater by HLC (88%: 13,831/15,718) than by PSC (12%: 1,887/15,723). This indicates that *An. gambiae* s.l. and *An. funestus* s.l. exit houses early in the morning (before PSC sampling which started at 6 a.m.). Biting rates of *An. gambiae* s.l. were particularly high in Lodja throughout the year and much lower in Inongo. In Lodja, the mean *An. gambiae* s.l. biting rate was 17 bites per person per night indoors and 35 outdoors, with a malaria sporozoite rate of 2.29% (55/2,400). This equates to an annual EIR of 218 infectious bites per person in Lodja. In Inongo, the mean *An. gambiae* s.l. biting rate was low at 0.54 bites per person per night indoors, with a sporozoite rate of 1.9% (2/104). This gave a much lower EIR of 3.8 infectious bites per person per year. In Kimpese, the mean *An. gambiae* s.l. sporozoite rate was 2.94% (33/1,124), and the annual *An. gambiae* s.l. EIR was 63 infectious bites per person per year. Also in Kimpese, the mean *An. funestus* s.l. biting rate was 21 bites

per person per night indoors and 22 outdoors, with a malaria sporozoite rate of 2.5% (6/240), giving an annual *An. funestus* s.l. EIR of 194 infectious bites per person per year. Combining data for both malaria vector species, gave an annual EIR of 257 infectious bites per person per year in Kimpese. The results highlight that there is an extremely high year-round malaria transmission risk in Lodja and Kimpese. They also show that there is heterogeneity across the country, with Inongo in southern DRC having a relatively low transmission risk

Molecular results showed that *An. gambiae s.s.* was the predominant species collected (99% of samples) in Kimpese. In Lodja and Inongo, there were sympatric populations of *An. gambiae s.s.* and *An. coluzzii*, with *An. gambiae s.s.* the most common species collected in both sites. Samples from monthly HLCs in Lodja, Kimpese, and Inongo showed no clear seasonal variation in species composition.

The climate of Lodja province in central DRC is particularly favorable for the proliferation of malaria vectors, with year-round high temperatures and only a short dry season. *An. gambiae* s.l. biting rates were high in this province throughout the year. The annual EIR of 218 infectious bites per person per year in Lodja and 257 infectious bites per person per year in Kimpese highlight the extremely high year-round malaria transmission risk in these provinces. However, the EIR was far lower in Inongo due to low biting rates of *An. gambiae* s.l. In high transmission areas such as Lodja and Kimpese, multiple interventions in addition to ITNs may need to be considered in order to have a significant impact on malaria transmission.

**Keys words**: VectorLink Collect, DHIS2, *Anopheles*, Democratic Republic of Congo

**ABS-171**

## Malaria vector surveillance in Central and Southern Malawi

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**Background:** Malaria is still a public health problem in Malawi despite wide coverage and use of vector control interventions. Malaria transmission can be sustained by one vector or several vectors consisting of primary and secondary vectors in an endemic setting. Primary vectors of malaria in Malawi are widely documented while secondary vectors remain unknown. The study evaluated the transmission potential of minor anopheline species in Malawi.

**Methods:** A longitudinal mosquito survey was carried out in Ntwana and Kamwendo villages in Chikwawa and Dedza districts, respectively. Mosquito sampling was conducted for eight months from August 2019 to March 2020 using traps indoors (Prokopack and CDC light traps) and outdoors (pit shelters and CDC light trap). Polymerase Chain Reaction (PCR) was used to identify sibling species within *Anopheles* species complexes and identify origin of blood meals. Sporozoites were detected using ELISA.

**Results:** A total of 31423 anophelines were collected, predominantly *Anopheles funestus* and *Anopheles gambiae* accounting for 16448 and 14332 respectively. Of the anophelines, 643 were potential secondary vectors which included 276 (43%) *An. tenebrosus,*173 (27%) *An. coustani*, 136 (21%) *An. pretoriensis*, 27 (0.08%) *An. pharoensis*, 30 (4%) *An. maculipupis*, and 1 (0.1%) *An. rufipes*. A total of 77 minor anophelines were tested for blood meals of which 32 had blood sources successfully identified. *An. squamosus* (n=2), *An. tenebrosus* (n=2) and *An. maculipalpis* (n=7) fed on both human and cattle. All tested *An. pharoensis* (n=1), *An. coustani* (n=5) and *An. rufipes* (n=1) fed exclusively on cattle. Molecular assays to detect sporozoites is currently underway.

**Conclusion:** This study provided an updated account of anophelines in Malawi. *An. Squamosus,An .tenebrosus* and *An. maculipalpis*may play a potential role in transmission of malaria as it was found to feed on humans. Data on sporozoite infection will provide information on the role of minor anophelines as secondary vectors.

**ABS-98**

## Validating entomological methods for evaluation of vector control tools

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The use of standard operating procedures (SOPs) allows us to produce robust, reproducible, and comparable data, which is operationally valuable when examining the efficacy and durability of vector control tools. As novel products are established, having a clear consensus on the methods used to evaluate them will facilitate their movement through the development pipeline and be vital to monitoring their effective longevity. The introduction of new AIs and product classes is exacerbating the methodological shortcomings that already exist in evaluation of vector control tools. Several products that are currently undergoing evaluation rely on entomological effects that differ from the pyrethroids' fast acting knockdown. There is little consensus on the methods used to monitor performance of these entomological effects, and although a lot of data is being generated, a lack of validated methodologies to provide comparable data could delay evaluation of these tools. Working with partners in local institutions, we are collating and interrogating methodologies currently in use to produce a set of consensus SOPs for methods such as mosquito strain characterisation and next-generation net durability testing. These 'consensus SOPs' have been internally and externally validated and are designed to be practical and manageable in an operational setting.

**ABS-99**

## Three consecutive years monitoring of malaria vector transmission in Kénieroba rural village in Mali.

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Malaria remains a real public health problem in Mali despite the great progress made in the control of this disease over the past decade. Vector transmission is the main way of malaria infections in endemic areas as Mali. The aim of this study was to monitor malaria vector transmission during three consecutive years in the rural village of Kénieroba. Repetitive monthly survey was carryout throughout 2016 to 2018 to determine annual and seasonal variation of Entomological Inoculation Rate (EIR). Sampling was based on the collection of Anopheles mosquitoes in human dwellings using mouth aspirators. A total of 5430 *Anopheles* were collected among them 1605 *An. gambiae* s.l. The PCR identification show that, 95.5% are *An. coluzzii*; followed by 2.5% *An. arabiensis*; 1.3% *An. gambiae* and 0.7% hybrids (M/S). A positive correlation between density and rainfall was found (R=0.7459 ; Spearman r). Human biting rate was highest in the rainy season. *An. gambiae* s.l. was more than 50% anthropophilic. *An. arabiensis* and hybrids (M/S) were present in both dry and wet seasons with different proportions. However, *An. gambiae* was more present in the rainy season. Infections were observed in the rainy season and also in dry season. The average Entomological Inoculation Rate in 2016, 2017 and 2018 was respectively 3.8; 5.3 and 2.6 bite/human/year. This study shows that, malaria transmission is stable and permanent through the year with *An. coluzzii* and *An. Arabiensis* as major vectors in the study area.

**Key words:** Malaria transmission, *Anopheles gambiae s.l.*, EIR, seasonality.

**ABS-236**

## Estimating the variability of Anopheles bionomics and its impact on malaria transmission with a Bayesian hierarchical model

Jeanne Lemant

**Background:** Locality-specific information is generally unavailable on how the bionomics of *Anopheles* mosquitoes affect the vectorial capacity for malaria, or on the vulnerability of local vectors to different vector control methods. To address this, we estimated geography-, time- and species-specific survival and behavioral parameters of *Anopheles* mosquitoes using the Malaria Atlas Project's global database of bionomics data.

**Methods:** A sensitivity analysis using an existing mathematical model of the impact of vector control was used

to determine which bionomics parameters are most influential. We then applied inclusion and exclusion criteria to select subsets of studies with relevant experimental designs that minimize bias from collection methods for parous, endophagy, and endophily rates. We performed a meta-analysis by fitting a Bayesian hierarchical model with levels based on *Anopheles* taxonomy. The resulting algorithm can be applied automatically to select relevant data for a specific country.

**Results:** Using 26 studies, we found a mean endophagy rate of African vectors of 46 ± 6%, with high inter-species variability: on average, 35 ± 3% of *Nili* complex and 66 ± 0.4% of *Anopheles arabiensis* mosquitoes bite indoors. Location is also highly influential: 67 ± 0.5% of *Anopheles arabiensis* bite indoors in East Africa, but only 39 ± 3% in West Africa. There were 30 studies reporting numbers of resting mosquitoes in Africa, but only four allowed to compare indoor- and outdoor-resting numbers by using both window traps and pyrethrum spray catches. With so few studies, estimating endophily is challenging.

**Conclusions:** The model allows extrapolation of knowledge on Anopheles bionomics and quantification of variability between species and geographies. The dataset can be readily augmented with more additional data, but there is still a need for more frequent and standardized entomological data collections to understand local behaviors of malaria vectors.

**ABS-91**

## Key findings of a global landscape analysis on entomological surveillance best practices

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**Background:** Entomological surveillance is essential for understanding baseline vector species, population dynamics, and bionomic traits as well as the suitability and potential efficacy of an intervention strategy. Yet despite the documented and growing recognition of the importance of entomological surveillance in malaria control and elimination, it remains neglected with critical gaps persisting in guidance, implementation, analysis and use for policy and decision-making. Thus, in 2020 the University of Notre Dame and UCSF's Malaria Elimination Initiative undertook a global landscape analysis to identify, validate, and document best practices in entomological surveillance.

**Methods:** The landscape analysis combined desk-based methods (document review) with semi-structured key informant interviews (KIIs) among stakeholders at global, regional, national, and subnational levels. KIIs explored a range of topics, including governance, prioritization, and funding of entomological surveillance; entomological surveillance activities, methodologies, and indicators; data collection, analysis, and use in decision-making; technical and operational capacities; and partnerships with local academic and research institutes.

**Results:** A total of 29 KIIs were conducted between March and August 2020 with respondents representing diverse geographies and all transmission settings (control, elimination, POR). Common themes emerged across respondents, and key best practice findings included: use of entomological surveillance to answer priority program questions; inclusion of trained entomologist at highest level of governance; internal and external advocacy for entomological surveillance; partnerships with in-country research or academic institutes; trainings and established career paths for entomologists; and clear reporting lines and responsibilities, among many others.

**Conclusion:** Best practices emerging from the landscape analysis can guide future policy, practices, and investments in entomological surveillance for malaria control and elimination. Successful adoption of the identified best practices can help prioritize, improve, and expand entomological surveillance towards increased use of the data in decision-making on vector control interventions.

**ABS-131**

## Insecticide resistance in the Anopheles gambiae complex – analysis of whole-genome sequence data from 19 countries and three mosquito species

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**Background:** Insecticide resistance continues to pose a major challenge for malaria vector control. Gathering molecular data on insecticide resistance in different vector species and countries is increasingly important, as new LLIN and IRS products involving different combinations of insecticides are deployed, and insecticide resistance management programmes search for the best ways to use them and maintain their efficacy.

**Methods:** We sequenced whole genomes of 2,784 wild-caught mosquitoes from 19 countries, including Anopheles gambiae, An. coluzzii and An. arabiensis. We compared sequence data from different individuals to identify single nucleotide polymorphisms (SNPs) and copy number variants (CNVs) and phase variants into haplotypes. We then analysed genetic variation within known insecticide resistance genes, and performed genome-wide selection scans to identify previously unknown insecticide resistance genes.

**Results:** Relevant to pyrethroid target-site resistance, we report protein-altering SNPs in the voltage-gated sodium channel gene. Of concern, we find a variety of double- or triple-mutant kdr haplotypes at high frequency, with both shared and unique variants in different species and regions. Relevant to pyrethroid metabolic resistance, CNVs in cytochrome P450 genes are at high frequency in West and East Africa, occurring together with kdr variants.

Relevant to organophosphate (OP) resistance, CNVs in the Ace1 gene are common in West Africa, and CNVs in Gste genes are common in East Africa. The presence of these OP resistance markers predates the use of Actellic for IRS.

Finally, three novel candidate insecticide resistance genes are under strong selection in multiple populations. One of these (Keap1) has a potential link to pyrethroid resistance and two (Coeae2f, Rdga) have potential links to OP resistance.

**Conclusions:** These data provide the most comprehensive view to date of insecticide resistance adaptations across malaria vector populations in the gambiae complex, and provide a foundation for ongoing genomic surveillance to detect and track new resistance variants as they emerge.

**ABS-177**

## Entomological impact of indoor residual spraying with clothianidin in Balaka district, Malawi

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**Background:** Indoor residual spraying (IRS) is used for the prevention of malaria in endemic districts in Malawi. IRS was implemented for the first time in Balaka district in November 2020. Entomological surveillance was carried out in sentinel sites across Balaka to monitor the impact of spraying Sumishield 50WG (clothianidin).

**Methods:** Indoor resting densities and longevity of the insecticide were monitored from November 2020 to April 2021. Monthly mosquito catches were performed using CDC light traps and pyrethrum spray catches (PSCs). Human Landing Catches (HLCs) were performed once every three months. WHO wall cone bioassays were performed monthly in houses with brick, mud or cement wall surfaces. A susceptible strain of *An. gambiae* Kisumu aged between 2 – 5 days were used in bioassays. Mortality was observed for seven consecutive days after exposure.

**Results:** A total of 302 *Anopheles* species were captured using light traps comprising of *An. gambiae* s.l. (58.3%), An. *funestus* s.l. (30.1%), *An. pretoriensis* (9.3%) and *An. tenebrosus* (2.3%). Of the147 *Anopheles* samples captured from PSCs, 69.4% were *An. gambiae* s.l., while 30.6% were *An. funestus* s.l. No anophelines were captured using HLC. Sumishield 50WG showed high residual activity (mortality at 100%) for four months after spraying on all the surfaces (cement, brick and mud).

**Conclusion:** Clothianidin was found to be effective in Balaka district and suppressed *Anopheles* densities five months after IRS. The insecticide has a long residual efficacy and is a good candidate for IRS.

**ABS-164**

## Human-biting activity and human exposure indices of major malaria vectors in Malawi

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**Background:** Malaria transmission persists in areas with wide coverage of treated bednets in Malawi. There is a need to better understand indoor and outdoor transmission and human behaviours that facilitate exposure to vector bites. This study sought to determine the biting patterns and human exposure indices of major malaria vectors in Malawi.

**Methods:** Mosquito and human behaviour surveys were carried out in villages in Chikwawa and Dedza districts. Mosquitoes were collected using Human Landing Catches (HLC) over a period of eight months between August 2019 to March 2020. HLC was conducted from 5pm till 11 am. Human behaviour data was collected during cross-sectional surveys performed once during the dry (October 2019) and rainy season (March 2020). Questionnaires were administered to participants to assess times and activities carried out indoors and outdoors.

**Results:** A total of 9,822 anophelines were caught across the study sites. *Anopheles arabiensis* (91%) was the major vector in Dedza and *An. funestus* (99%) in Chikwawa. The Human biting rate (HBR) of *An. funestus* was 3.2 bites/person/night in Chikwawa and *An. gambiae* 13.2 bites/person/night in Dedza. The biting activity of *An. arabiensis* was higher outdoors than indoors (OR=1.04, CI=[1.046-1.048], P<0.001). *An. funestus* was most likely to bite indoors compared to outdoors (OR=1.12, CI=[1.11-1.13], P<0.001). Taking into account human behaviour, exposure to *An. funestus* bites for non-bednet users mainly occurred indoors (95 – 99% in Chikwawa and 90 - 95% in Dedza) across seasons. Exposure to *An. arabiensis* bites indoors and when people were asleep was between 92% and 96% in both districts. Treated bednets were estimated to offer >70% protection against *Anopheles* bites for users (78% in Chikwawa and 74% in Dedza).

**Conclusion:** Malaria transmission primarily occurs indoors at night when people are asleep in Chikwawa and Dedza. Use of bednets should be prioritized in both districts.

**ABS-182**

## Maintaining *Anopheles gambiae* s.l. mosquitoes using an artificial membrane feeding technique at Vestergaard-NMIMR Vector Labs, Ghana.

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**Background:** Many hematophagous insects require a blood meal to product eggs. Artificial membrane feeding is a way of supplying blood meals to female anopheline mosquitoes that provides an alternative to direct feeding on live animals. Advantages of membrane feeding are that it allows more flexibility and control of the blood meal and it is more humane than direct feeding. The membrane feeding apparatus and conditions should simulate direct feeding on an animal, to match the adapted feeding mechanism of the female mosquito. The Vestergaard-NMIMR Vector Labs (VNVL) in Ghana produces over a million mosquitoes every year for bio-efficacy testing of current and new vector control products. The aim of this project was to transition VNVL colonies from direct feeding to membrane feeding.

**Methods:** Three to five days old female *Anopheles gambiae* s.l. mosquitoes were used. Mosquitoes were bloodfed using the Hemotek feeding apparatus with a parafilm membrane and sheep blood. Mosquitoes were starved for 1.5 hours prior to feeding, the parafilm was rubbed with human sweat, and the sheep blood was held at 33±2°C to encourage probing. The feeder was set up and placed on the cage for about 30 minutes to allow the female mosquitoes to feed.

**Results:** Majority of the susceptible mosquito colony is now produced using this technique. The larval pupation rate for this colony ranges from 7 - 11 days at 27°C. Mosquitoes produced using artificial membrane feeding are within normal size for *An. gambiae* (wing length ranging from 2.67 – 2.95mm). The artificial membrane feeding method has been used successfully for three years at VNVL and the mass rearing protocols have been effective.

**Conclusion:** Membrane feeding is a cost-effective, efficient, and humane method of meeting the nutritional requirement of laboratory colonized mosquitoes. After adaptation by the colony, the method has been successfully implemented at VNVL.

**ABS-200**

## High insecticide resistance in the main Malaria Vector *An. gambiae* s.l. is challenging vectors control in Yaoundé Cameroon before and during larval control intervention and its relevance for future malaria control.

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**Introduction:** Insecticide resistance has emerged as one of the major challenges affecting malaria vector control in Africa. The present study aimed to update data relating to insecticide susceptibility and to determine the molecular basis of resistance involved in *An. gambiae* populations to insecticides before and during larval control intervention in the city of Yaoundé Cameroon with larviciding as an additional tool for managing resistance and malaria transmission.

**Methods:** Bioassays were conducted on 3-5-day-old adult *An. gambiae* s.l. mosquitoes reared from larval collections to 07 insecticides belonging to the four insecticide classes for susceptibility test in 32 districts of the city of Yaoundé Cameroon before and during larval control intervention with larviciding between 2017 and 2019. The molecular mechanisms of mosquito resistance to these insecticides were investigated using Taqman assay. The voltage-gated sodium channel region of mosquitoes was also screened for the presence of knockdown resistance mutations (kdr west and east) by Taqman method. WHO´s susceptibility bioassays with synergist PBO were carried out to assess the implication of detoxifying enzymes in the production of resistant phenotypes. Resistance intensity and molecular identification of mosquitoes was also conducted.

**Results:** *An. Coluzzii* was predominant in Yaoundé, followed by *An. gambiae* s.s.. Resistance to pyrethroids, organochlorines and carbamates was persistent before and during larval control treatments with vectomax G suggesting that there was no significant variation of resistance mechanisms found in *An. gambiae* s.l. strains in Yaoundé. Interestingly, the demonstration of susceptibility against organophosphate compounds suggests that insecticides of this class can be used for controlling malaria transmission and elimination. Our results revealed a metabolic resistance and resistance associated with a mutation of the sodium voltage-gated channel gene at position 1016.

**Conclusion:** The present study showed rapid evolution of insecticide resistance in vector populations and the challenges that control programs face to maintain the continued effectiveness of insecticide-based interventions.

**Keywords**: Vector control; larviciding; *Anopheles gambiae*; insecticide resistance; resistance mechanism; Cameroon

**ABS-90**

## Transgenerational effects in life history traits and malaria infection induced by insecticide sub-lethal exposure in the mosquito *Anopheles gambiae*

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**Background:** Mosquitoes can alter their behaviour and life-history traits in response to insecticide exposure in two different ways: through short-term phenotypic change or longer-term genetic selection. While this latter process has been well documented in malaria mosquito populations, including the emergence of hereditary physiological and behavioural insecticide resistance, the proximate effects of insecticide exposure are less understood. As increasing numbers of resistant mosquitoes can survive insecticide exposure in the field, it is essential to understand if changes in life-history traits induced by insecticides could influence vector-borne disease transmission. This work investigated if the maternal transgenerational effects of a sub-lethal insecticide exposure alter the fitness and susceptibility to *Plasmodium falciparum* of *Anopheles gambiae* malaria mosquitoes.

**Methods:** Three day old *An. gambiae* females were blood fed and immediately exposed to a sublethal dose of permethrin (0.3%) or control for one hour, using a standard WHO tube, then after three days allowed to lay eggs. Larvae of the two groups were then reared under the same standardized conditions. Emerging female adults were fed with either *Pl. falciparum* infected or uninfected blood and immediately exposed to a sublethal dose of permethrin (0.3%) or control. Larval and adult survival, developmental time, fecundity and malaria infection prevalence and intensity were measured. Generalized linear mixed models and cox-proportional hazard models were used to analysed the data.

**Results:** Exposure to insecticide just before a blood meal influenced fecundity, and decreased both larval survival and developmental time, with no effects on the body size of the emerging adult females. The adult progeny of insecticide exposed or control mothers showed no difference in survival upon insecticide exposure, however, maternal insecticide exposure significantly altered their fecundity and susceptibility to malaria.

**Conclusions:** These results show that insecticide exposure in adult female mosquitoes influence larval development and survival, as well as the response of the progeny to subsequent insecticide exposure and malaria infection. These evidences will be discussed in light of potential changes in the vectorial capacity of mosquito populations under continuous insecticide exposure in the field.

**ABS-125**

**Exposure to pyrethroid nets reduces blood feeding efficiency and longevity in resistant mosquitoes.**

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The need to determine the full extent of the impact on *Anopheles* of exposure to insecticide-treated nets (ITNs) is widely recognized. We investigated the effects of PermaNet® 2.0 (P2), PermaNet® 3.0 (P3) and Olyset ITNs on individual *Anopheles gambiae* s.l. mosquitoes, during and after bloodfeeding on human skin. First, using "cup assays", highly resistant mosquitoes from Côte d'Ivoire were allowed to feed through a P2, P3 or untreated net (UtN) for 5min and we measured time spent on the net, feeding success, bloodfeeding duration and longevity after exposure. Second, using a "baited box", we measured behavioural events and blood volume ingested by pyrethroid susceptible and resistant laboratory strains feeding through P2, Olyset or UtN. In cup assays, blood feeding increased longevity by 25%, which is positively correlated with the time spent on the net. However, an exposure to a P2 reduced the blood feeding success as well as the times spent on the net and bloodfeeding. In the second experiment, ITNs reduced feeding success by 40% and increased the number of landings. With resistant mosquitoes, the presence of insecticide delayed the start of bloodfeeding and reduced bloodmeal duration by 2.5 and 1.5 min at P2 and Olyset respectively. The volume of blood ingested was reduced in proportion to the bloodmeal duration. Thus, although extremely resistant mosquitoes do not die within 24 hours of ITN exposure, multiple less apparent effects can also impact on vectorial capacity. Protocols that capture these and other potential impacts are essential if we are to manage insecticide resistance in African vector populations using the next generation of ITNs.

ABS -232

**VECTRON T500 (broflanilide) a new meta-diamide insecticide for indoor residual spraying, shows prolonged efficacy against pyrethroid-resistant malaria vectors**

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## Background

The rotational use of insecticides with different modes of action for indoor residual spraying (IRS) is recommended for improving malaria vector control and managing insecticide resistance. Insecticides with new chemistries are urgently needed. Broflanilide is a newly discovered insecticide under consideration.

## Method

We investigated the efficacy of a wettable powder (WP) formulation of broflanilide (VECTRON T500) for IRS on mud and cement walls against wild pyrethroid-resistant malaria vectors in Covè, Benin. The trial lasted 12 months. Monthly wall cone bioassays were performed to assess the residual efficacy of the insecticide. CDC bottle bioassays were also performed to investigate cross-resistance to pyrethroids and broflanilide in the local vector population.

## Results

There was no evidence of cross-resistance between pyrethroids and broflanilide. At application rates of 100 mg/m$^2$, overall mortality over 12 months of wild pyrethroid-resistant *An. gambiae* sl entering experimental huts in Covè, Benin treated with VECTRON T500 (53% - 63%) was generally similar to Actellic 300CS CS (53%), regardless of wall substrates. Initial wild mosquito mortality rates in VECTRON T500 huts were steady, lasting up to 9 months. Monthly *in situ* wall cone bioassay mortality of susceptible and pyrethroid resistant *An gambiae* mosquitoes was > 80% for over 18 months with VECTRON T500 irrespective of the substrate *vs* 6-7 months with Actellic 300CS.

## Conclusion

IRS with broflanilide shows potential to significantly improved and prolonged control of malaria transmitted by pyrethroid-resistant mosquito vectors and could thus be a crucial addition to the current portfolio of IRS insecticides.

**ABS-77**

## Polymorphism analysis of CYP6M2, a main metabolic resistance gene in *Anopheles gambiae* from Yaoundé, Cameroon

Fotso Gaétan, TY

**Background:** The rapid spread of insecticide resistance in malaria vectors populations is reducing the effectiveness of control tools. Elucidating the molecular basis of this resistance is vital to improve vectors control. However, despite playing a major role, metabolic resistance remains poorly characterised. Here, we analysed the polymorphisms of the cytochrome-P450 *CYP6M2* in *An. gambiae* to detect potential resistance markers.

**Method:** Larval collection was carried out from November to December 2019 in Yaoundé and bioassays were performed to determine the resistance profile. Permethrin survivors were crossed with susceptible lab-strain and F4 individuals were then segregated into highly resistant (HS) and highly susceptible (HR) mosquitoes. The *CYP6M2* gene and upstream region of F4 were both sequenced for polymorphism analysis.

**Results:** High levels of permethrin resistance were observed in field-caught mosquitoes with a low mortality rate of 3.97±1.96% and a partial recovery of susceptibility after PBO pre-exposure, with increased mortality to 21.33±4.38%, suggesting an implication of P450-based metabolic resistance. These was correlated with the result of RT-qPCR which revealed an 8.30-fold overexpression of *CYP6M2* in field permethrin-resistant compared to susceptible lab-strain. The analysis of 930 bp fragments of upstream region revealed low polymorphism in HR (Hd=0.2) and HS (Hd=0.3) defining 2 haplotypes. The analysis of 1.5kb of full-gene showed 50 polymorphic sites, 11 haplotypes for HR against 53 polymorphic sites, 6 haplotypes for HS; with one non-synonymous mutation *A392S* (coding region). This mutation was found more in HR ($392S_{frequency}$=71,43%) than HS (57,14%) A designed AS-PCR assay did not revealed significative association between this *Cyp6m2-A392S* and pyrethroid resistance (OR=1.708, P=0.085).

**Conclusion:** Significant differences were observed in the polymorphisms of the major metabolic resistance gene *CYP6M2* between resistant and susceptible mosquitoes in Cameroon. However further work is needed to determine the causative variants which will help design molecular assay to track resistance in the field.

**ABS-152**

## CYP6P9-Driven Signatures of Selective Sweep of Metabolic Resistance to Pyrethroids in the Malaria Vector Anopheles funestus Reveal Contemporary Barriers to Gene Flow

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Pyrethroid resistance in major malaria vectors such as *Anopheles funestus* threatens malaria control efforts in Africa. Cytochrome P450-mediated metabolic resistance is best understood for CYP6P9 genes in southern Africa *in An. funestus*. However, we do not know if this resistance mechanism is spreading across Africa and how it relates to broader patterns of gene flow across the continent. Nucleotide diversity of the CYP6P9a gene and the diversity pattern of five gene fragments spanning a region of 120 kb around the CYP6P9a gene were surveyed in mosquitoes from southern, eastern and central Africa. These analyses revealed that a Cyp6P9a resistance-associated allele has swept through southern and eastern Africa and is now fixed in these regions. A similar diversity profile was observed when analysing genomic regions located 34 kb upstream to 86 kb downstream of the CYP6P9a locus, concordant with a selective sweep throughout the rp1 locus. We identify reduced gene flow between southern/eastern Africa and central Africa, which we hypothesise is due to the Great Rift Valley. These potential barriers to gene flow are likely to prevent or slow the spread of CYP6P9-based resistance mechanism to other parts of Africa and would to be considered in future vector control interventions such as gene drive.

**ABS-45**

## A 6.5kb intergenic structural variation exacerbates fitness cost of P450- metabolic resistance in the major African malaria vector *Anopheles funestus*

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### Abstract

Insecticide resistance limits the control of medically important pests and is extremely detrimental in the on going struggle to control or eradicate vectors of diseases. Elucidating the fitness cost of metabolic resistance in malaria vectors is of a great importance for insecticide resistance management. Using the hybrid strain obtained from the crossing between two *An. funestus* laboratory strains, we evaluated the fitness cost of the 6.5kb structural variant between the duplicated CYP6P9a/b P450s. Furthermore, we assessed the cumulative impact of this marker with the duplicated P450 genes. We established that resistant individuals homozygote resistant for the SV presented reduced fecundity and slow development than susceptible. Furthermore, this marker combined with *CYP6P9a* and *CYP6P9b* to additively exacerbate the reduced fecundity and increased development time of resistant mosquitoes since double/triple homozygote susceptible (SS/SS/SS) significantly laid more eggs and developed faster than other genotypes. Moreover, an increased proportion of susceptible individuals was noted over 10 generations in the insecticide-free environment. This study highlights the negative impact of P450-resistance on various life-traits of *An. funestus* which is enhanced by the SV. Such negative impact is very important against the maintenance and dispersion of the resistant individuals in the field. This should, therefore, encourage future strategies based on the rotation of insecticides to reduce the selection pressure and slow the spread of pyrethroid resistance.

**Keywords:** Malaria, *Anopheles funestus,* vector control, metabolic resistance, cytochrome P450, and fitness cost

**ABS-267**

## Short-term metabolic resistance inductive effect of different agrochemical groups on *Anopheles gambiae* mosquitoes

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**Context:** In order to assess the impact of the different groups of agricultural pesticides used in Côte d'Ivoire on the increase of mosquitoes resistance to insecticides, the expression profiles of 7 P450 cytochromes and one GSTE2 of *Anopheles gambiae* involved in mosquito resistance to insecticides were studied.

**Methods:** Three groups of pesticides were selected: The first group is composed of agricultural insecticide solutions, the second is made up of none-insecticide pesticide solutions (a mixture of herbicides and fungicides) and the third group is made up of a mixture of the first two. A fourth non-pesticide solution was used as a control. Four groups of each stage 2 larvae were exposed to 20% concentrated solution for 24 hours. Susceptibility tests for DDT and Deltamethrin were carried out on adults aged 2-5 days. RT-qPCR was performed to quantify the expression of eight metabolic genes involved in mosquito resistance to insecticides.

**Results:** Tests susceptibility to DDT showed a similar increase in the time required to down 50% of mosquitoes ($kdt_{50}$) in l colonies exposed to insecticides and none-insecticides compared to the control colony. As for deltamethrin, $kdt_{50}$ was higher in the colonies exposed to insecticides and the pesticide mixture compared to the colony exposed to none-insecticides. Of all the genes studied in all colonies, except for CYP6P1 induced only in the colony consisting of the pesticide mixture, no genes were induced.

**Conclusion:** This study confirmed that induction is influenced by the duration, the concentration of the solution and the type of xenobiotic used as an inducer. The overexpression of CYP6P1 confirmed the inductive effect that a short exposure of mosquito larvae to agricultural pesticides could have.

**ABS-183**

## Putative pleiotropic effects of the knock-down resistance (L1014F) allele on the life-history traits in *Anopheles gambiae*

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**Background**: Existing mechanisms of insecticide resistance have been known to help the survival of mosquitoes following contact with chemical compounds, even though they could negatively affect the life-history traits of resistant malaria vectors. In West Africa, the knock-down resistance *kdr*$^{R}$ (L1014F) is the most common. However, little knowledge is available on its effects on mosquito life traits. We investigated the fitness effects associated with this resistance allele in *Anopheles gambiae sensu stricto* (*s.s.*).

**Methods**: Two laboratory strains of *An. gambiae s.s.,* Kisumu (susceptible) and KisKdr (*kdr* resistant) were used. Female mosquitoes were fed and allowed to lay eggs. Fecundity and fertility were assessed by examining the number of eggs per mosquito and larval hatching rates. Larval survivorship and pupation rates were also measured. Female mosquitoes of both strains were blood-fed through membrane feeding assays, then the feeding success, blood volume and adult survivorship were monitored.

**Results**: The KisKdr females showed lower ability to lay eggs. The mean number of larvae in Kisumu females was overall threefold higher than that seen in KisKdr females with significant difference in the hatching rates (81.89% in Kisumu vs. 72.89% in KisKdr, $p$= 0.003). KisKdr larvae had a significant higher larval survivorship than Kisumu. The blood feeding success was significantly higher ($p$= 2.2.10$^{-16}$) in the resistant mosquitoes (84%) than that in susceptible ones (34.75%). However, the mean blood volume was 1.36 µL/mg, 1.45 µL/mg and 1.68 µL/mg in Kisumu, homozygote and heterozygote KisKdr respectively. After blood meal, the heterozygote KisKdr displayed highest survivorship when compared to that of Kisumu.

**Conclusions**: The presence of *kdr*$^{R}$ (L1014F) allele tends to have an impact on *An. gambiae* life traits such as fecundity, fertility, larval survivorship and blood feeding behaviour. These data could help to guide the implementation of more reliable strategies for malaria vector control.

**Key words**: *kdr*$^{R}$ allele, fitness effects, life-history traits, *Anopheles gambiae*, malaria.

**ABS-278**

## Exploring the spread of metabolic (*GSTe2*) and target-site (*Rdl*) insecticide resistance alleles in *Anopheles funestus* vector populations across a major mountainous landscape (the Mount Cameroon)

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Increased levels of insecticide resistance in major malaria vectors such as *Anopheles funestus* threaten the effectiveness of insecticide-based control programmes. Understanding the landscape features impacting the spread of resistance makers is necessary to design suitable resistance management strategies. Here, we examined the influence of the highest mountain in West Africa (Mount Cameroon; 4095 m elevation) on the spread of metabolic and target-site resistance alleles in *An. funestus* populations. Vector composition varied across the four localities surveyed along the altitudinal cline with major vectors exhibiting high parity rate (80.5%). *Plasmodium* infection rates ranged from 0.79% (*An. melas*) to 4.67% (*An. funestus*). High frequencies of $GSTe2^R$ (67–81%) and $Rdl^R$ (49–90%) resistance alleles were observed in *An. funestus* throughout the study area, with $GSTe2^R$ frequency increasing with altitude, whereas the opposite is observed for $Rdl^R$. Patterns of genetic diversity and population structure analyses revealed high levels of polymorphisms with 12 and 16 haplotypes respectively for *GSTe2* and *Rdl*. However, the reduced diversity patterns of resistance allele carriers revealed signatures of positive selection on the two genes across the study area irrespective of the altitude. Despite slight variations associated with the altitude, the spread of resistance alleles suggest that control strategies could be implemented against malaria vectors across mountainous landscapes.

**ABS-173**

## Nationwide distribution of Acetylcholinesterase (Ace-1R) target site mutation G119S and resistance to carbamates and organophosphates in Anopheles gambiae s.l populations in Cameroon

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**Background**: Cameroon is considering the implementation of indoor residual spraying (IRS) as an alternative to control malaria in the context of high pyrethroids resistance in major vectors. Non-pyrethroids insecticide classes such as organophosphate and carbamate might be indicated for these IRS since both have never been used in public health in the country. The success of this strategy, however, depends, on a good knowledge of the resistance status of malaria vectors to carbamate and organophosphate across the country. In this study, we assessed the susceptible profile of *Anopheles gambiae s.l.* to carbamate and organophosphate and the distribution of the molecular mechanism underlying resistance to these insecticides.

**Methods**: *An. gambiae s.l.* mosquitoes were collected from 9 sites across the country and bio-assayed with bendiocarb, propoxur and pyrimiphos-methyl. The Ace-1 target site substitution G119S was genotyped using a Taqman assay.

**Results**: Pyrimiphos-methyl induced full mortality in *An. gambiae s.l.* from all study sites whereas for carbamate a full susceptibility, a suspected and confirmed resistance was observed in 2, 4 and 3 localities, respectively, with the lowest mortality rate recorded in Mangoum (17.78±5.02% for bendiocarb and 18.61±3.86% for propoxur) in the southern part of Cameroon. *An. coluzzii* was found to be the predominant species in the northern part of the country where it is sympatric with *An. arabiensis*, whereas in the southern localities, it was predominant in urban settings while *An. gambiae* was the most abundant species in rural areas. The Ace-1 target site substitution G119S was detected only in *An. gambiae* species and only in the sites located in southern Cameroon with the highest allelic frequency (0.36) found in Mangoum. The phylogenetic analyses of the ace-1 gene indicated that the G119S mutation has recently occurred in *An. gambiae s.l.* population from Cameroon.

**Conclusion**: The occurrence of the ace-1 target site substitution G119S in *An. gambiae s.l.* population highlights the challenge associated with the coming deployment of IRS in Cameroon using carbamate or organophosphate. It is therefore important to think about a resistance management plan including the use of other insecticide classes, to guarantee a successful implementation of IRS in Cameroon.

Keywords: Ace-1 G119S mutation, Insecticide resistance, *An. gambiae s.l.*, Cameroon,

**ABS-259**

## The Cytochrome P450 *CYP325A* is a major driver of pyrethroid resistance in the major malaria vector *Anopheles funestus* in Central Africa

Amelie Regine, WN.

The overexpression and overactivity of key cytochrome P450s (CYP450) genes are major drivers of metabolic resistance to insecticides in African malaria vectors such as *Anopheles funestus* s.s. Previous RNAseq-based transcription analyses revealed elevated expression of *CYP325A* specific to Central African populations but a role in conferring resistance has not previously been demonstrated. In this study, RT-qPCR consistently confirmed that *CYP325A* is highly over-expressed in pyrethroid-resistant *An. funestus* from Cameroon, compared with a control strain and insecticide-unexposed mosquitoes. A synergist bioassay with PBO significantly recovered

susceptibility for permethrin and deltamethrin indicating P450-based metabolic resistance. Polymorphism analyses of the coding sequence of *CYP325A* Africa-wide detected high-levels of polymorphism, but no predominant alleles selected by pyrethroid resistance. Geographical amino acid changes were detected notably in Cameroon. *In silico* homology modelling and molecular docking simulations predicted that *CYP325A* binds and metabolise type I and type II pyrethroids. Heterologous expression of recombinant CYP325A and metabolic assays confirmed that the most-common Cameroonian haplotype metabolises both type I and type II pyrethroids with depletion rate ~2-time that of the DR Congo. Analysis of the 1kb fragment of the promoter region revealed reduced diversity in resistant mosquitoes compared to susceptible ones, concordant with a selective sweep in this region. The establishment of *CYP325A* as a pyrethroid resistance-conferring gene explains pyrethroid resistance in Central African populations of *An. funestus.* Our work will facilitate future efforts to detect the causative resistance markers in the promoter region of *CYP325A* to design field applicable DNA-based diagnostic tools.

**Keywords:** *Anopheles funestus*, malaria, pyrethroids, metabolic resistance, cytochrome P450, *CYP325A,* Central Africa

**ABS-185**

## Understanding the long-term efficacy of permanet® 3.0 through post market surveillance

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**Background:** Pyrethroid-PBO LLINs are one of the core malaria prevention interventions targeted for deployment in areas of pyrethroid resistance. Given the different physicochemical properties of piperonyl butoxide (PBO) compared to pyrethroids, understanding the long-term durability including efficacy of pyrethroid-PBO LLINs is required. In addition to the long-term durability studies (former WHOPES Phase III studies) that were conducted in three countries, Vestergaard has conducted further monitoring of PermaNet® 3.0 under a post market surveillance programme.

**Methods:** Between 2015 and 2020, used PermaNet® 3.0 were collected from households in Nigeria, Equatorial Guinea, Sudan, Ethiopia, and Uganda 2-3 years following distribution. Chemical content analyses and bioefficacy testing were conducted based on the WHO guidelines for laboratory and field evaluation of LLINs. Samples from Uganda were tested further against a characterised resistant *Anopheles* lab strain with documented target site and metabolic mechanisms including P450 monooxygenase. New PermaNet® 3.0 and PermaNet® 2.0 were used as positive controls for tests with the pyrethroid resistant strain.

**Results:** From PermaNet® 3.0 collected through post market surveillance, deltamethrin content in PermaNet® 3.0 roof ranged from 1.8-3.5 g/kg while PBO content ranged from 3.5-8.6 g/kg. All samples passed the WHO optimal effectiveness criteria with susceptible mosquitoes. Used PermaNet® 3.0 were observed to kill 4.5 times more resistant mosquitoes than PermaNet® 2.0. Reduced mortality was reported compared to a new PermaNet® 3.0 indicating a reduction in efficacy over the lifetime of the net, but still significantly more efficacious than a pyrethroid-only net.

**Conclusion:** Chemical content and bioefficacy data from post market surveillance were in line with the long-term (former WHOPES Phase III) studies. Routine, long-term monitoring is essential for understanding the long-term efficacy of PBO nets. There is need to expand the current WHO guidelines to include testing with well characterised pyrethroid resistant strains in addition to guide post market surveillance.

**ABS-58**

## Potential efficacy of Piperonyl Butoxide (PBO) synergist on deltamethrin resistant anopheles mosquitoes in Namibia

**Background**: Routine insecticide resistance monitoring in endemic regions in Namibia in 2018-2020 confirmed widespread deltamethrin resistance of malaria vectors. This undermines effectiveness of indoor residual spraying (IRS) and long-lasting insecticidal nets (LLINs) based on pyrethroids. To meet this resistance challenge, the WHO recommended use of next-generation piperonyl butoxide (PBO) LLINs against pyrethroid-resistant mosquito populations in areas with confirmed pyrethroid resistance conferred partly by the monooxygenase-based resistance mechanism. These new nets combine pyrethroids and the synergist PBO that enhances the killing effect of pyrethroids against resistant mosquitoes. To inform selection of effective pyrethroid LLINs, the National Vector-borne Disease Control Program (NVDCP) aimed to determine the potential efficacy of PBO LLINs in Namibia by confirming persistence of pyrethroid resistance through involvement of monooxygenase-based resistance mechanism in mosquito populations in endemic regions.

**Methods**: Wild larvae were sampled from two endemic regions: Oshana and Oshikoto. Three to five day old $F_1$ female *Anopheles* mosquitoes that emerged from wild-caught larvae were subjected to WHO insecticide susceptibility tube assays. Batches of 20 female adult *Anopheles* mosquitoes were exposed simultaneously to deltamethrin (0.05%) alone, to PBO (4%) + Deltamethrin, PBO alone and an untreated control for 1 hour. Mortality was recorded after 24 hours.

**Results**: Deltamethrin alone induced 93.3% and 95.0% mortality in Oshana and Oshikoto, respectively. After exposure to PBO synergist followed by deltamethrin, susceptibility was restored to 100.0% mortality in both Oshana and Oshikoto regions. This indicated suspected resistance conferred by monooxygenase-based resistance mechanism in mosquito populations in both regions.

**Conclusions**: Following these results, the NVDCP decided to distribute PBO LLINs to populations that live in unsprayable structures and are not protected by IRS. The selection of PBO nets informed by routine pyrethroid resistance data is expected to improve protection against resistant vectors. Further resistance monitoring will continue to inform selection of vector control interventions.

**ABS-79**

## Pyrethroid-piperonyl butoxide (PBO) nets reduce the efficacy of indoor residual spraying with pirimiphos-methyl: an experimental hut evaluation in southern Benin

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**Background:** Most indoor residual spraying (IRS) campaigns are deployed against a background of high long-lasting insecticidal net (LLIN) coverage. Pyrethroid-piperonyl butoxide (PBO) LLINs have recently been

recommended for malaria control and are replacing pyrethroid LLINs in endemic communities. PBO acts by inhibiting enzymes responsible for pyrethroid resistance, namely cytochrome P450 monooxygenases (CYPs). Pirimiphos-methyl is also widely applied for IRS campaigns however; it is a pro-insecticide that requires activation by CYPs in order to exert full toxicity. The inhibitory action of pyrethroid-PBO LLINs against CYPs may, therefore, reduce the toxicity of pirimiphos-methyl IRS when these interventions are combined.

**Methods:** We performed a series of experimental hut trials to evaluate the impact of combining different pyrethroid-PBO LLINs with pirimiphos-methyl IRS against a pyrethroid-resistant vector population in Benin. Comparison was made to either method alone and combinations based on pyrethroid LLINs as a positive control. WHO susceptibility bioassays were performed to determine the resistance profile of the vector population.

**Results:** WHO susceptibility bioassays revealed the vector population was highly resistant to pyrethroids but susceptible to organophosphates. PBO pre-exposure only partially restored pyrethroid susceptibility. Vector mortality in huts containing pirimiphos-methyl IRS and pyrethroid-only LLINs (81%) was similar to IRS alone (85%, p=0.129). In contrast, mortality was significantly reduced with combinations of pirimiphos-methyl IRS and pyrethroid-PBO LLINs (55–59%) relative to IRS alone (77–78%, p<0.001).

**Conclusions:** This study provides evidence for reduced efficacy of pirimiphos-methyl IRS in the presence of pyrethroid-PBO LLINs. Control programmes may consider withholding pyrethroid-PBO LLIN distribution in areas scheduled for IRS with pirimiphos-methyl as a precaution.

**ABS - 281**

**Interceptor G2 net has Multiple effects on *Anopheles* mosquitoes**

Elizabeth Bandason

**Background**

Interceptor G2 (IG2) is one of the new generation nets which has been developed to curb the pyrethroid resistance problem in the control of Anopheles mosquitoes. It is assumed the IG2 is designed to kill malaria vectors after physical contact and downstream physiological effects on mosquitoes remain elusive. We conducted this study to assess toxicity and physiological effects in mosquitoes following contact and non-contact exposure to IG2.

**Methods**

We decoded forced contact and non-contact toxicity effects of IG2 net in Anopheles mosquitoes using insecticide sensitive *Anopheles gambiae, Kisumu* strain, wild collected *An. gambiae sl* and *An. funestus* sl using a modified carbondioxide baited WHO cone assay. We employed arm in cage assay to assess host seeking in mosquitoes. We used blood feeding assays for propensity of mosquitoes to blood feed after exposure and assessed egg laying and hatch rate after exposure.

**Results**

Toxicity effect of IG2 net in Anopheles mosquitoes is dependent on the length of physical contact and mosquito

strains. Particularly, the net is more effective when mosquitoes are in contact with it longer and mosquito strains or species may respond differently. Moreover, the IG2 net, can cause knockdown effects, alter host seeking, blood feeding and fecundity in Anopheles mosquitoes without physical contact.

**Conclusion**

These findings not only provide new insights into the mode of action of IG2 net but also offer valuable information in understanding the downstream behavioural effects in Anopheles mosquitoes that may impact malaria transmission.

**ABS-239**

**Meeting the challenge of insecticide resistance**

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[3]*SumiShield™ 50WG: Meeting the challenge of insecticide resistance*

**Background:** SumiShield™ 50WG, containing the neonicotinoid clothianidin, was prequalified by WHO in October 2017 - making this the first WHO recommended new mode of action chemistry for Indoor Residual Spraying (IRS) in 40 years. Programs now have a choice of effective chemistries which is critical for the long term future of IRS, as this allows the implementation of rotational strategies. SumiShield™ 50WG is now being deployed extensively throughout Africa.

**Methods:** This presentation will share recent lab and field efficacy data where SumiShield™ 50WG has been evaluated alongside other IRS products under a range of conditions.

**Results:** Studies indicate excellent and long residual activity of SumiShield™ 50WG and widespread field susceptibility against a range of *Anopheles* species.

**Conclusions:** While results are very encouraging for the continued future of IRS, we need to ensure IRS products with different modes of action are rotated to help preserve their effectiveness.

*TM: Trademark of Sumitomo Chemical Co., Ltd.

**ABS-87**

## Analyses of Insecticide Resistance Genes in *Aedes aegypti* and *Aedes albopictus* Mosquito Populations from Cameroon

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The emergence of insecticide resistance in *Aedes mosquitoes* could pose major challenges for arboviral-borne disease control. In this paper, insecticide susceptibility level and resistance mechanisms were assessed in *Aedes aegypti* (Linnaeus, 1762) and *Aedes albopictus* (Skuse, 1894) from urban settings of Cameroon. The F1 progeny of *Aedes aegypti* and *Aedes albopictus* collected in Douala, Yaoundé and Dschang from August to December 2020 was tested using WHO tube assays with four insecticides: deltamethrin 0.05%, permethrin 0.75%, DDT 4% and bendiocarb 0.1%. TaqMan, qPCR and RT-qPCR assays were used to detect kdr mutations and the expression profiles of eight detoxification genes. *Aedes aegypti* mosquitoes from Douala were found to be resistant to DDT, permethrin and deltamethrin. Three kdr mutations, F1534C, V1016G and V1016I were detected in *Aedes aegypti* populations from Douala and Dschang. The kdr allele F1534C was predominant (90%) in *Aedes aegypti* and was detected for the first time in *Aedes albopictus* (2.08%). P450s genes, Cyp9J28 (2.23–7.03 folds), Cyp9M6 (1.49–2.59 folds), Cyp9J32 (1.29–3.75 folds) and GSTD4 (1.34–55.3 folds) were found overexpressed in the Douala and Yaoundé *Aedes aegypti* populations. The emergence of insecticide resistance in *Aedes aegypti* and *Aedes albopictus* calls for alternative strategies towards the control and prevention of arboviral vector-borne diseases in Cameroon.

**Keywords:** *Aedes aegypti*; *Aedes albopictus*; insecticide resistance diagnostics; arbovirus; mechanisms; urban settings; Cameroon

**ABS-67**

## Implementing Quality; a missing piece with a need for process of behavior change: A case for implementing Quality Community Based Indoor Residual Spraying Delivery Model in Zambia.

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**Background:** In the wake of increasing malaria cases in Zambia, IRS has been coming under increasing accountable pressure from the public for quality IRS performance and its decentralized approach. In response, a new IRS approach; Community-Based Indoor Residual Spraying (IRS)Delivery model has been introduced in the country and institutionalized in the community health care system. The objective of this study was to introduce quality assurance approach methods in terms of structure, process and outcomes for the model quality performance.

**Materials and Methods:** We reviewed both published and unpublished documents, articles, papers on quality service delivery and explored field experiences and the understanding of IRS service delivery. The Donabedian model has been found to lead to improvements of quality that in turn could improve the health outcome of the community. Equally, dimensions of quality were analyzed under effectiveness, efficacy, acceptability, equity and relevance in IRS delivery of services and best approaches.

**Results:** Quality assurance becomes strong and successful when its well organized with features of a health atmosphere that motivates IRS teams, Spray operators (SOPs), and the house hold owners , thus becoming a common goal as a result of good level management. The District IRS Operational Committee, typically must possess quality assurance superior technical skills and expertise. However, it is not only quality assurance guidelines that strengthens team building but also established rules, processes, tracking of progress, IRS quality assurance learning environment, improvements and leadership support initiatives. These could be supplemented by enabling tools and a nurturing quality friendly atmosphere within the IRS teams and SOPs as front liners. Donabedian model for improvement of quality has been widely adopted in the hospital care set up, but has not yet been fully recognized, utilized and validated in the vector control system.

**Conclusion:** The study suggests that the Donabedian`s structure-process-outcome is a valid model for implementing quality CB-IRS Delivery model in the IRS program campaign. The interventions that perform well in terms of structure tend to perform better for quality service delivery processes, that in turn have favorable influence on the community health status outcome.

**Key words:** Quality, Process of Behavior Change, CB-IRS-Delivery Model, Spray Operator, Zambia

**ABS –110**

**Analysis of the impact of malaria on the labour productivity of cotton farmers in Burkina Faso.**

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**Background:** Malaria is both a public health problem and a performance barrier in agricultural countries. Burkina Faso has been facing a gradual decline in cotton productivity since 2014. Cotton, the main agricultural export and source of household income, is a labour-intensive rainfed crop.

The decline would be partly explained by the low labour productivity due to malaria infection. The study aims to analyze the impact of malaria on the labour productivity of cotton farmers.

**Methods:** Panel data techniques and methods were utilized on 25 cotton producing provinces over the period 2014-2018 in the Central, Eastern and Western regions. An augmented growth model of Solow was used to explore the association between malaria and labor productivity. The homogeneity and Hausman test were respectively conducted to identify the possible heterogeneity between provinces and specify the appropriate estimation method depending on whether the individual model effect is fixed or random.

**Results:** At 1%, the Fisher test shows the presence of heterogeneity, hence the adoption of an individual effect model. Similarly, the value of the Hausman statistic is= 42.02 and the P-value = 0.000 < 5%. The individual fixed-effect model is the best one and the parameters of the model were estimated by the ordinary least squares method. The econometrics results show that an increase in malaria incidence of 1% leads to a decrease in cotton farmer productivity of 0.425%, all other variables being held constant. In addition, education is found to be important variable in labor productivity improvement.

**Conclusions:** These results imply further health policies to reduce the incidence of malaria among cotton farmers. In addition, advocate more investment in the education of cotton farmers is need. Because the best educated farmers avoid the misuse of inputs.

**ABS – 120**

**Perceptions and practices of communities during a larviciding trial in the city of Yaounde, Cameroon**

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**Background:** Urban malaria is becoming a major public health concern in major cities in Cameroon. To improve malaria vector control a pilot larviciding trial was conducted to assess its impact on mosquito density and malaria transmission intensity in Yaoundé. The present study investigates perceptions and practices of communities during the larviciding trial implemented in Yaounde.

**Methods:** Quantitative and qualitative data were collected in both non-intervention and intervention areas. For quantitative data analysis, data were collected during three cross-sectional surveys using a structured pre-tested questionnaire. For the qualitative study, a total of 26 interviews with community leaders and eight focus group discussions were performed with community members. A binary logistic regression model was used to assess the perception of the community on larviciding impact on some malaria or bed nets use indicators.

**Results:** People living in intervention areas were 2.64 times more likely to know the mode of malaria transmission and 1.3 time more to have knowledge about mosquito breeding habitats compared to those living in non-intervention areas. No evidence supporting changes in the knowledge of malaria symptoms and bed net usage as a result of the larviciding intervention was found. In intervention areas, Interviewee opinions on larviciding were generally good i.e., most interviewees reported having noticed a reduction in mosquito nuisance and malaria cases following larviciding implementation; whereas in non-intervention areas no reduction was observed. LLINs were regularly used by the population despite the implementation of larviciding. There was high interest in larviciding program and demand for continuation, even if this needs the community involvement.

**Conclusion:** The larviciding program in the city of Yaoundé did not negatively affected community members' behaviour and practices concerning the use of treated nets. The study indicated the acceptance of larviciding program by the population.

**Keywords:** Malaria, Vector control, Larviciding, Behaviour change, LLIN, Yaounde

**ABS-181**

## Larval source management for malaria control in Africa: divergence in policy, funding and adoption; a 'funding-evidence' catch-22

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**Background:** Besides insecticide resistance, implementation-related challenges that hinder optimal coverage and poor uptake of existing vector control interventions threaten recent control progress. Alongside development of new insecticides, existing efficacious vector control interventions could contribute to restoring progress towards elimination targets. Larval source management (LSM) has historical successes; WHO recommends LSM as a supplementary measure for vector control; however adoption has been subpar in many African countries. Combined with experiences from a trial of LSM and housing improvement in Malawi, we undertook this research to understand policy adoption drivers, financing, opportunities, challenges, and impact of LSM in Africa.

**Method:** We completed a desk-based policy analysis using a well-known model (Walt and Gilson, 1994) and applied framework analysis to policy documents (2008–2020) of malaria-endemic, English-speaking African

countries with an LSM policy and adoption date in the 2016 World Malaria Report. We also reviewed WHO policy documents and original research at country level to supplement the analysis (2008-2020).

**Results:** In the six countries identified, the main drivers for LSM adoption were malaria elimination, insecticide resistance, residual malaria, integrated vector management, manmade breading sites and historical success. LSM effectiveness data was found for three countries (Eritrea, Uganda and Nigeria) but was of poor quality. Although all six countries mention LSM in Global Fund (GF) applications, only Eritrea secured GF funding; two countries mention government funding. Four countries had a performance measure for larviciding, and Eritrea included a measure relating to environmental management. LSM is not monitored by the GF.

**Conclusions:** Our results indicate that LSM is recognised by national and international policy makers, but country-level policy adoption and implementation remain a challenge. We will discuss possible reasons for lack of LSM adoption and implementation challenges for African countries, including reflections from a cluster-randomised trial of LSM conducted in a rural area in Malawi.

**ABS-66**

## Assessing malaria transmission and vector dynamic in a context of larviciding trial in the city of Yaoundé, Cameroon.

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**Introduction:** Malaria remains a public health problem in Cameroon. The prevention of this disease is slowling down by insecticide resistance, mosquito changing behaviour and the fast demographic growth of urban population. To manage those challenges, larval control could be effective. In the frame of a larviciding trial in the city of Yaoundé, a study was conducted in 26 districts from March 2017 to November 2020 to assess its impact on adult anophelinae densities, malaria transmission dynamic and prevalence.

**Methods:** A baseline survey was performed during one year then the larviciding was applied in 13 districts while the 13 others served as control. Entomological surveys were carried out once every two months to collect adult mosquitoes using CDC light traps and Human Landing Catches. Mosquitoes were identified up to the species level via PCR then analysed for *plasmodium falciparum* infectivity via ELISA. Two parasitological surveys were also conducted through malaria testing using blood smears and RDTs while dried blood spots were collected

on filter papers to identify *Plasmodium* species. Slides were stained with Giemsa and examined by microscopy for malaria parasites detection.

**Results:** Indoor and outdoor anophelinae densities recorded with CDC declined by 69.13% and 61.55 % respectively during the larvicide treatment. The same trend was observed with HLC densities regarding the reduction rate of 79.99% and 63.47% recorded. Results also show that the spatio-temporal distribution of anophelinae species in the city was affected by the treatment. In the same way, larviciding reduced indoor and outdoor transmission by 68.97% and 61.77% respectively. The intervention was also associated with a reduction in malaria prevalence.

**Conclusions:** The study highlights the efficacy of larviciding in reducing anophelinae density, malaria transmission and malaria prevalence in the city of Yaoundé Cameroon. This approach could be undertaken to sustain the efficacy of existing tools.

**Keywords:** Larviciding, VectoMax, malaria, Anopheles, transmission, Yaoundé, Cameroon.

**ABS -64**

## Achieving improvements in malaria behaviors and behavioral determinants through integrated social and behavior change activities in Tanzania Mainland.

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Promising progress has been made in malaria control in Tanzania over the last decade. Yet, malaria remains one of the country's most critical public health problems, with more than 5 million cases annually. Under its integrated social and behavior change (SBC) platform, NAWEZA, the USAID Tulonge Afya project promotes uptake of prevention and care-seeking behaviors in support of the country's malaria control objectives. NAWEZA activities targeting pregnant women and their partners, and parents and caregivers of children under 5, address behavioral determinants of ITN use, IPTp uptake, and prompt care-seeking for fever via multiple reinforcing channels: mass media, social media, print media, and intensified community-level programming (interpersonal communication, community theater, and community events) in 29 districts. Compared to the previous year, in FY20, the project implemented more intensive mass media and an expanded set of community activities; this resulted in an increase in the proportion of people exposed to NAWEZA media or activities, from 23% to 35%. Over the same time period, the project recorded positive shifts in promoted behaviors and behavioral determinants: an increase in the proportion of pregnant women confident in their ability to prevent malaria during pregnancy (74% to 78%); increase in the proportion of pregnant women and partners who understand malaria poses an increased risk in pregnancy (48% to 52%) and with positive attitude towards ITN use during pregnancy (59% to 64%); increase in the proportion of parents/caregivers with comprehensive and correct knowledge of malaria (from 47% to 75%) and with positive attitudes towards malaria treatment (from 65% to 69%). These shifts in determinants corresponded to increases in ownership of at least one ITN (from 75% to 89% of households), proportion of the population with access to an ITN (63% to 70%), proportion of pregnant women that slept under an ITN the night before (83% to 94%), and proportion of pregnant women who took IPTp3 (50% to 53%). These results point to the important contribution that SBC can make as part of larger malaria control efforts.

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# Bioinformatics Resources for Invertebrate Vectors of Human Pathogens

## VectorBase welcomes you to the 2021 annual PAMCA meeting

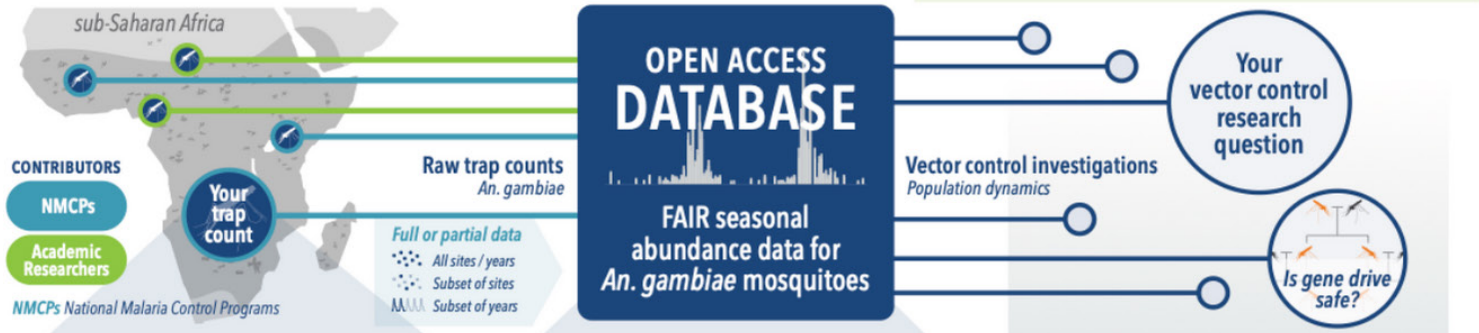
## VECTOR POPULATION DYNAMICS *Anopheles gambiae* complex

Understanding the population dynamics of *Anopheles gambiae*, the dominant malaria vector across Africa, requires time series data on mosquito abundance at different sites. This project seeks to collect raw trap count data from many different contributors, collate it in a public database, and make it available for visualization and download via an unrestricted, open access web interface. In this way, a little data from many diverse contributors can add up to a comprehensive resource for all.

Visit the VectorBase MapVEu interface to see / download the data we have collected so far. If you have abundance data, please consider contacting us (Sam Rund, srund@nd.edu) to learn more about becoming a contributor.

***To our African colleagues:*** *Open data can be a critical driver of new research opportunities, discoveries, and collaborations – yet also presents possibilities for exacerbating historical north-south research exploitation and disparities. We respectfully request your consideration of submitting data to this project. We are available for open dialogue on how we can mutually engage on this project, and to answer any questions, receive feedback, and provide assistance for use of our existing resources.*

*– The VectorBase and DEERA teams, contact Sam Rund srund@nd.edu*




### INPUT DATA

- Abundance*, e.g. catch per unit effort data
- Per sample unit, e.g. trap, individual, or house
- Member species of *Anopheles gambiae* complex, if known
- Longitudinal daily/weekly/monthly sampling
- Continuous duration, at least 12 months
- Published or unpublished

* *Non-intervention control/surveillance locations preferred*

### PUBLIC DATABASE

- Accessible for open access / download by all via VectorBase MapVEu interface
- FAIR[1] abundance data for *An. gambiae*
- Spatial – representing sites across sub-Saharan geographical region
- Temporal – longitudinal monitoring to capture seasonal cycles

[1] *FAIR: Findable, Accessible, Interoperable, and Reusable*

### DATA QUERIES

Database can be queried to address a variety of vector poplulation dynamics questions, inc:

- *Anopheles gambiae* genetic vector control risk assessments
- Spatio-temporal populations sizes
- Seasonality
- Other research questions by the community...

A collaboration between VectorBase and the CSIRO Data61 Ecological and Enviromental Risk Assessment (DEERA) team, funded by the Bill and Melinda Gates Foundation and the Foundation for the National Institutes of Health.

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**ABS-275**

## Horizontal transmission of the symbiont Microsporidia MB in *Anopheles arabiensis*

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Malaria continues to be a burden in Africa and the fight against malaria is increasingly being challenged by insecticide resistance and change in biting behavior among the main malaria vectors. This had led to a growing interest in symbionts such as *Wolbachia* and *Microsporidia* as novel and possibly sustainable biocontrol tools. A novel microsporidian (*Microsporidia MB*), recently isolated from *Anopheles arabiensis* in regions of central and western Kenya, was found to effectively block *Plasmodium* transmission. No significant difference was found in the fertility and life span of *Microsporidia MB* infected and non-infected mosquitoes. Moreover, *Microsporidia MB* was observed to be vertically transmitted from an infected mother to its offspring. These results suggested the potential of using *Microsporidia MB* as a biological control agent against malaria transmission. Our study, therefore aimed at investigating other routes of transmission of *Microsporidia MB* with the ultimate goal of proliferating infections within the wild mosquito populations. We showed that, in addition to *Microsporidia MB* being vertically transmitted from field mothers to the offspring (45%-100% depending on the Microsporidia density in the female), it is also horizontally transmitted in adults through mating. The transmission rate from infected male to uninfected female was 59% and from F1 infected female to uninfected male was 33%. Females that acquired *Microsporidia MB* from infected males were able to transmit to 37% of their offspring. qPCR analysis of the male seminal secretions proved *Microsporidia MB* presence. These results show that *Microsporidia MB* is transmitted horizontally through mating and has the potential to be a self-sustainable control strategy for malaria. Future studies will explore more transmission routes and factors that can increase horizontal transmission. This will allow us to establish *Microsporidia MB* colony that can be used to disseminate *Microsporidia MB* in the wild populations.

**ABS-144**

## Assessing the microbiome in *Anopheles coluzzii* and *Anopheles gambiae* from natural swarm

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**Background:** Microbiome play key roles in the physiology and vector competence of mosquitoes borne diseases and can influence their behaviour, reproduction, and susceptibility to pathogens. This study characterizes the microbiome of males *Anopheles gambiae* and *An. coluzzii* successfully mated versus unmated collected from natural swarm.

**Methods:** Mated and unmated mosquitoes were collected in Vallée du Kou and Soumousso, two distinct environments representative of different ecological communities of *An. gambiae* s.l.,

DNA was extracted from 100 *An. gambiae* complex mosquitoes: 50 males from Bama (25 mated and 25 unmated) and 50 males from Soumousso (25 mated and 25 unmated). Bacterial communities were identified using high throughput sequencing targeting 16S rRNA gene.

**Results:** A total of 41 bacterial phyla was found among all samples. Proteobacteria (74.4%) was most dominant, followed by Firmicutes (12.0%), Bacteroidetes (4.64%), and Actinobacteria (3.6%). The Wilcoxon Rank Sum test

highlighted differential abundances in the Operational Taxonomic Units (OTUs) assigned at the Phyla level across our samples ($P < 0.05$). The unmated males harbored OTUs with higher abundances in Bama samples whereas at Soumousso mated males exhibit higher abundance. However, there is no significant difference was found in term of bacterial communities' diversity between mated and unmated males. Interestingly, some endosymbionts known to get potential relevance for malaria control as *Thorsellia* (20%), *Asaia* (32%), Spiroplasma (6%) *Rickettsia* (18%), and *Wolbachia* (1%) were detected.

**Conclusions:** Our study provides a first details analysis of the microbiome composition of mated and unmated males of main human disease including endosymbiotic bacteria that can be potentially exploited in terms of vector control strategy.

**Keywords:** Mosquito microbiome, 16S rRNA gene amplicon sequencing, Mated, Unmated, *Anopheles gambiae*, *Anopheles coluzzii,* Mating success.

**ABS-145**

**Molecular detection and maternal transmission of a bacterial symbiont *Asaia* species in the field-caught *Anopheles* mosquitoes from Cameroon.**

Miss Grâce maffo Tatsinkou

**Background:** Malaria control relies mainly on insecticide-based tools. However, the effectiveness of these tools is threatened by the widespread insecticide resistance in malaria vectors highlighting the need for alternative control approaches. The endosymbiont *Asaia* has emerged as a promising candidate for paratransgenic control of malaria but its biology and genetics still need to be further analyzed across Africa. Here, we investigated the genetic diversity of *Asaia* as well as its maternal transmission in the natural population of *Anopheles* mosquitoes in Cameroon.

**Methods:** Adults indoor resting mosquitoes belonging to 4 species (*An. coluzzii, An. arabiensis, An. funestus* and *An. gambiae*) were collected from eight localities across Cameroon from July 2016 to February 2020. PCR was performed on the *Asaia* specific 16S ribosomal RNA gene, and positive samples for PCR *Asaia* were confirmed by Sanger sequencing and phylogenetic analysis. The vertical transmission of *Asaia* was investigated by screening F1 mosquitoes belonging to F0 *Asaia* positive females.

**Results:** A total of 895 mosquitoes were screened. We found 43% (384) *Asaia* infection prevalence in four mosquito's species. Phylogenetic analysis revealed that *Asaia* from Cameroon cluster together with the strains of *Asaia* isolated in other parts of the world. In addition, 7 haplotypes were found with a low genetic diversity ($\pi$= 0.00241) and haplotype diversity (Hd=0.481). *Asaia* was vertically transmitted with a high frequency (range from 42.5% to 100%).

**Conclusion:** This study provides a field-based evidence of the presence of *Asaia* in *Anopheles* mosquitoes in Cameroon which is a critical prerequisite for using it as symbiotic control in Sub-Saharan Africa.

**Keywords:** Malaria, *Anopheles, Asaia*, genetic diversity, maternal transmission, detection, Cameroon

**ABS-142**

**The road to the elaboration of a community agreement model for gene drive mosquito releases in africa**

Naima Sykes, Jude Bigirwenkya, Bakara Dicko, Mouhamed Drabo, Lea Pare Toe, Delphine Thizy

**Background:** The emerging guidance on the release of gene drive mosquitoes (from who, nasem, etc.) All point to the necessity to obtain "community authorization" before proceeding to any release, but they do not provide details about that process.

**Description:** Based on its experience with the release of non-gene drive sterile male mosquitoes in burkina faso in 2019, target malaria started a reflexive process about a potential community agreement model for the

future release of gene drive mosquitoes. In 2020, the project organized a workshop (adapted in a virtual event due to the covid-19 pandemic) to gather inputs from bioethicists, social scientists, engagement practitioners, vector control experts. This led to a publication of the workshop proceeding in 2021, highlighting key aspects of such a model and some of the gaps. Since january 2021, the project has been working on addressing those gaps and building a comprehensive legitimate agreement model through experts' hearing and engagement of key stakeholders.

**Lessons learned:** The process has been an opportunity to create a community exploring the opportunities and challenges of community agreement and going beyond the question of acceptance for a specific technology. This process has shown the importance of confronting theoretical frameworks with implementation challenges to ensure that the model would be applicable and address critical ethical questions.

**Conclusions:** This process has shown the importance of starting early to engage a broad set of stakeholders to co-develop a community agreement model. It hopes to create new partnership and a community of practice for social scientists and community engagement practitioners working on this topic.

**ABS-227**

## Prospects on the development of physical methods of females elimination in *Anopheles arabiensis* for an sterile insect technique program

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**Introduction:** Malaria is considered the most important Sub-Saharan public health concern. With no effective vaccines or drugs to prevent or treat malaria, the most effective strategy is to reduce contacts between vector and human. Therefore, sex separation of mosquitoes at different stages is currently being attempted to ensure the successful release of male mosquitoes in novel vector control approaches. However, these strategies are still lacking an efficient sexing method required for production of males at an industrial scale. Here, we propose to use temperature in order to develop an efficient sex separation method for male-only releases in an area-wide mosquito population suppression strategies.

**Method:** Male pupae were irradiated 20-22h before adult emergence at 30 and 40Gy and backcrossed with virgin heat sensitive F0 females. L1 larvae were exposed to 41°C in water for 3 hours and screened for thermal resistance over six consecutive generations. A translocated line with favorable male biased sex-ratio was established. Adult longevity, pupation rate, fecundity, fertility and sex-ratio of the translocated line were evaluated and results compared to the control.

**Result:** Irradiation doesn't affect adult emergence while fecundity and fertility have decreased compared to control. From F2 to F6, 153 isomale families were screened for thermal resistance, resulting in isolation of a translocated line yielding 80% males and 20% females. Although promising results are obtained, this study

paves the way for construction of an *An. arabiensis* full translocated strain.

**Keywords:** *Anopheles arabiensis*, translocated strain, gamma-rays (Gy), sterile insect technique (SIT).

**ABS-73**

## Collection performance of the new bg-pro mosquito traps in various locations around the world

Jennifer Kay McCaw

**Background:** CDC lights traps have been in use for decades since their introduction in 1962. They were the first portable traps that could easily be operated in almost any field setting and allowed live capture of mosquitoes, which is especially important for arbovirus isolation.

Biogents has recently developed and tested a new CDC style trap that uses a novel catch bag and a 3-bladed fan. The prototype, now called the bg-pro, incorporated the same style lid and incandescent light as the standard CDC miniature light trap however brings several advantages including flexibility, high production quality, low power consumption and option of using power banks for operation.

**Methods:** The bg pro was evaluated in comparison to conventional surveillance traps including CDC, EVS and bg-sentinel traps in 10 studies across 7 countries including the USA, Germany, France, brazil, Australia and Mozambique. This allowed for evaluations under varying climatic conditions and for different target species using varying trap configurations and attractants. All experiments followed a Latin square design.

**Results:** The new bg-pro prototype trap collected more species and more total mosquitoes than the relevant conventional monitoring traps in several locations around the world.

**Conclusions:** We demonstrated that depending on the target species, the bg pro in its respective configurations is in most cases as good as, or significantly better, than the most commonly used traps in mosquito surveillance. It is therefore a powerful tool that can be used for the surveillance of mosquito species that are usually monitored with bg sentinel, CDC, or EVS traps.

**ABS-165**

## The impact of Good Laboratory Practice certification on vector control product evaluation at a GLP-Compliant Facility (CREC/LSHTM/PAMVERC) in Benin, West Africa

**Corine Ngufor[1,2,3]**, Jackson Nyarko[1,3], Victoria Ariori[1,3], Martin Akogbeto

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[2]*London School of Hygiene and Tropical Medicine (LSHTM), London, UK*

[3]*Panafrican Malaria Vector Research Consortium (PAMVERC), Benin*

**Introduction:** The development and rapid spread of insecticide resistance in malaria vectors has necessitated the development of a new generation of vector control products. The registration of such new products requires the generation of reliable high-quality data demonstrating their efficacy to target vectors. It is recommended that vector control product efficacy studies be conducted in line with principles of Good Laboratory Practice (GLP). The CREC/LSHTM/PAMVERC Facility, a collaborative vector control product testing unit based at the Ministry of Health in Benin, achieved GLP-compliance in 2019 to generate efficacy data for new vector control products for WHO prequalification and national/regional registration following WHO guidelines, becoming the first of its kind in West Africa.

**Methods:** A series of improvements were made to establish a GLP-compliant quality system for the Facility: infrastructural improvements, re-organisation of personnel, establishment of a personnel training system, development of appropriate standard operating procedures for different testing methods and development of

suitable systems for the management of laboratory equipment, study data, test items, test systems, staff safety, insecticide waste, archiving etc. A quality assurance unit was also set up to ensure the continuous compliance of the Facility. Quality indicators such as the levels of control mosquito mortality in bioassays, the productivity of the insectary, quantity of products tested, speed of product testing, quality of insecticide treatments, employee and client satisfaction etc were used to assess the impact of GLP-accreditation on the overall performance of the Facility.

**Results:** Since achieving GLP-certification, the CREC/LSHTM/PAMVERC Facility has experienced a substantial improvement in quality indicators. The number of insectary mosquito cages produced increased from <100 cages/strain/year before GLP-certification to ~300 cages/strain/year in 2020. All laboratory bioassays and hut trials were conducted within the acceptable environmental and control conditions after accreditation. 90% of IRS applications to experimental huts were within the target volume and/or dose range. The number of new brands of vector control products tested increased from 8 before GLP-certification (2017-2018) to 15 after GLP-certification (2019-2020) and the speed of product testing from reception to completion of final report increased by 40%. Employee and client/funder satisfaction were also very high after GLP certification.

**Conclusion:** GLP-certification contributed substantially to improving the quality and speed of vector control product evaluation at the CREC/LSHTM/PAMVERC Facility in Benin

**ABS – 279**

## Productive collaboration between scientists and community in genetics research: case of Target Malaria research in Burkina Faso

Lea Pare Toe[1], Nourou Barry[1], Anselm D. Ky[1], Wilfrid Meda, Korotimi Bayala[1]

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**Background**. Most health research that focuses on vector-borne- diseases has not sufficiently involved communities: it is often conceived and executed at a distance from the community, even when the purpose is to improve his wellbeing. This may represent a barrier to research findings acceptance.

Collaboration between scientists and non-scientists has been considered since the 1950s onwards as a requirement of accountability of science to the public through the phenomena of art-science. Recently, Target Malaria project, a pioneer on gene drive research for malaria elimination has relaunched this historical debate by highlighting stakeholder engagement as a central piece of the development of the technology. The current paper describes a productive collaboration between scientists and non-scientists that enables community to influence the pathway of the research and then improve the technology acceptance.

**Description.** Target Malaria establishes a collaboration with the community hosting the research for their involvement on it. Various activities were concerned by the collaboration such the creation of glossary in local language to communicate on genetic science and the monitoring of the release of non-gene drive mosquitoes.

**Lessons learned.**

The genuine collaboration initiated by the research team allowed community empowerment for informed decision regarding their participation to the research process as well as taking more active role in the research activities.

Cultivating a thorough understanding of key concepts raised a deep level of reflection among non-experts, whom supported the two-way dialogue in valuable and unpredicted ways, such as improving aspects of the research thinking, the pathway, and the nature of the collaboration itself.

**Conclusion**

Involving communities in the development process of gene-drive technology, not just from the perspective of science communication will – promote self-determination in the decision-making process and improve usage of research findings “given”:”Pamela A”,”non-dropping-particle”:””,”parse-names”:false ,”suffix”:””},{“dropping-particle”:”V”,”family”:”Lavery”,”given”:”James”,”non-dropping-particle”:””,”parse-names”:false,”suffix”:””}],”container-title”:”Gates open research”,”id”:”ITEM-1”,”issued”:{“date-parts ”:[[“2017”]]},”publisher”:”Gates Foundation-Open Access”,”title”:”Informed consent in field trials of gene-drive mosquitoes”,”type”:”article-journal”,”volume”:”1”},”uris”:[“http://www.mendeley.com/documents/?uuid=19bea5d7-1b73-41d2-9713-9c0fd2220ea5”]},{“id”:”ITEM-2”,”itemData”:{“ISSN”:”1472-6939”,”author”:[{“dropping-particle”:””,”family”:”Singh”,”given”:”Jerome Amir”,”non-dropping-particle”:””,”parse-names”:false,”suffix”:””}],”container-title”:”BMC medical ethics”,”id”:”ITEM-2”,”issue”:”1”,”issued”:{“date-pa rts”:[[“2019”]]},”page”:”54”,”publisher”:”Springer”,”title”:”Informed consent and community engagement in open field research: lessons for gene drive science”,”type”:”article-journal”,”volume”:”20”},”uris”:[“ht tp://www.mendeley.com/documents/?uuid=cd68b31c-ec72-429b-a1e4-f315c301316d”]},{“id”:”ITEM-3”,”itemData”:{“DOI”:”10.1016/j.socscimed.2004.03.037”,”ISSN”:”02779536”,”abstract”:”In our research unit on the Kenyan Coast, parents sign consent for over 4000 children to be involved in research activities every year. Children are recruited into studies ranging from purely observational research to the testing of new procedures and drugs. Thousands more community members consent verbally or in writing to the interviews and sometimes invasive procedures required in community-based research. Although every study and consent form is reviewed in advance by independent national and international committees, the views and understanding of the ‘subjects’ of these activities had not been documented before this study. In this paper, we focus on participant understanding of one field-based and two hospital-based studies, all of which involve blood sampling. The findings highlight a range of inter-related issues for consideration in the study setting and beyond, including conceptual and linguistic barriers to communicating effectively about research, the critical and complex role of communicators (fieldworkers and nurses.

Key words. Target Malaria, gene drive research, stakeholder engagement, Malaria, social science

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**ABS -223**

## Using high-resolution drone imagery to understand the impact of human-made larval habitat on dry season malaria transmission in rural Malawi

Michelle Stanton, C

**Background:** During the dry season in Malawi, mosquito densities in rural areas are generally low, in part due a reduction in surface water. Human activities however e.g., agricultural practices and dam construction increase the number of potential larval habitat during these dry periods. The purpose of this study was to measure the impact of these human-made refugia on dry season mosquito populations.

**Methods:** This study was undertaken in three communities in central Malawi between May – August 2021. Communities were selected based on their proximity to a dam which was being used to support small-scale irrigation, with the furthest being 2km away. Drone imagery of the area was captured each month and was used to identify potential larval habitat around the three communities and guide larval sampling. Simultaneously, CDC light traps were used to capture adult mosquitoes in 30 houses per community for two nights each month. Catches were morphologically identified in the field and preserved in silica gel for molecular analysis.

**Results:** Analyses of drone imagery revealed that the majority of potential larval habitat in the area (excluding the dam and its reservoir) took the form of shallow wells in cultivated fields. Both *Anophles gambaie* and *An. funestus* adults and larvae were found in all three communities, with *An funestus* becoming more dominant as the dry season progressed. A larger abundance of anophelines were found in the community closest to the dam, with densities decreasing as distance from the dam increased.

**Conclusions:** We have demonstrated the influence of human-made environmental changes on mosquito density on the small geographical scale. Drone-assisted mapping has the potential to help in identifying these larval habitats, providing information that can be used to guide locally tailored vector control strategies such as larval source management.

**ABS -254**

## Electric fields can be used to repel mosquitoes: Laboratory experiments and use cases.

Dr. Andreas Rose[1]. Ms. Ndev Bassin Jobe[2], Mr. Farooq Tanveer[1], Mr. Max Epple[1], Prof. Krijn Paaijmans[2]

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When electrical conductors like metal slats, pipes, or wires are installed parallel to each other, and a voltage is applied between them, electric fields are formed. The strength and structure of these electric fields depend on the voltage, distance and geometry of the conductors.In a proof of concept, we have shown that host-seeking mosquitoes flying towards a human volunteer were effectively repelled by electric fields that formed between the slats of a metal grate. These experiments were conducted in cage and room tests, with *Aedes aegypti*. Repellency depended on the field strength, with maximum repellency exceeding 90%, at a field strength of 1kV/cm. The repellent effect is purely physical and can be switched on and off with the touch of a button. The voltage needed can be safely generated from rechargeable batteries, with a minimum power consumption, without danger for the user or non-target organisms.In our presentation, we will summarize the initial proof of concept and present experiments that evaluated the influence of the geometry of different conductors, using room tests and a novel, largely automated experimental set-up using an automatic mosquito counter, the BG-Counter.We will also discuss possible use cases of this novel repellent technology, such as protecting windows, open eaves, or other ventilation openings, repellent fences, etc. and its potential application in a new type of push-pull concept.

**ABS-187**

## Detection of *Plasmodium falciparum* in laboratory-reared and naturally infected wild mosquitoes using near-infrared spectroscopy

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There is an urgent need for high throughput, affordable methods of detecting pathogens inside insect vectors to facilitate surveillance. Near-infrared spectroscopy (NIRS) has shown promise to detect arbovirus and malaria in the laboratory but has not been evaluated in field conditions. Here we investigate the ability of NIRS to identify *Plasmodium falciparum* in *Anopheles coluzzii* mosquitoes. NIRS models trained on laboratory-reared mosquitoes infected with wild malaria parasites can detect the parasite in comparable mosquitoes with moderate accuracy though fails to detect oocysts or sporozoites in naturally infected field caught mosquitoes. Models trained on field mosquitoes were unable to predict the infection status of other field mosquitoes. Restricting analyses to mosquitoes of uninfectious and highly-infectious status did improve predictions suggesting sensitivity and specificity may be better in mosquitoes with higher numbers of parasites. Detection of infection appears restricted to homogenous groups of mosquitoes diminishing NIRS utility for detecting malaria within mosquitoes.

**Key word:** Malaria, *Plasmodium*, *Anopheles*, Near-infrared spectroscopy

**ABS-102**

## Tensorflow and vector fertility: the automatic classification of pyriproxyfen-damaged mosquito ovaries

M T Fowler, R Lees, C Ngufor, N Matowo, N Protopopoff, A. Spiers.

**Background & objective:** Pyriproxyfen (ppf) offers an alternative to pyrethroids in areas where pyrethroid-resistant vectors are prevalent. The efficacy of ppf is currently assessed through the manual inspection of vector ovary damage by human experts. However, this manual process is inefficient, inconsistent, difficult to replicate and its accuracy is hard to substantiate. Furthermore, the required expertise can be difficult to train and is not available in many contexts. Therefore, a freely available alternative method for the accurate, quick and automatic classification of ovary damage is required.

**Materials & method:** Using the tensorflow library within python, a resnet-50 convolutional neural network (cnn) was pre-trained using the imagenet dataset. This cnn architecture was then repurposed and measured using a novel dataset of 163 dissected ovary images whose fertility status and ppf exposure was known. Data augmentation was employed to maximise the training dataset and produce 2 552 random images. A test set of 47 images was used to measure accuracy.

**Results & discussion:** The model produced an accuracy score (correct predictions divided by total number of predictions) of 0.936 (94%) and an auc (a comparison of true positive against false positive) of 0.902 (90%). The application of the model on the 47 images in the test set took 12.83 seconds.

**Conclusion & recommendation:** Reliance on experts to determine the efficacy of ppf is subject to limitations.

We show that these can be overcome using a cnn model that automates the classification of ovary fertility status. Such a model can achieve an acceptable level of precision, in a quick, robust format and has the potential to be easily distributed in a practical and accessible manner. Furthermore, this approach is applicable to any ppf treated tool, or similarly acting insecticide, and is useful for measuring efficacy and in durability monitoring.

**ABS-124**

**A larval mosquito rearing robot inspired by the Covid-19 induced lockdowns**

Dr. Laban Njoroge

With the advent of covid-19 infections in Kenya, the need for social distancing as one of the containment measures recommended by the ministry of Health became apparent. As a result, working from home was highly encouraged. This meant reduced work place attendance. Labour intensive activities such as captivity rearing of mosquitoes were therefore affected. To minimize the lockdown effects, an innovative larval mosquito rearing method was developed at the National Museum of Kenya. A patent pending robot was developed to dispense larval mosquito food at pre-determined intervals all day and night. It incorporated a water mixing step before each feeding event to reduce scum formation. The robot effectively controlled a 12-hr period of lighting and 12 hr darkness with gradual lighting and dimming. One hundred first instar of *Anopheles gambiae s.s* Kisumu strain were reared to adults. A finely ground larval food developed at the same institution was dispensed by the robot. No human input happened until after pupation. Over 85% of the 100 larvae successfully pupated. The robot functioned as intended till pupation of the mosquitoes. This innovation not only helped in reducing contact during the pandemic but also demonstrated a less labour intensive and cost-effective mosquito rearing procedure.

**ABS-89**

**An Online Platform for Malaria Vector Surveillance in Africa using Artificial Intelligence and mosquito Infrared Spectroscopy**

Mr. Bazoumana Bala Danouma Sow

**Background:** In order to evaluate and improve malaria vector control interventions, it is necessary to monitor and accurately estimate the age structures and species distribution of mosquito populations. These parameters provide vital information on the intensity of malaria transmission. Current laboratory procedures which involve dissection to assess parity rate and PCR (polymerase chain reactions) or laborious ovary dissections are expensive, inaccurate and time consuming. Mid-infrared spectroscopy (MIRS) has emerged as a cheap and accurate alternative. We present a web-based platform that provides users with the functionality to upload and make predictions on MIRS data. Specifically, the web application makes use of previously published machine learning models to simultaneously determine species and age in malaria vectors.

**Methods:** This online platform will allow user to signup, log in or log out; store locations (longitude and latitude) where mosquito have been collected; collect and store relevant metadata (type of machine, wave numbers, spectral resolution, storage and collection temperature, humidity, location name, sex and insecticide resistance status); upload and filter spectra (data cleansing to compensate for atmospheric water and CO2 interference bands); make predictions using artificial intelligence models (classical machine learning and deep learning) algorithms.

**Results:** For the targeted *Anopheles* gambiae s.l. complex (*An. gambiae, An. coluzzi and An. arabiensis*) the user will be able to upload their dataset and obtain age and species predictions using supervised machine learning and deep learning (convolutional neural networks). Results will be visualized using confusion matrices and demographic tables (age and species) and printable for the user's future report.

**Conclusions:** Our online platform will provide an easy-to-use tool for age and species classification of *Anopheles gambiae s.l* mosquitoes based on MIRS spectra. More broadly, these processes could be applicable to the others *Anopheles* mosquitoes, as well as *Culex* and *Aedes* upon calibrating new predicting models.

**ABS-245**

## The Global Vector Hub - building entomological capacity worldwide and improving epidemic preparedness

Dr. Frederik Seelig

The Global Vector Hub (GVH) is an exciting new online platform currently under development at the London School of Hygiene & Tropical Medicine (LSHTM), focusing on control of arthropod disease vectors globally. An early beta version was launched in summer 2020 in the context of the COVID-19 pandemic to address the urgent need for accurate and up-to-date information and resources on vector-borne diseases and vector control interventions. Following on from this success, a full version will be released in July 2021.The aims of the GVH are to assist in **capacity building** for vector control globally, establish a **community of practice** for vector control interventions, and enable stakeholders to make **evidence-based decisions**. The main audiences of the GVH are **public health officials, vector control agents** and **vector researchers**.

The GVH consists of a community-led, online, **open-access** resource to provide comprehensive information on vector control and vector biology. This includes geo-tagged entomological **data** (including abundance data, surveillance for insecticide resistance, and pathogens vectored) and epidemiological data, a searchable registry and worldwide **network** of vector researchers and vector controllers, and a comprehensive **resource** database of training and educational materials, vector control guidelines and research tools.

In addition, the Special Programme for Research and Training in Tropical Diseases (TDR) and the Global Vector Hub have developed a web-based **global directory of medical entomology courses** as a new resource for strengthening the capacity of scientists combating neglected tropical diseases and other vector-borne diseases. The directory currently lists a total of 126 medical entomology courses offered both on-campus and through distance learning in 32 countries across all WHO regions, covering seven languages. The freely available directory was developed in collaboration with the GVH and ARCTEC at LSHTM, following the mapping of courses available globally. WHO's Department of Control of Neglected Tropical Diseases and the WHO Global Malaria Programme have also reviewed the directory and provided recommendations. For each course, session dates, course outline, fees, language of instruction and responsible managers are listed.

We are also planning to include versions in Spanish, French and Portuguese as soon as possible.

You can learn more about the GVH (and register) here:

**https://globalvectorhub.lshtm.ac.uk/**


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**ABS-201**

## Risk of dengue in Central Africa: vector competence studies with *Aedes aegypti* and *Aedes albopictus* (Diptera: Culicidae) populations and dengue 2 virus

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Dengue is one of the most important mosquito-borne diseases worldwide but was considered scarce in West-Central Africa. During the last decade, dengue outbreaks have increasingly been reported in urban foci in this region suggesting major epidemiological changes. However, in Central Africa where both vectors, *Aedes aegypti* and *Aedes albopictus* are well established, the role of each species in dengue transmission remains poorly investigated. Here, we assessed the ability of *Ae. aegypti* and *Ae. albopictus* collected in different ecological settings in Central Africa to transmit dengue 2 virus (DENV-2). We provide evidence that both *Ae. aegypti* and *Ae. albopictus* in Central Africa were able to transmit dengue virus with *Ae. aegypti* exhibiting a higher transmission rate. Unexpectedly, two *Ae. aegypti* populations from Bénoué and Maroua, in northern Cameroon, were not able to transmit DENV-2. We conclude that both species are susceptible to DENV-2 and may intervene as active dengue vectors.

**Key words:** *Aedes aegypti*, *Aedes albopictus*, dengue virus, vector competence, Central Africa

**ABS-96**

## Efficient traps for xenomonitoring onchocerciasis vectors: optimising visual cues for host seeking *Simulium damnosum*.

Lasane Koala

**Background:** Despite decades of research and a recognisable need, few traps have been developed and deployed successfully to sample or control disease vectors. The vectors of onchocerciasis in Africa, *Simulium damnosum* feed on human hosts by day at high biting and infection rates but there is no standard trap either for surveillance or control and human landing collection (HLC) remains the standard sampling method despite the ethical issues. We sought to develop replacement attractant traps for hostseeking *S. damnosum,* beginning with an investigation into visual and olfactory cues.

**Method:** Working in SW Burkina Faso, blackflies were caught with electrocuting grids at targets of different sizes, shapes, with synthetic odour baits. Numbers of blackflies/ trap or trap surface area/ day and total *S. damnosum*/ target area were compared in Latin square design tests.

**Results:** Larger square traps (<1 sq metre) caught more *S. damnosum* but the numbers caught per unit area declined with target size. Horizontal oblongs caught nearly 1.5 times more than square ones, and 3 times more

than the vertical oblong. Shape preference was consistent over the range of target sizes. Blue targets collected more *S. damnosum* than black and blue-black targets. Experiments are ongoing.

**Conclusion:** These preliminary results from our studies on visual cues indicate that a trap for the savannah forms of *S. damnosum* could be horizontal oblong in shape and relatively small in size, measuring 0.25x0.25 m (0.0625m2). However, the next stage of the study, the evaluation the visual traps with added synthetic host odour blends, is underway at present and results will be presented at PAMCA.

**ABS-100**

## Multiple insecticide resistance and first evidence of V410L kdr mutation in *Aedes aegypti* from Burkina Faso

Hyacinthe K. TOE, Soumanaba Zongo, Moussa W. Guelbeogo, Basile Kamgang, Hilary Ranson, Philip J. McCall

**Introduction:** Burkina Faso responded to major dengue outbreaks in 2013 and 2016 with insecticide-based vector control targeting *Aedes aegypti.* We investigated the susceptibility profile, and underlying mechanisms, for the main insecticide classes in *Aedes aegypti* populations from urban and peri-urban areas from 2019 to 2020.

**Methods:** Immature stages were collected from July to October in Ouagadougou and Banfora. Adult F0 or F1 females were exposed to insecticides in WHO susceptibility tests (including pre-exposure to piperonyl butoxide (PBO) and quantitative bioassays). Real time melting curve qPCR analyses were performed to genotype the F1534C V1016I V410L *Aedes* kdr mutations in unexposed and in live and dead mosquitoes, 4h post-exposure to 0.03% deltamethrin.

**Results:** *Aedes aegypti* from both cities showed moderate resistance to 0.1% bendiocarb (80-100%), 0.8% Malathion (60-100%) and 0.21% pirimiphos-methyl (75-97%), and high resistance to 0.03% deltamethrin (5-70% mortality). Mortality was 75% and 92% following exposure to 0.25% and 0.5% deltamethrin respectively. Mortality was below 50% following 4h exposure to 0.3% deltamethrin. Pre-exposure to PBO significantly increased mortality to 0.03% deltamethrin and 0.03% alpha-cypermethrin ($p<0.0001$) suggesting the involvement of cytochrome p450s monooxygenases. Genotyping detected the presence of F1534C and V1016I at frequencies of 0.45-0.92 and 0.1-0.32 respectively. The V410L mutation was detected for the first time in Burkina Faso at frequencies of 0.1-0.32 depending on location. High frequencies also occurred in mosquitoes surviving 4h exposure to 0.03% deltamethrin, but the difference was significant only for the 1534C mutation (0.70 vs. 0.96, $p<0.0001$).

**Conclusion**: Burkina Faso populations of *Aedes aegypti* are resistant to multiple classes of insecticide with multiple mechanisms involved. This highlights the urgent need for a nationwide monitoring programme to manage insecticide resistance and ensure effective control in future outbreaks of dengue or other arboviruses transmitted by *Aedes aegypti.*

**Keyword**: *Aedes aegypti*, insecticide resistance, kdr mutations, Burkina Faso

**ABS-158**

## *Aedes* mosquitoes in Ghana: risk of transmission of arboviral diseases in an urban forest and community

Nukunu E. Akyea-Bobi, Godwin K. Amlalo. Samuel Akporh Sowah, Jewelna Akorli, Reginald Quansah, Dominic Acquah-Baidoo, Rebecca Pwalia, Joseph H.N. Osei, Sellase Pi-Bansa, Millicent Opoku, Helena Anokyewaa Boakye, Mufeez Abudu, Esinam Akorli, Kojo K. Frempong, Kofi Bonney, Samuel K. Dadzie

**Background:** Dengue, Zika and Chikungunya are *Aedes*-borne viral diseases that have become significant global health concerns over the past few years. Ghana shares borders with countries that have reported outbreaks of these diseases but, the country remains free of an outbreak. Recent studies have uncovered antibodies and viral RNA of the Dengue virus serotype-2 among individuals in some localities; an indication of silent transmission ongoing in the population, hence the need to assess the risk of transmission of these viruses in the country.

**Methods:** This was a cross-sectional study that assessed the risk of transmission of Dengue, Zika and

Chikungunya viruses in a forest and (peri-) domestic setting. All stages of the *Aedes* mosquito were collected and identified. The Breteau (BI), House (HI), Container (CI) and Positive ovitrap (POI) indices were determined and RT-PCR was conducted to determine the presence of Dengue, Zika and Chikungunya viruses in the larvae and adults collected.

**Results:** A significantly higher number of *Aedes* eggs were collected in the forest area compared to the (peri-) domestic site ($P = 0.03$). The predominant *Aedes* species identified from both sites was *Aedes aegypti* (98%). Other species identified in the (peri-) domestic site included *Aedes albopictus* (1.5%). The forest sites had the higher species diversity. Almost all risk indices recorded for both sites were higher than the WHO thresholds allowed for these indices; (peri-) domestic: POI = 26.6%, CI = 36.8%, HI = 19.8%, BI = 70.4%; forest: POI = 34.2% and CI = 67.9%. RT-PCR to detect the presence of Dengue, Chikungunya and Zika viruses was negative.

**Conclusion:** All entomological risk indicators estimated showed that both sites had a high potential of an outbreak following the introduction of these viruses, and a well-structured surveillance for these vectors is highly recommended. The presence of *Ae. albopictus*, an invasive species is of great concern.

**ABS-137**

**Concurrent circulation of dengue serotype 1, 2 and 3 among acute febrile patients in Cameroon**

Dr. Huguette SIMO TCHETGNA

**Background & Objective:** Dengue is the most prevalent mosquito-borne arboviral disease throughout the tropics and sub-tropics globally. Long considered to be scarce in Africa, dengue has been on the rise on the continent in the past two decades. Yet little is known of dengue epidemiology and even the range of active serotypes is unknown in many countries, including Cameroon. As part of ongoing studies on arbovirus epidemiology in Cameroon, we investigated the contribution of dengue infections to the burden of acute febrile illness recorded in public hospitals.

**Material and method:** Between July to December 2020, volunteers over three years of age presenting with acute febrile illness of less that 7 days duration were recruited in four hospitals in Douala. Dengue infections were detected, and serotype determined using real time RT-PCR to target a fragment of the 5' and 3' UTR genomic regions. The envelope gene of dengue positive samples was amplified by RT-PCR, sequenced, and phylogenetic trees were inferred for genotype identification.

**Results and discussion:** In total, 12.8% (41/320) of a sample of acute febrile patients in four public hospitals in Douala were positive for dengue. Dengue virus 3 (DENV-3) was the most common serotype found (68.3%), followed by DENV-2 (19.5%) and DENV-1 (4.9%). Co-infections of DENV-3 and DENV-2 were found in 3 cases. Infections were more prevalent in adults (78.38%) than in children below 15 years old (21,62%). Jaundice and headache were the most frequent clinical signs associated with infection and 23 cases (55%) were co-infections with malaria. Phylogenetic analysis of the envelope gene identified DENV-1 as belonging to genotype V, DENV-2 to genotype II and DENV-3 to genotype III.

**Conclusion:** The simultaneous occurrence of three serotypes in Douala reveals dengue as a serious public health threat for Cameroon and highlights the need for further epidemiological studies and dengue outbreak prevention and response plans in the major cities of this region.

**ABS-263**

**Transmission of cutaneous leishmaniasis and bacterial co-infection of cutaneous lesions in the Nkwanta south district of Ghana**

Miss Owusu Ntim

Cutaneous leishmaniasis (CL) continues to persist in endemic communities within Ghana. The disease is caused by *Leishmania* parasites acquired through the bite of an infected female sand fly. Even though CL has been present in the Volta region since 1999, there is limited data on vector species and reservoirs. Studies in the past have usually focused on the Volta region. This study extended the scope to the Nkwanta South District in the new Oti region where there have been reports of suspected CL cases from the health directorate. It aimed to determine the presence of cutaneous leishmaniasis in some selected communities, identify the sand fly and *Leishmania* species present and detect bacteria present in active lesions. CDC light traps and sticky traps

were used to collect sand flies. A questionnaire was issued to each recruited participant after consent was acquired to assess his or her knowledge of the disease. Suspected cutaneous lesions were swabbed onto filter papers and transported to the laboratory for processing. To detect *Leishmania* infection, DNA was extracted from samples collected on filter paper using a Qiagen extraction kit.

About 452 inhabitants from eight communities were recruited into the study. A significant number of the respondents knew about the disease, although most were below 15 years of age. The community Basare recorded the highest number of suspected CL cases. Out of 1,007 sand flies morphologically identified, *Sergentomyia ghesquierei (922* (91.57%)) were the most predominant species distributed across all eight communities, with the least being *Phlebotomus rodhaini (2* (0.2%)). Molecular identification of pooled sand fly however, identified *Lutzomyia anduzei haplotype* (7 (15.5%)), *Phlebotomus chinensis* (34 (75.5%)) and the remaining (5 (10%)) made up of different insects through the sequencing of the Cytochrome Oxidase I (COI) gene. The Internal Transcribed Spacer 2 (ITS2) marker was used to identify *Leishmania major* and *Leishmania tropica* parasites. Among the bacterial co-infections identified, *Staphylococcus aureus* (21 (63.6%)) was the most prevalent in the lesions followed by *Serratia marcescens* (13 (39.4%)) and the least was Coagulase Negative Organisms (12 (36.4%)).

This study has confirmed the persistence of CL in endemic communities within the country. The diagnosis of secondary bacterial infections should be included in CL cases for effective management of the disease.

**ABS-82**

**Epidemic risk of arboviral diseases: determining the habitats, spatial-temporal distribution, and abundance of immature *Aedes aegypti* in the Urban and Rural areas of Zanzibar, Tanzania.**

Fatma Saleh

**Background:** In Zanzibar, little is known about the arboviral disease vector *Aedes aegypti* in terms of abundance, spatio-temporal distribution of its larval habitats or factors associated with its proliferation. Effective control of arboviral diseases requires knowledge on vector ecology and habitat characteristics which is currently limited in Zanzibar.

**Methodology:** We conducted entomological surveys in households and surrounding compounds from February to May 2018 in the urban (Mwembemakumbi and Chumbuni) and rural (Chuini and Kama) *Shehias* (lowest government administrative unit) situated in the Urban-West region of Unguja island, Zanzibar. Larvae and pupae were collected, transported to the insectary, reared to adult, and identified to species. Characteristics and types of water containers were also recorded on site. Generalized linear mixed models with binomial and negative binomial distributions were applied to determine significant predictors of the presence and abundance of immature *Ae. aegypti* (i.e. both larvae and pupae) or pupae, respectively.

**Results:** The survey provided evidence of widespread presence and abundance of *Ae. aegypti* mosquitoes in both urban and rural settings of Unguja Island. Higher House and Breteau indices were recorded in rural compared to the urban setting. There was no statistically significant difference in *Stegomyia* indices between seasons across settings. Unmanaged solid waste materials and water storage appliances accounted for the majority of the habitats. Plastics, metal containers and car tires were identified as the most productive habitats which collectively produced over 90% of all *Ae. aegypti* pupae. Water storage, sun exposure, vegetation, and organic matter were significant predictors of the abundance of immature *Ae. aegypti.*

**Conclusions:** Widespread presence and abundance of *Ae. aegypti* signify a high risk of arboviral disease epidemics in Zanzibar island. Strategies for mosquito control are urgently needed and should focus not only on environmental management but also intersectoral collaboration for improved solid waste management and domestic water supply to minimize the water-storing practices that provide larval habitats for *Ae. aegypti*.

## POSTER ABSTRACTS

### DAY 1: Poster session 1 : 2:00 – 3:00 pm UTC

**ABS-57**

## Comparative lethal effects of three *ocimum* plants species against *culex quinquefasciatus* mosquito larvae

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### Abstract

Much work has been done in the attempt to eradicate mosquito borne diseases some of which involved the use of botanical derivatives as larvicides, repellents and insecticides which were success. The toxicity of the aqueous, methanolic and oil extracts of the three plants: *Ocimum gratissimum* L., *O. canum* Sims and *O. basilicum* L. (family: Labiacae) were tested on the late (3rd) instars larvae of *Culex quinquefasciatus* mosquitoes which is an important vector for transmission of diseases such as filariasis, encephalitis to humans. This approach is meant to find a safer and cheaper alternative for the vector control. The plant extracts were graded into different concentrations and the larvae were exposed to test for 3 and 24 hours with percentage mortality of 74.17% at $LC_{50}$ value of 0.95g/ml in methanolic extract of O. *basilicum* being the most potent after 24 hours followed by *O. canum* (methanol) with 71.83%, *O. basilicum* aqueous (68.33%), *O. gratissimum* methanol extract (65%). However, the oil extract of *O. canum* was most potent after 3 hours with 57.33% mortality with $LC_{50}$ value of 1.0g. ml, followed by *O. basilicum* 49.33%, $LC_{50}$ of 1.0 while *O. gratissimum* was the least toxic at 42.00% mortality and LC50 2.0g/ml. Comparatively, of all the three plant extracts, aqueous extract of *O. canum* was less toxic with 83% mortality at $LC_{50}$ value of 0.58g/ml while the least toxic is the aqueous extract of the *O. gratissimum* with 5.83%mortality with no $LC_{50}$ value. Invariably, these plants can be incorporated as botanical larvicides to inhibit the growth of mosquito vectors in order to prevent transmission of the mosquito borne diseases.

### Keywords

Toxicity, Extracts, *Ocimum gratissimum* L., *Ocimum canum* Sims, *Ocimum basilicum* L., Mosquito.

**ABS-229**

## Susceptibility status and resistance mechanisms of Anopheles gambiae s.l. to insecticides in the health area of Mbandjock, central region of Cameroon

Lorraine FOKOU

### Background

Due to the continued emergence and spread of insecticide resistance among malaria vectors, malaria continues to be a major public health problem in Cameroon. There is a need for increased resistance surveillance to better guide malaria vector control strategies. To this end, the evaluation of susceptibility status and resistance mechanisms of A*n. gambiae s.l.* to insecticides was investigated in the Mbandjock health area, centre region of Cameroon.

**Methods:** *Anopheles* larvae were collected in November 2018 by dipping and reared until adult emerged. Adult female *an. Gambiae* 3-5 days were used for susceptibility, intensity tests and for investigation of resistance mechanisms with the enzyme inhibitor pbo. The knockdown time was determined during 1 hour of exposure and the mortality rates 24 hours thereafter. A random sample of *An. gambiae s.l.* was used to identify the siblings using sine pcr technique.

**Results:** *An. gambiae s.s.* (76.2%) and *An. Coluzzii* (23.8%), the main malaria vectors in Mbandjock were resistant to all classes of insecticides tested at the diagnostic dose with knockdown rate of 19.8% (deltamethrin), 0% (permethrin), 0% (ddt) and 0% (bendiocarb); mortality rate of 10.9% (deltamethrin), 6% (permethrin), 0% (ddt), and 73.27% (bendiocarb) and exhibited high intensity resistance with the class of pyrethroids according to who classification whose resistance mechanisms involve the overexpression of cytochrome p450 monooxygenases in addition to knockdown resistance.

**Conclusion:** These results provide useful data on insecticide resistance and highlight the necessity for nmcp to develop and implement a proper insecticide resistance management plan in order to effectively control *an. Gambiae* populations in the mbandjock health area.

**ABS - 231**

## The Impact of *Anopheles gambiae* Complex on Fruit Set and Their Role in a Natural Pollinator Community

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Pollination, an important ecosystem service, is necessary for the reproduction of over 90% of the 250,000 species of modern vascular plants with as much as 85% of global food crops benefiting from animal pollination. Wild plants and food crops depend on the diversity of animal pollinators, hence a reduction and/or loss of either will affect the survival of both. Though, flies are known pollinators of several plants, less is known about the influence of true flies, including members of the *Anopheles gambiae* complex, on pollination. These flies are diverse, common, widely distributed, and among the most ubiquitous insect species in both natural and managed habitats. Hence, they could be a more important pollinator group than has always been anticipated. Although the *An. gambiae* complex group is not a known pollinator of any plant, they visit flowers to feed on nectar, thus, have the potential to pollinate flowers. Because many malaria control strategies, including the gene drive approach target the vector it is important to assess the impact of these mosquitoes on pollination and seed sets, as well as to study their role in the pollination community. This work will provide a better understanding of the ecological role of *An. gambiae* using both observational and experimental studies. Both male and female *An. gambiae* will be collected, and through DNA metabarcoding, will identify any attached pollen to determine the plants that are visited and potentially pollinated by *An. gambiae*. To establish the direct impact of *An. gambiae* pollination on fruit set, a semi-field experiment will be run to unravel the effects of self and wind pollination, from *An. gambiae* specific pollination and natural pollination. The number and quality of fruit sets and dry weight of fruit yield in each group will be used to determine the specific impact of *An. gambiae* pollination on yield. To establish the role of *An. gambiae* complex in a natural pollinator community; all insects on flowers along defined transects will be sampled to construct a quantitative visitation network. Using this data, the role of *An. gambiae* in relation to the broader insect pollination community will be determined. Collectively, this research will identify potential consequences of new and existing methods of malaria vector control on pollination and plant reproduction.

**ABS-42**

## Entomological baseline data collection to assess the effect of mosquito swarm-killing interventions on malaria transmission in south-western Burkina Faso

Abdoulaye Niang

**Abstract**

Prior to intervene and assess the impact of swarm-killing approach, a baseline data collection was conducted from June to November 2016 in ten villages divided into two areas in western Burkina Faso. The data consider both ecological and demographic characteristics to monitor the key entomological parameters. The mean number of swarms observed was 35 per village and ranged from 25 to 70 swarms according to the village. In both areas A and B, the female density varied significantly as a function of the village and the period of collection as well. The human biting rate was also significantly affected by the period of collection and by the fact that collection was carried out indoors or outdoors. The averages of the parity rate were tremendously high in both areas during whole the periods of collection ranging from 60 % to 90 % and, from 80 % to 100 % of females were found inseminated. The sporozoite rates were ranged between 1.6% and 7.2% depending to the villages. The molecular identification of resting and swarming mosquitoes shows the presence of the three major malaria vectors in Burkina Faso, at different proportions in the villages of both areas. The distribution of the potential swarm markers and observed swarms in the village level suggests that swarms are clustered across space, making the intervention easier and all useful entomological parameters to assess a swarm-killing intervention can be estimated in the selected village of the two areas in western Burkina Faso.

**Keywords**

Baseline data, Vector control, Malaria, Swarm-killing intervention, Burkina Faso

**ABS-40**

## MosquitoDB: A comprehensive-electronically-based entomological surveillance system for the control and elimination of mosquito-borne diseases.

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**Background:** Most National Disease Control/Elimination Program and researchers lack a robust entomological surveillance system that can manage field and laboratory based mosquito data leading to inability to make timely informed decisions on the deployment of vector control tools.

**Method and findings:** We have developed electronically mosquito database management system (MosquitoDB) that can manage diverse entomological studies for the control and elimination of vector borne diseases. The system is freely and securely accessible online with the data collection application available in Google Play Store – capable of validating and recording geolocation mosquito data even in the absence of internet connection. The key functionalities include but not limited to customization of variables by forms, proper linkage of field and laboratory data, data sharing capabilities in standardized formats, multi-language support, and access to linked datasets with summarized reports in different formats. Also, an interactive dashboard to support making informed decisions on where, when, how, and which vector control tool(s) should be implemented. MosquitoDB can easily be linked to other databases (e.g., epidemiological) with ability to push key entomological indicators to DHSI2. Current users include mostly researchers and some national malaria control programs focusing on malaria vectors.

**Conclusion:** MosquitoDB is an effective and comprehensive electronically-based entomological surveillance system that can support national diseases control with entomological routine surveillance and researchers with complex diverse entomological studies.

**Keywords:** Mosquito, malaria, entomological, vector borne diseases, database, surveillance

**ABS-186**

## Study of malaria transmission by direct skin feeding of Anopheles coluzzii t children in Donéguébougou, MALI

Chata Doumbia

### Abstract

Malaria is part of diseases causing high rate of mortality mostly with children in Africa. Causal principal vectors of this disease are *Anopheles Gambiae large sense et Anopheles Funestus* which population could vary according agroclimatic zones in addition to season. Despite some measurements, this persists due to the vector behavior also the species and environment. Understanding malaria transmission characteristics trough assessment of some entomologic parameters could be a good strategic to control this disease. Some indicators such as anthropophilic rate, vectorial density, entomological inoculation rate and vectorial capacity are used trough techniques which are insecticide spraying, human bait capture, and window trap techniques to study malaria transmission to human. For the current study, direct skin feeding technique of *Anopheles Coluzzii* was used to study malaria transmission with 380 voluntaries from 9 to 18 ages at the village of Donéguébougou in Mali. Data were collected from parameters such as feeding rate, survival rate, infection rate and Direct Skin finding (DSF) positivity. Data analysis revealed 99.86% and 66.53 as rates for feeding and survival, respectively. The global infection rate was 0.29% and that of DSF positivity was 1.72%. Moreover, 45 individuals are infected mosquitoes. Current results shown effectiveness of Direct Skin Feeding (DSF) technique to Study malaria transmission to children from 9 to 18 age with very high level of transmission from October to January with a pick in December (41%). This study has allowed to know individuals that infected several time mosquitoes, these constituted could be considered as parasite reservoir. These results could be exploited for vaccine clinical assays to test its blockage of malaria transmission.

**ABS-140**

## PROGRESS IN THE PATHWAY TO EVALUATION FOR A GENE DRIVE MOSQUITO

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## Background

Target malaria is a not-for-profit research consortium, developing novel genetic control methods for malaria vectors in sub-Saharan Africa.

## Description

The project is using a phased pathway approach building towards field testing of a gene drive mosquito. The phases allow for testing the biology of genetically modified mosquitoes (GMM) in contained laboratory experiments, their performance in field conditions, and capacity building for mosquito rearing, stakeholder engagement, and biosafety/regulatory practices. The first phase is a non-gene drive sterile mosquito, followed by a non-gene drive self-limiting strain, before the final self-sustaining gene-drive. Since 2012 the consortium has included several African research institutes as partners; IRSS in Burkina Faso, UVRI in Uganda and MRTC in Mali. These partners have led the planning and preparation required so far for the early, non-gene drive, stages of the pathway. These preparations have included extensive surveys of local mosquitoes and non-target organisms, building of insectary facilities for contained experiments with GMMS, stakeholder engagement around project activities, and interaction with national biosafety agencies. Our site in Burkina Faso was the first location in Africa to obtain a permit and proceed to the small-scale release of a non-gene drive GMM.

## Lessons learned

Active collaboration between the different countries has enabled initiatives in capacity building across the African region, including a joint PAMCA workshop on gene drive. Phases are active at different times in different countries, resulting in productive sharing of scientific, stakeholder engagement and regulatory experiences. Working across different sites also allows flexibility in the project strategy, with not every site being required to carry out every phase.

## Next steps

We will present an update on the progress of the pathway to evaluation of this new technology, including plans for the next phases. The project is working towards trials of a gene drive strain within the next decade.

## ABS-86

## Costs and Cost-Effectiveness of Malaria Control Interventions: A Systematic Literature Review

Lesong Conteh PhD, Kathryn Shuford MPH, Efundem AgborawPhD, Mara Kont Msc, Jan Kolaczinski PhD, Edith Patouillard PhD

## Objectives

No significant reduction in malaria burden has been recorded since 2015, and in some countries, the disease burden is on the rise. Global investments in malaria are below the estimated resource needs to achieve progress. Updated evidence on the unit cost and cost-effectiveness of malaria control interventions becomes ever more important, and how resources are allocated, to inform decision-making processes for national malaria control strategies.

## Methods

Ten databases and gray literature sources were searched, mostly in Sub-Sharan Africa, in English, French and Spanish, to identify evidence relevant to the period 2005 to 2018. Studies with primary financial or economic cost data from malaria endemic countries that took a provider, provider and household, or societal perspective were included.

## Results

We identified 103 costing studies from over 39 countries. The majority of studies focused on individual rather than combined interventions, notably insecticide-treated bed nets and treatment, and commonly took a provider perspective. A third of all studies took place in 3 countries. The median provider economic cost of protecting 1 person per year ranged from $1.18 to $5.70 with vector control and from $0.53 to $5.97 with chemoprevention. The median provider economic cost per case diagnosed with rapid diagnostic tests was $6.06 and per case treated $9.31 or $89.93 depending on clinical severity. Other interventions did not share enough similarities to be summarized. Cost drivers were rarely reported. Cost-effectiveness of malaria control was reiterated, but care in methodological and reporting standards is required to enhance data transferability.

## Conclusions

Important information that can support resource allocation was reviewed. Given the variability in methods and reporting, global efforts to follow existing standards are required for the evidence to be most useful outside their study context, supplemented by guidance on options for transferring existing data across settings.

## ABS-138

## Participation of a colonised *Anopheles coluzzii* strain in wild *Anopheles gambiae* s.l. swarms: Results of a 2-year survey in the Sudano-Savannah ecological zone of Mali

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## Abstract

Mosquito release strategies are one of the novel tools proposed for controlling malaria vector populations that are increasingly resistant to chemical indoor mosquito control measures. The success of releases control programs depends on effective mating between released males and wild females.

Here, the behavior of a males from a locally-colonized strains *Anopheles coluzzii* in wild swarms of *Anopheles gambiae* s.l. was explored. The size of wild swarms of *Anopheles gambiae* s.l., their height in relation to the ground and the type of marker used was recorded in the villages of Tieneguebougou and Ouassorola in the Kati district. There after, for two consecutive years, mark-release-recapture experiments were carried out. For each experiment, approximately 5,000 adult male *Anopheles coluzzii* mosquitoes were released.

The distribution of swarms by village was as follows: 60% of swarms were found in the village of Tieneguebougou and 40% in Ouassorola. Most of the *Anopheles gambiae* s.l. swarm markers were not far from the center of the village of Tieneguebougou unlike the village of Ouassorola where swarm markers were more scattered. In Tieneguebougou and Ouassorola, respectively, the most common swarm markers were patches of bare soil (59.1% and 54.5%), followed by patches of herbaceous soil (21.2% and 25%). The average number of *An. gambiae* s.l. in the swarms was 23.87 individuals in Ouassorola and 15.33 individuals in Tieneguebougou.

*Anopheles coluzzii* was predominant (67.7%) in the swarms of *An. gambiae* s.l. in Tieneguebougou while *An. gambiae* (76.9%) was mainly found in Ouassorola. Although, marked released males were recaptured in wild swarms, they were found only in swarms located in vicinity of animal sheds.

These studies show that despite some phenotypic divergence of males from the locally-colonised strains of *An. coluzzii*, they actively participate in swarms which opens the possibility of targeting malaria vector populations using mosquito release strategies.

**Keywords**

*Anopheles coluzzii*, swarm size, swarm height, male mosquitoes.

**ABS-270**

## Physical integrity and bio-efficacy of long-lasting insecticide treated nets two years after the 2017 mass campaign in Benin

Filémon Tokponnon, Razaki Osse, Rock Aikpon, Germain Gil Padonou, Fortuné Dagnon, Daniel Impoinvil, Aurore Ogouyemi Hounto, Martin Akogbeto.

In 2017, the National Malaria Control Program of Benin conducted a mass campaign of Long-Lasting Insecticide Treated Nets (LLINs). To determine the physical integrity and bio-efficacy of LLINs two years post-distribution, surveys were done in all 12 administrative departments of Benin.

In each department, one commune was randomly selected and one campaign LLIN in-use from the 2017 distribution was selected from 50 different houses. A total of 600 houses and 600 LLINs were surveyed. From each selected house, a resident was asked about the net. To assess LLIN physical integrity, the holes on sampled nets were measured and the WHO's Proportionate Hole Index (pHI) was calculated. Using the WHO cone test to determine the bio-efficacy of the LLINs, susceptible *Anopheles gambiae* s.s. Kisumu mosquitoes were exposed to 600 nets for 3 minutes and mortality was recorded after 24 hours.

After 2 years of use, 87.7% of LLINs were found with holes across all departments. The percentage of nets with holes was 96.6% for Dawa Plus 2.0, 92.0% for PermaNet 2.0 and 78.8% for Yorkool. Based on the proportional hole index, 35.5 % of Yorkool, 14.7 % of PermaNet 2.0 and 5.0 % of Dawa Plus 2.0 were found in (pHI>643) across all departments. The mosquito killing activity of the LLINs after two years, was 100.0% for PermaNet 2.0, 85.3% for Yorkool and 84.4% for Dawa Plus 2.0.

The survey on LLIN preference suggested that households were satisfied with the 2017 LLINs. Still, it is important to monitor and respond to community satisfaction to ensure retention and use of LLINs. After two years of use of the LLINs distributed in 2017, there was high percentage LLINs with holes. However, recovered LLINs had high bio-efficacy. These results suggest that it may useful to investigate reasons for this high damage rate and potentially promote greater care of LLINs.

**Key Word**

Household, LLINs used, Physical integrity, Bio-efficacy, Benin.

**ABS-207**

## A systematic review assessing the potential for release of vector species from competition following insecticide-based population suppression of *Anopheles* species in Africa

John Connolly, Senior Regulatory Science Officer, Target Malaria.

**Abstract**

Understanding the potential role of competitive displacement between vector species could inform both current insecticide-based vector control programmes and the development of future complementary interventions. A systematic review was conducted to identify studies of insecticide-based vector control of *Anopheles* species in Africa that reported indices for absolute densities of vector species. After screening against inclusion, exclusion and risk of bias criteria, studies were assigned to three categories based on whether they showed population density changes involving decreases in two or more vector species (D), increases in two or more vector species (I), or increases in one vector species concomitant with decreases in another vector species (ID). Category ID studies could thus provide evidence consistent with the release of vector species from competition following the insecticide-based population suppression of Anopheles species. Of 5,569 papers identified, 30 were selected for quantitative and qualitative analysis. Nineteen studies were assigned to category D and one study to category I. Ten studies categorised as ID provided evidence ranging from weak to persuasive that release from competition could have contributed to changes in species composition. Category ID showed no statistical differences from category D for reductions in malaria transmission and levels of insecticide resistance, but did so for insecticide type, pyrethroids being associated with category ID. A qualitative assessment identified five studies that provided the most convincing evidence that release from competition could have contributed to changes in species composition. While it remains uncertain whether this evidence is representative of most entomological sequelae from the use insecticide-based vector control in the field, five studies provided persuasive evidence that insecticide use could lead, at least under some circumstances, to competitive release of non-targeted vector species. These results should inform considerations on niche replacement for current and future integrated vector management approaches to malaria control.

**ABS-196**

## Strengthening the capacity of researchers and professional organisations to influence regional vector control policies in sub-Saharan Africa: Evidence from the Partnership for Increasing the Impact of Vector Control (PIIVeC) programme.

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**Introduction:** Analysis of stakeholders in the vector-borne disease (VBD) landscape in sub-Saharan Africa shows that while researchers and professional bodies such as PAMCA have high interest and expertise in issues of vector control (VC), their influence in policy decision-making spaces is limited. Lessons from the PIIVeC programme demonstrate that generation of policy-relevant evidence provides leverage. In addition, understanding the key stakeholders to engage is critical to achieving policy influence. The objective of this paper is to show the strengths and weaknesses of researchers and professional research institutions, such as PAMCA, in VC policy, and to provide lessons from PIIVeC that can help strengthen their capacity to influence policies in countries and key regional policy making spaces such as the African Union. The study specifically uses research outputs generated by PIIVeC researchers in Burkina Faso, Cameroon, and Malawi to draw on these lessons.

**Methods:** A rapid desk review of relevant stakeholders in the African region was conducted. Stakeholders were identified through Google by utilizing a structured search strategy and reviewed websites of initial stakeholders for reference of similar stakeholders. We scored each stakeholder's interest and influence based on a matrix developed by PIIVeC. We also synthesised the PIIVeC research output to identify potential areas of use in the policy process.

**Results:** Stakeholders were categorised into major funders such as Global Fund; economic blocs (African Union); health bodies and organisations (West African Health Organisation); and VBD-specific regional institutions (PAMCA). Of critical interest are the VBD-specific institutions that have a high interest in VBDs but little influence in the decision-making space. The PIIVeC programme through its research output has supported various types of research including basic, epidemiology, implementation, and operational. This research can potentially be utilised during policy agenda setting, development, and implementation. Through the research output, the programme holds critical powers to utilize as an engagement strategy to leverage with institutions of high power and interest for policy decision.

**Conclusion:** Institutions with low power but high interests should focus on generating relevant evidence for engagement with other stakeholders to influence policy at both regional and national levels.

**ABS-133**

## Human and entomological factors influencing HAT transmission in Congo.

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### Background

The situation of sleeping sickness is little known in the Republic of Congo. Between 1960 and 1990, a lot of work was carried out. Unfortunately, for more than 15 years, entomological surveys have not been carried out in the various foci that are still active. The objective of this work is to determine tsetse fly diversity and to evaluate the level of knowledge of the populations about the disease.

### Method

Entomological and household surveys were conducted in three endemic foci in the country, namely Mpouya, Ngabé and Loudima. The tsetse fly collected were all identified morphologically and then confirmed by PCR analysis. People living in the various study sites were asked to complete a questionnaire.

### Results

Three species of tsetse were mainly captured in these different outbreaks. Out of a total of 652 tsetse flies, 118 Glossina fuscipes quazensis and a single Glossina fusca congolensis were captured in the Mpouya and Ngabé outbreaks, while 533 Glossina palpalis palpalis were captured in Loudima. The latter was the only species found in this outbreak. The tenerals were represented by 3% of the total number of tsetse flies and the apparent densities were of the order of 0.13, 1.78 and 5.43 tsetse flies/trap respectively in Mpouya, Ngabé and Loudima. In these households, the main activity was agriculture. Of 160 households interviewed, 35 reported having had a case of the disease. Of these, 15 households reported having had at least one family member with trypanosomiasis in the last ten years. Recognition of the vector in pictures was made by 53% of the households interviewed.

### Conclusion

Our study indicated that there is a risk of transmission of the disease, especially with the presence of teneral flies in the sites.

**Key words**

Trypanosomiasis, tsetse flies, risk factors, Republic of Congo

**ABS-184**

## Malaria prevalence and Knowledge, Attitudes and Practice (KAP) about malaria among population before implementing a new control measure on the site of the hydroelectric dam of menve'ele, South Cameroon

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### Background

In the context where malaria elimination is back to the agenda, and for long-term sustainable intervention, supplemental vector control approaches to complement existing ones (LLINS, IRS) are dire needed. Before implementing a new control measure, it is important to know the level of understanding and application of the pre-existing measures by the target population. In the present study, we assessed the prevalence of malaria, and the level of knowledge, attitude and practice of the population towards malaria and the actual level of coverage and use of LLINs.

**Methods:** The present study was carried out in an area of the equatorial forest on the site of the hydroelectric dam of menve'ele, South Cameroon. Heads of households or their representatives were interviewed using a structured questionnaire consisting of 20 questions. Identification of the parasite carriers was done by rapid diagnostic test (RDT) and direct microscopic visualization (100x) of *Plasmodium* parasites on thick blood smears and thick drops stained with Giemsa 10%. The significance level of all parameters was set at 0.05

**Results:** In total, 107 people were interviewed and 198 examined. The prevalence of malaria was 34.85% (69/198) despite an LLIN coverage rate of 88.79% (95/107).There was no significant difference (p 0.5) between the use of bed nets and the level of education. About 63.55% of the study community related the mode of transmission to the bite of infective mosquitoes. Mosquitoes are believed to bite human beings at night (51.4%), breed in stagnant water (43.93%) and just 10.28% believed that they rest in dark places inside houses. Also, majority (67.29%) of the participants correctly expressed most important symptoms of malaria. However, some misconceptions on malaria disease, its transmission and prevention have been noted.

**Conclusion:** This study showed that the use of LLINs alone is not effective in the fight against malaria. There is appropriate level of knowledge and attitudes among population of study site. Alongside of people's knowledge and attitudes, their practice about malaria should be increased as an effective factor for malaria elimination.

This study would make inroads into the implementation effective malaria interventions in the area and beyond, focusing on enhancing community awareness and scaling up coverage of evidence-based intervention as housing improvement.

**Keywords**

malaria; prevalence; knowledge; attitude; practice; hydroelectric dam of menve'ele, South Cameroun

**ABS-214**

## Impact of the use of LLINs on the transmission of malaria in Kintele and Djoumouna (Brazzaville, Congo)

Nianga Bikouta Grace Odera Tainsie, Bitsindou Patrick and Lenga Arsene

**Background:** The achievements of the implementation of vector control strategies for malaria are evaluated through the monitoring of vector dynamics and their role in the transmission of malaria. This study was carried out from September 2016 to August 2017 in Kintele and Djoumouna and in August 2019 in Djoumouna alone.

The objective of this study was to identify the *Anopheles* species involved in the transmission of malaria, their dynamics over time and to evaluate the entomological indices according to the type of bedroom investigated.

**Methods:** *Anopheles* were collected from the residual morning fauna. Entomological indices were determined after dissection of anopheles.

**Results:** Collections were carried out in 541 bedrooms. The Anophelian fauna collected was composed of *Anopheles gambiae s.l.* (1130), *Culex quinquefasciatus* (681), *Mansonia uniformis* (5), *Aedes albopictus* (1) and *Anopheles funestus* (1). Of the 343 females of *An. gambiae s.l.* whose DNA was amplified by PCR, the species of the An. gambiae s.l. complex identified consisted of *An. gambiae* (248), from *An. coluzzii* (93), from *An. arabiensis* (1) and hydride (1).

**Conclusions:** These species have been shown to be involved in the transmission of malaria. This was more intense in bedrooms without a Long-Lasting Insecticide Impregnated Mosquito Net (LLINs), mainly in Djoumouna. In these bedrooms, one person received 1 infectious bite every 27 days.

Monitoring the status of LLINs and vectors appeared necessary to preserve the knowledge of LLINs.

**Keywords:** Malaria, *An. gambiae, An. coluzzii, An. arabiensis*, hybrid, transmission, LLIN, vector, EIR, Congo.

**ABS-216**

## Multiple insecticide resistance in *Anopheles gambiae* (Diptera: Culicidae) from tori-bossito, Republic of Benin

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**Abstract**

In order to detect the multiple insecticide resistance in *Anopheles gambiae* populations in the district of Tori-Bossito, southern Benin from June-September 2020, firstly adult females aged to 2-5 were subjected to susceptible test using impregnated papers (Permethrin 0.75%, delthamethrin 0.05%, DDT 4%, and bendiocarb 0.1%) following WHO testing protocol. Death and survival of *An. gambiae* populations from the test were screened for knock down resistance (*KDR*) and acetylcholinesterase (*Ace-1R*) mutations. Finally, biochemical analysis was done in order to detect Mixed Function Oxydase (MFO), non-specific esterase (NSE) and glutathione-S-transferases (GST) activity in individual 2–5 days old adult *An. gambiae* that had been reared from larvae and not previously exposed to insecticides. This research showed that *An. gambiae* populations from urban and rural areas were of resistance to DDT (2% as a means of mortality), permethrin (40%) and delthamethrin (72%) but fully susceptible bendiocarb. The kdr mutation due to the use of insecticides was the main resistance mechanism identified in these *An. gambiae* populations (0.72 as a means of frequency). The *Ace-1* mutation was found at a very low frequency (≤ 5%). Moreover, enzymatic activities (Esterase, Glutathione-s-transferase (GST) and P450 monooxygenase) in the wild population of *An. gambiae* were significantly higher than the control strain ($P < 0,05$). This study provides clear evidence that there is a multiple insecticide resistance in *Anopheles gambiae* populations from Tori-Bossito. This will jeopardise the successful of fighting against malaria in this district.

**Key words**

Insecticides; *An. gambiae*; Resistance; Benin

**ABS-134**

## Genetic variability within populations of *An. coustani* from Madagascar

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### Background

Malaria remains a major public health concern in Madagascar despite multiple malaria control and prevention measures. Aside from the primary malaria vectors (*Anopheles gambiae* s.l. and *Anopheles funestus*), the anthropophilic tendency of secondary or local vectors, primarily zoophilic, suggests their potential contribution to malaria transmission. Secondary vectors, such as *Anopheles coustani*, are thought to be of minor importance and thus understudied in terms of population structure and vectorial competence, despite being found infected with *Plasmodium* in many African countries. The current study is a preliminary molecular analysis to investigate the presence of distinct genetic populations or even sibling species within Malagasy *An. coustani* and potential link with different roles in malaria transmission in Madagascar.

### Methods

Morphologically identified *An. coustani* mosquitoes were collected in two villages (Ambohitromby and Miarinarivo, Maevatanana district) in northwestern Madagascar using human landing catches (HLC) and catches in zebu parks. Additional samples came from zebu parks in the eastern part of the country (Vavatenina, Toamasina). The genetic diversity of twenty-two *An. coustani* was explored using the mitochondrial cytochrome c oxidase subunit I (COI) and the ribosomal internal transcript spacer region 2 (ITS2) markers.

### Results

Our current analysis based on COI sequences revealed the presence of two phylogenetic groups of *An coustani,* supported by mutation signatures. These two groups included mosquito samples collected in each of the three geographic areas surveyed and were collected using different collection methods. No variation of ITS2 sequences was found in the current study.

## Conclusion

Our current data suggest the existence of differentiated *An. coustani* populations in Madagascar. In order to refine these findings and properly determine genetic variations within this species, additional mosquito specimens from other locations of Madagascar, as well as different collection methods, will be analyzed.

**Keywords:** *Anopheles coustani*, COI, ITS2, genetic diversity, sibling species, malaria, Madagascar

## ABS-230

## Arbovirus transmission risk and *aedes aegypti* larval breeding determinants and susceptibility to insecticides in côte d'ivoire, west africa

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### Objective

In most African countries, *Aedes aegypti* arbovirus vector control is limited thus resulting in multiple outbreaks of dengue and yellow fever. We assessed arbovirus transmission risk, and *Aedes aegypti* breeding eco-bio-social determinants and susceptibility to insecticides in disease foci in Côte d'Ivoire.

### Methods

We sampled *Ae. aegypti* larvae and breeding containers, and household socio-ecological data in two rubber tree areas (Koffikro and Samo), two oil palm areas (Ehania, and Agbaou) and two urban neighbourhoods (Bingerville and Cocody) in Abidjan, Côte d'Ivoire from June to December 2020. *Stegomyia* indices (container index: CI, household index: HI and Breteau index: BI) were determined. Additionally, we tested *Ae. aegypti* larvae and adults against biolarvicide (*Bacilus thurengiensis: Bti*) and insecticides (DDT, malathion, lambda-cyhalothrin, permethrin and deltamethrin). Mortality was recorded.

### Results

The most productive *Ae. aegypti* breeding sites were tyres, discarded cans, water storage containers and rubber latex collection cups. *Stegomyia* indices were highest in urban areas, followed by rubber areas and oil palm areas, with HI of 98.3, 81.2 and 67.82 CI of 69.7, 57.3 and 29.5, and BI of 99.7, 65.9 and 13.8, respectively. *Ae. aegypti* larval infestation was correlated with complex community behaviours, including water storage practices and solid waste management. *Ae. aegypti* breeding sites' positivity was associated with unmanaged

solid waste, water supply interruptions, water storage duration and insecticide-susceptibility status. *Ae. aegypti* was susceptible to *Bti*, lambda-cyhalothrin and malathion (mortality rate: ~100%) in all areas, but showed possible resistance to deltamethrin (mortality: 87,3-90.8%) rubber and oil palm areas, and resistance to DDT (mortality: 57,3-60.1%) in Abidjan and permethrin (mortality: 79.5-85.4%) in rubber and oil palm areas.

**Conclusion**

In Côte d'Ivoire, *Ae. aegypti* larval indices and dengue and yellow fever transmission risk were correlated with socio-ecological factors and insecticide-resistance level. Integrated community-based vector control is recommended.

**ABS-163**

**Infrared and AI-based approaches for malaria screening in population surveys and clinical settings**

Issa Mshani, Emanuel Mwanga, Francesco Baldini, Fredros Okumu and Simon Babayan

**Abstract**

Accurate diagnosis of malaria infections is essential for understanding transmission patterns, estimating epidemiological burden, and informing the appropriate treatment of malaria cases. Despite the great contribution of the existing malaria diagnosis methods, each method has individual disadvantages that leave gaps to be addressed toward malaria elimination, especially as prevalence decreases and requires increased diagnostic effort. Specifically, microscopy techniques are labour-intensive, PCR is expensive and technical expertise is required hence not applicable in low-income communities, and the rapid diagnostic test has poor positive predictive value for the diagnosis of patients with low parasite densities. To address these challenges, cost-effective and sensitive tools for the detection of malaria infections are needed. Recently, mid-infrared and machine learning approaches have shown good potential for detecting malaria infections. This technique depends on the ability of machine learning models to depict the subtle differences of biochemical signals obtained after passing mid-infrared light through blood samples. This technique is reagent-free, cost-effective, and requires little labour. Despite these advantages, the thresholds of malaria parasites this technique can detect are not known. This work focuses on establishing the lowest reliable amount of malaria parasites that can be detected by mid-infrared and artificial intelligence models. Here we will present a laboratory experiment conducted to create multiple dry blood spots with different known malaria parasitemia, and evaluating the lowest thresholds of malaria parasites that machine-learning models can detect. Moreover, we will present the applications of the mid-infrared and machine learning-based approach for the detection of malaria parasites during population surveys in both areas with higher and lower transmission intensities for validation. This study will contribute knowledge on the sensitivity and specificity of infrared and machine learning-based techniques and will indicate whether this method can complement current tools for detecting malaria infections in low transmission settings.

**ABS-123**

**A novel 3 in 1 mosquito trap from Kenya**

Laban Njoroge

A new trap that operates as an odor-baited trap, a light trap and a gravid trap has been developed in Kenya. The patent pending prototype has shown high potential for outdoor sampling of both host-seeking as well as gravid mosquitoes. A unique feature of the trap is the ability to substitute baits as well as an optional use of light and heat depending on the target mosquito species. Initial data has shown potential for collection of the mosquito genera namely Anopheles, Aedes, and Culex to which major disease vectors belong. Other non-mosquito species appearing in the trap in large numbers include the black flies (Simuliidae) and moth flies (Psychodidae). The trap weighing just under 4 kgs has potential for arboreal mosquito species such as those responsible for yellow fever transmission. Possible applications of this trap include vector surveillance, mosquito control to reduce biting nuisance and disease transmission as well as entomological inoculation rate

estimations. Its twin utilisation of solar charged batteries as well as use of easily available attractants means that it can be applied in the remotest of places.

**ABS-54**

## Utilizing a Campaign Information Management System and high performance liquid chromatography for improved Quality Control of Indoor Residual Spraying with Actellic 300 CS organophosphate insecticide on Bioko Island of Equatorial Guinea.

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Quality control of Indoor Residual Spraying (IRS) is necessary to ensure spray operators do not falsify spray records and that they deposit the recommended lethal dose of insecticides on spray walls. Insecticide Quantification Kits (IQK) for in-field quality control of IRS currently detects only concentrations of alpha-cyano pyrethroids and carbamates. IQK kits for in-field quality control with organophosphates are not yet developed though IRS programs are increasingly using organophosphates due to Insecticide resistance to pyrethroids and DDT. This study examined the use of an advanced campaign information management system (CIMS) and high performance liquid chromatography (HPLC) for IRS quality control with an organophosphate insecticide. The Bioko Island Malaria Control Project (BIMCP) currently uses Actellic 300CS organophosphate insecticide with pirimiphos methyl as the active ingredient. A total of 17,600 households were sprayed in 2017 using 63 spray operators. BIMCP instituted a quality control procedure to test houses randomly selected from the CIMS that maps and capture data in real time houses reportedly sprayed each day. Insecticide samples were tape-lifted from structures reported sprayed and analyzed using HPLC. Spray operators were monitored in 2017 and 2018. During the 2017 monitoring, all the selected houses monitored had the insecticides deposits as detected by HPLC. However, 11.1% of the spray operators deposited less amount of the insecticide (<1.0g a.i./$m^2$) on the wall, 54.0% deposited the target dose of 1.0g a.i./$m^2$ and 34.9% deposited over-dose >1.0 g a.i./$m^2$). These results were compared with the 2018 monitoring results. The ability to randomly select, locate and test via HPLC houses reportedly sprayed within a week has markedly improved the quality of IRS on Bioko Island, virtually eliminating falsification, and enabling the project to better evaluate its performance. The results obtained will also form the basis for developing new tool kits for in-field monitoring of organophosphates insecticides.

**ABS-204**

## Larvicidal efficacy of *Uvariodendron anguistifolium* (Baker f.) essential oil against the malaria vector *Anopheles gambiae*.

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**Abstract**

The use of synthetic insecticides in public health for malaria vector control is threatened by the appearance and proliferation of resistance mechanisms against the existing insecticides. In this context, the use of natural insecticidal molecules with lower toxicity for humans, turns out to be an alternative approach towards malaria elimination goal. The objective of this work is to assess the larvicidal activity of *Uvariodendron anguistifolium* (*Uv. Anguistifolium*) leaves essential oil on *Anopheles gambiae* mosquitoes.

Essential oil extract from *Uv. Anguistifolium* leaves is used for larvicidal activity against third instars larvae of three *Anopheles gambiae* laboratory strains (Kisumu, Acerkis and Kiskdr). These strains share the same genetic background, but differ in being homozygous for the presence or absence of the G119S and L1014F mutations at the ace-1 and *Vgsc* locus respectively. Biological tests were performed at concentrations of 20 to 120 ppm according to the standard protocol of the World Health Organization. The mortality was recorded and the $LC_{50}$ for the extract is estimated after 24 hours of exposure.

The results revealed that the essential oil have remarkable larvicidal properties on the three strains of *An. gambiae*. The essential oil from the leaves had respectively $LC_{50}$ and $LC_{95}$ values of 63.71 and 128.97 ppm on Kisumu; 61.22 and 121.16 ppm on Acerkis; 65.52 and 119.19 ppm on Kiskdr larvae. The Likely ratio test showed that there is no difference between the mortality-dose regressions for the different strains (Kisumu vs Acerkis, p=0.49; Kisumu vs Kiskdr, p=0.16; Kiskdr vs Acerkis, p=0.11) indicated that no resistance toward the essential oil.

The findings of this study suggest that the essential oil of *Uv. Anguistifolium* leaves is a promising source of biocide against *Anopheles gambiae* larvae and could be useful for the discovery of new natural larvicidal compounds.

**Keywords**

*Uv. Anguistifolium*, *Anopheles gambiae*, essential oil, larvicidal activity.

**ABS-68**

## Indoor Residual Spraying Community-Based Delivery Model and Community Empowerment for Malaria Elimination. Lessons Learnt, Best Practices and Approach Methods in Zambia.

Emmanuel Kooma

**Background:** Integrating Indoor Residual Spraying (IRS) into institutionalized community health system is more efficient than the traditional District-Based IRS Delivery Model. This study explored experiences, best practices and approach methods for the implementation of the Community-Based IRS Delivery Model.

**Methods:** The study was descriptive and analyzed research reports on community action cycle for community mobilization, empowerment, collaboration, PHC system, spray coverage, quality and time, environmental compliance, comparative analysis, gender disparities, cost analysis, efficiency, capacity building and sustainability.

**Results:** Studies carried out in Ethiopia, Northern Tanzania and Sinazongwe district of Zambia indicate that the model meets IRS challenges in malaria "hot spots", hard-to –reach areas, high absenteeism and refusal rates. The model merits were; community ownership, maximization of coverage, leveraging leadership web of influence and mobilizing the villages. High acceptance, trust, reduced operational costs, increased awareness and coverage were reported. However, demerits of initial high cost on increased number of SOPs and cost of PPEs, training, spray teams, data management were challenges without close supervision.

**Conclusion:** The approach success is linked to strong relationship of the community action cycle for community mobilization. Capacity building, is a key ingredient in redressing social exclusion, inequality and vulnerability. The Model is appropriate regards the desired outcome to intervene IRS community challenges.

We recommend that:**1)** to get a good outcome there must be a strategic district operational plan **2)** Begin with community action cycle **3)** Facilitate removal of barriers that prevent people from participating in IRS **4)** Provide collaborative leadership 5**)** Integrate PHC system into the model approach.

**Key words**

CB-IRS Delivery Model, Community empowerment, Community Action cycle, Community mobilization, PHC.

**ABS-225**

## Small-scale field evaluation of the efficacy and residual effect of Fludora ® Fusion (mixture of clothianidin and deltamethrin) against susceptible and resistant *Anopheles gambiae* populations from Benin, West Africa.

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**Abstract**

In recognition of the threat of insecticide resistance in vectors of malaria, the WHO Global Malaria Programme recommends the development of an appropriate and comprehensive response to insecticide resistance. In principle, good resistance management practice requires the application of multiple insecticides of different modes of action, for example, in rotations and mixtures. Insecticides recommended by the World Health Organization for indoor residual spraying and long-lasting insecticide nets are limited. It is, therefore, judicious to prevent the rapid spread of insecticide resistance by evaluating new insecticides formulations with different modes of action and long residual effect.

Fludora® Fusion, a new neonicotinoid IRS formulation (a mixture of 500 g/kg clothianidin and 62.5 g/kg deltamethrin applied 200 mg ai/sqm + 25 mg ai/sqm, respectively) was tested. Small scale field evaluation of this product was conducted in the district of Dangbo in Benin, to compare its efficacy and residual effect on cement and mud walls against those of clothianidin 200 mg ai/sqm (WG 70) alone, and of deltamethrin 25 mg ai/sqm (WG 250) alone. WHO wall cone bioassays were conducted monthly with laboratory susceptible Anopheles "Kisumu" and wild *Anopheles gambiae* sensu stricto (s.s.) population from Dangbo. The induced mortality by each treatment per wall substrate for 24 h, 48 h, and 72 h post exposure were recorded every month and analysed.

Fludora® Fusion and clothianidin WG 70 showed mortality rates over 80% WHO bio-efficacy threshold on cement walls either with susceptible or resistant *An. gambiae* s.s. over a period of 10 and 9 months, respectively. Treatment with Fludora ® Fusion and clothianidin WG 70 on the mud walls showed residual effect for 6 months and 5 months respectively against both susceptible and resistant mosquitoes. During the whole evaluation period, deltamethrin WG 250 showed mortality rates below 80% against resistant Anopheles population. Furthermore, the knock down rates observed with the Fludora ® Fusion combination were significantly higher ($p < 5\%$) than those induced by Clothiandin WG 70.

Both the Fludora ® Fusion combination and clothianidin alone showed very good and lasting efficacy for IRS against resistant Anopheles with some residual benefit provided by the combination. The residual efficacy of the Fludora ® Fusion combination evaluated at 10 months shows this product is a good candidate for IRS interventions.

**Keywords**

Fludora® Fusion, Clothianidin, Deltamethrin *Anopheles gambiae*, Efficacy, Benin

**ABS-280**

## Optimizing the experimental conditions for the blood-feeding of wild *An. funestus s.l.* and *An. gambiae s.l.*

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One component of malaria parasite transmission that remains poorly characterized is vector competence in natural populations of mosquitoes, i.e. whether gametocytes ingested by the mosquito develop to the infectious sporozoite stage. Membrane feeding assays with parasite-infected blood are commonly used to quantify human-to-mosquito parasite transmission. However, adult mosquitoes in nature feed directly through the skin of their vertebrate hosts. Therefore, feeding rates can be low under experimental membrane feeding conditions, although feeding rates may increase by adjusting certain experimental conditions. Because of that, we conducted a pilot study with the aim of optimizing the experimental conditions for the blood-feeding of wild *An. funestus s.l.* and *An. gambiae s.l.*. To achieve this, wild mosquitoes (F1 offspring) were obtained from blood-fed adult females, which were collected resting indoors in southern Malawi. Starved F1 mosquitoes were presented with human blood from 20 minutes to 2 hours, and the blood-feeding rate was assessed. Two controls were used: wild *Anopheles* fed on direct skin and the lab-reared *An. gambiae* s.s. (Kisumu strain) fed on membrane feeds. Preliminary results show that a longer starvation duration (about 24 hours), a longer feeding duration (2 hours), and the adding of human odor attractant, increased the feeding rate. Furthermore, *Anopheles funestus* s.l. fed better during late night (starting at 23:00 h) and early morning (04:00 h and 07:00 h) than evening (18:00 h). Also, *An. gambiae s.l.* showed a higher blood-feeding rate (44.5%) compared to *An. funestus s.l.* (14.0%). Optimizing experimental conditions to increase the blood-feeding rate of wild malaria vector species will reduce the time and resources invested in conducting vector competence studies, which are critical for understanding potential variation in effectiveness of both current and future malaria intervention.

**ABS-115**

## Biting behavior of Culicidae at the Faculty of Sciences and Techniques of the university of Sciences Techniques and Technologies of Bamako.

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**Abstract**

Mosquitoes have been able to adapt to different climate changes and manage to live in rural as well as in urban areas. The purpose of this study is to determine mosquito's nuisance at the Faculty of Sciences and Techniques of the University of Sciences, Techniques and Technologies of Bamako. A longitudinal survey with cross sectional collection was carried out using human landing catch as sampling method. Collections were done at night and day time in 5 different spots. In total, 4007 mosquitoes were collected: 312 males and 3695 females from three genus of culicidae were identified: *Aedes*; *Culex* and *Anopheles*. Females were separated by gonotrophic state: 2860 unfed (1445 *Culex*; 1356 *Aedes* and 59 Anopheles); 549 fed (280 *Aedes*; 240 *Culex* and 29 Anopheles), 70 semi-gravids (42 *Culex*, 26 *Aedes* and 2 *Anopheles*) and 216 gravids (122 *Aedes*; 90 *Culex* and 4 *Anopheles*). From this study, it was found that *Culex* are the most dominant Culicidae, followed by *Aedes* and Anopheles. The nuisance of mosquitoes through their biting is much more intense at sun set before darkness for *Aedes* and at the night for *Anopheles* and *Culex*. On the other hand, mosquitoes of the *Aedes* genus remain aggressive throughout the day but with a peak of bites at sun set and in the early morning. All of these mosquitoes are vectors of pathogens and increase pathogens transmission to people in the university.

**Keywords**

Culicidae, academia, biting behavior, FST-USTTB, Mali.

**ABS-226**

## Knowledge, attitude and practices (KAP) of human populations towards malaria control in four eco-epidemiological settings in Cameroon.

KALA Nelly Armanda

**Background:** Malaria remains a major public health problem in Cameroon. Critical steps to improve disease control include assessing human population adherence to vector control interventions especially in areas with different cultural background. The present study sought to assess knowledge, attitude and practices (KAP) of population toward malaria prevention in four eco-epidemiological settings in Cameroon**.**

**Methods:** A cross-sectional malaria KAP survey was conducted from August to September 2019 in households of the localities of Kaélé, Tibati, Bertoua and Santchou. A semi structured questionnaire was administered to randomly selected households in the different localities. Data recorded were analyzed using SPSS v 20 and MedCalc v14.8.1.

**Results:** A total of 739 households were surveyed. The majority of participants had a secondary level of education (48.71%). A substantial number of participants (over 90%) in all the localities were able to make an accurate association between malaria and mosquito bites. The main sources of information for community members were Television sets in Santchou and Tibati and interpersonal conversation in Bertoua and Kaélé. Mosquito nets were the most commonly used protective measure against malaria, and the majority of nets in households came from the free-of-charge mass distribution campaigns organized by the Government. Participants with secondary and higher levels of education were more aware of good practices towards malaria control compared to those with primary level of education.

**Conclusion:** The study revealed that, populations' knowledge, attitude and practices differed according to localities and culture. More sensitization and education need to be done to improve adherence to prevention programs.

**Keyword**

Knowledge, attitude, practices, malaria, eco-epidemiological settings, Cameroon.

**ABS-199**

## Divergence and similarities on insecticides resistance profiles recorded with populations of *An. gambiae s.l.* breeding in vegetable farms within the same city of Yaounde in Cameroon

DEFO Blaise Armand

**Background**

Pesticide management by vegetable farmers might play a key role in the selection of insecticide resistance in wild of mosquito vectors. Here, we investigated the distribution of insecticides resistance profiles recorded with populations of *An. gambiae s.l.* breeding in vegetable farms in the city of Yaoundé in Cameroon.

**Methodology**

Four sites were selected; Nkolondom, Famassi and Ezazou as test sites and Mvan as control site. The knowledge, attitudes and practices of 50 vegetable farmers were collected in test sites through semi-structured questionnaire. Wild *An. gambiae s.l.* populations were collected and their susceptibility pattern to lambdacyhalothrin and permethrin assessed using WHO bioassay tests. Synergist bioassays with PBO were conducted and kdr target-site mutations were investigated using the TaqMan genotyping assay. The genetic diversity of *An. gambiae s.l.* was assessed by sequencing of the exon-20 element of the voltage-gated sodium channel.

**Results**

Overall, Lambdacyhalothrin constituted the main insecticide used by vegetable farmers in test sites. Mortalities to lambdacyhalohrin were 8.71%, 20.38%, 41.02% and 49% respectively at Nkolondom, Famassi Ezazou and Mvan. Susceptibilities to permethrin at Nkolondom, Famassi Ezazou and Mvan were respectively 6.14%, 13.19%, 17.11% and 9.62%. The PBO synergist assays showed partial recovery of the susceptibility to lambdacyhalothrin in *Anopheles gambiae sl* population as to permethrin. In all sites, the kdr 1014F was close to fixation and Ace1 mutations were low.

**Conclusions**

There was heterogeneity in *An. gambiae sl* population in resistance profile to pyrethroid, involvement of cytochrome P50 and in genetic diversity from one site to another. There was a similarity in Kdr mutation and Ace1-R distribution in all sites. This study suggests vector control strategies should also be implemented at a small scale for a better management of malaria transmission.

**Keywords**

Divergence, similarities, insecticides resistance, *An. gambiae sl*, vegetable farms

**ABS-65**

## Qualitative Assessment Of Community Based Continuous ITN Distribution In Zanzibar, Tanzania.

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Zanzibar, which is working toward malaria elimination, experienced a spike in malaria cases in 2018/2019. At the same time, there was a decline in the uptake of ITNs through community-based net distribution. ZAMEP in collaboration with partners conducted a qualitative assessment to identify barriers associated with this distribution channel. Data were collected through focus group discussions in December 2019 with 36 respondents including heads of household, female caregivers, facility health workers, Shehas and their representatives. Results revealed misconceptions (side effects of LLINs) and negative attitudes (net appearance and discomfort) towards "free" ITNs leading to the use of unconventional preventive measures like botanical remedies. Also, some people did not understand what the coupon was for and where they could attain it which led to non-use and misplaced coupons. Elsewhere, there was reported bias on how shehas issued coupons causing people not to trust the distribution system. Facility-level barriers like long wait times, queues and recorded ITN stock out during coupon redemption led to unsatisfied clients. Distribution barriers included delayed distribution of ITNs and coupons in response to facility stock requests; uneven supply of coupons and ITNs from Central Medical Stores leading to health facilities limiting the supply of coupons and ITNs to control demand surge; delayed submission of duplicate copies of used coupon books by shehas at health facility leading to lags in coupon refill. To ensure the community channel succeeds, the findings from this qualitative assessment suggest that SBC activities should focus on clarifying how people can access ITNs through the community distribution system. The findings also suggest that SBC activities should address misconceptions about free ITNs to promote their use. The findings also highlight the importance of addressing supply-side factors to ensure a consistent supply of ITNs and coupons to meet demand. Strengthening the community distribution channel will be crucial in ensuring ITN coverage levels are maintained, an important component in Zanzibar's progress toward malaria elimination.

**ABS-88**

## High insecticide resistance mediated by different mechanisms in *Culex quinquefasciatus* populations from the city of Yaoundé, Cameroon

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### Background

*Culex* mosquitoes particularly *Culex quinquefasciatus* are important arboviral and filariasis vectors, however despite this important epidemiological role, there is still a paucity of data on their bionomics. The present study was undertaken to assess the insecticide resistance status of *Cx. quinquefasciatus* populations from four districts of Yaoundé (Cameroon).

### Methods

*Culex quinquefasciatus* populations from four city districts were collected and analysed. Mosquitoes were tested against five insecticides used in public health. In addition, mosquitoes were screened for the presence of the *kdr* L1014F, L1014S, L1014C and *ACE*-1 G119S mutations. The expression levels of six detoxification genes were also analysed while the mosqutioes' cuticle hydrocarbon lipid content was evaluated, as an indicator of cuticle/reduced insecticide penetration resistance.

### Results

All *Culex quinquefasciatus* populations except one displayed high resistance to bendiocarb and malathion with mortalities ranging from 0-89% while high resistance intensity against both permethrin and deltamethrin was

recorded. Molecular analyses revealed high frequencies of the *ACE*-1 G119S mutation (ranging from 0-33%) and *kdr* L1014F allele (ranging from 55-74%) in all *Cx. quinquefasciatus* populations. Significant overexpression was detected for cytochrome P450s genes *CYP6AA7* and *CYP6Z10*, as well as for *Esterase A* and *Esterase B* genes. The total cuticular hydrocarbon content, a proxy of cuticular resistance, was significantly increased (compared to the S-lab strain) in one population.

## Conclusion

The study confirms strong insecticide resistance mediated by different mechanisms in *Cx. quinquefasciatus* populations from the city of Yaoundé. The expansion of insecticide resistance in *Culex* populations could affect the effectiveness of current vector control measures and stress the need for the implementation of integrated vector control strategies in urban settings.


## Keywords

*Culex quinquefasciatus*, insecticide resistance, metabolic resistance, kdr, Yaoundé


## ABS-43

## Identification of malaria vectors and insecticide resistant using microdiffuse reflectance spectroscopy and quantum cascade lasers


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## Background

Mid-infrared spectroscopy has shown the potential to classify mosquito samples into species and different age groups. However, it requires a large sample size for calibration, and most of the spectral data come from the thorax, thus, neglecting other tissues that might be more informative for traits such as cuticular insecticide resistant. Moreover, the technology used on spectroscopy is not optimal to focus on smaller tissues. Therefore, we tested microdiffuse reflectance spectroscopy (µDRIFT) to explore other mosquito tissues for age, species and insecticide resistant classification.

**Methods**: A total of 344 spectra from legs were collected from female laboratory reared *Anopheles* mosquitoes using µDRIFT. We used two species (*An. gambiae* and *An. coluzzii*), two ages groups (3 days and 10 days old) and different insecticide resistant status (Tiassale, Kisumu and Ngousso strains). Classification was performed using logistic regression.

**Results:** Species classification accuracy was 66.5% (59% *An. gambiae*, 74% *An. coluzzii*). For age prediction, accuracy reached 87% (89% 3 days old, 85% 10 days old) and accuracy for insecticide resistance prediction was 69.5% (67% susceptible class, 72% resistant class). Even though our sample size is small, our accuracies are

above 60%, which suggest legs are informative for classification. Therefore, we have implemented a portable spectrometer using quantum cascade lasers for high throughput spectral measurement of legs. This new laser system will improve the light source of current technology making it more compact, faster and cheaper.

**Conclusions:** Our results highlight the potential of different mosquito tissues and µDRIFT as tools for biological trait identification on mosquitoes that transmit malaria. These results can guide new ways of identifying mosquito traits which can help the creation of innovative surveillance programs by adapting new technology into mosquito surveillance and control tools.

**ABS-191**

## Community knowledge and acceptance of eliminating mosquito population from an area for malaria prevention: a focus group discussion in two villages in Ghana

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### Abstract

The widespread of insecticide resistance and behavioral changes in the major malaria vectors are threatening the gains made so far in malaria control. Thus, the need for additional methods to combat the disease is widely recognized. Recent advances in molecular biology offers the possibility of using genetically modified mosquitoes (GMMs) as complementary tool in the fight against malaria. One of the GMM approaches aim at the elimination or suppression of the target vector population. Like any vector borne control tool, effective approach would require the robust and meaningful engagement of communities. As a first step, this study investigated the community perception of the benefits of mosquitoes and their acceptance in eliminating them from their communities. The study was conducted in two farming communities in the Volta Region of Ghana in 2019. In each community, two focus group discussion (FGD) were carried out to gain insight on their perception on the benefits of mosquitoes and the level of acceptance in case mosquitoes is eliminated from their community as way of preventing malaria. Descriptive statistics were used to summarize the findings and thematic content analysis was used to identify key concepts and interpret the findings. All the 35 participants that were involved in the four FGD said they would support any intervention to eliminate mosquitoes from their community. One participate said “I am ready to offer my support and assist in getting rid of mosquitoes from my community. I know there will be peace and comfort when mosquitoes are no longer among us”. Most of the participants did not see any benefits of mosquitoes. However, one participants said “I don’t see the benefit of mosquitoes directly but other animals, which are beneficial to man may feed on mosquitoes. The fish that we eat may also be feeding on them”. The community was mainly aware of the use of chemical to kill mosquitoes. In summary, most of the people did not see any benefit of mosquitoes and as such would support the elimination of mosquitoes from their community. However, the study did not determine if besides chemicals, the use other technologies such GMM to eliminate mosquitoes from their communities will get similar level of acceptance.

**ABS-205**

## Efficacy of an indoor residual spray VECTRON™ T500 against pyrethroid-resistant and wild Anopheline vectors in Northern Tanzania

Janneke Snetselaar

**Background:** TENEBENAL™ (broflanilide) is a novel meta-diamide insecticide that acts as a GABA-gated chloride channel allosteric modulator and has potentially be used to control pyrethroid-resistant malaria vectors. Here, we report results of evaluation studies in Tanzania of an indoor residual spray (IRS) product, VECTRON™ T500, containing TENEBENAL™ as an active ingredient, against pyrethroid resistant and wild Anopheline mosquitoes.

**Methods:** Two initial experimental hut trials were conducted; the first evaluating the efficacy of three concentrations using a prototype formulation, and the second trial evaluating an improved formulation VECTRON™ T500. Currently a GLP study composed of laboratory and experimental hut trial components to evaluate the residual efficacy of VECTRON™ T500 against pyrethroid-resistant wild *Anopheles arabiensis* is being conducted.

**Results:** The prototype formulation showed a dosage-mortality response of broflanilide and 3-8 months of residual activity, with longer activity on concrete than mud. VECTRON™ T500 showed prolonged residual efficacy on mud, and even higher mosquito mortality on the concrete wall surface ~~ranged~~ over the 7 months duration of the trial. Results with free-flying, wild *Anopheles arabiensis* echoed the mortality trend shown in cone assays, with the highest dose inducing the highest mortality and the improved formulation showing increased mortality rates. No blood-feeding inhibition or insecticide-induced exiting effects were observed. Results from the GLP studies will be reported at the time of PAMCA 2021.

**Conclusion:** In conclusion these results indicate the potential of VECTRON™T500 as an addition to the current arsenal of IRS products needed to control malaria and resistance management of malaria transmitting mosquitoes.

**ABS-265**

## The invasive weed *Parthenium hysterophorus* modulates oviposition behavior and survival of the malaria vector *An. gambiae*

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### Abstract

The invasive weed *Parthenium hysterophorus* (Asteraceae) is widespread in tropical and sub-tropical regions of the world and is a suitable sugar source for the Afro-tropical malaria vector *An. gambiae*. Parthenin, the key secondary metabolite of *P. hysterophorus,* is known to be toxic to humans and animals but is tolerated by adult female *An. gambiae* mosquito. We posited that tolerance to parthenin by mosquitoes is due to learned behavior from the immature stages through suboptimal exposure to the plant metabolite released in the root exudates. Consequently, we assessed the egg laying behavior of *An. gambiae* on the plant exudates and

parthenin and quantified the percentage egg hatchability, larval and adult survival rate. We observed gravid females to be attracted to the root exudate treated-water than to the control water. Parthenin on the other hand, deterred oviposition. Both root exudate and parthenin reduced egg hatching rate. However, adults that emerged from immature stages pre-exposed to parthenin in the rearing water lived five days longer compared to the non-exposed mosquitoes. These findings present opportunities for further studies on the impact of plant allelochemicals on vector bionomics which may have implications for disease control.

**ABS-56**

## Bioefficacy of clothianidin and pirimiphos-methyl in north-western lake zone regions in TANZANIA TO CONTROL PYRETHROID RESISTANT MALARIA VECTORS

Zablon

### Background

The aim of this study was to assess the residual efficacy of clothianidin and pirimiphos-methyl (p-methyl) used as indoor residual spray (IRS) on different wall surfaces inside houses and their effectiveness in controlling malaria vectors in Tanzania from October 2019 to September 2020.

### Methods

WHO wall cone and fumigant bioassays were conducted monthly for 12 months with laboratory susceptible *An. gambiae* s.s. Kisumu strain on different wall surface types sprayed with either clothianidin or p-methyl. The walls were mud, oil or water painted, lime washed, unplastered cement and burnt bricks. Claypots, CDC light traps, Prokopack aspirators and collection bottle rotators with CDC light traps were used during monthly entomological surveillance conducted in 10 districts (6 IRS and 4 without IRS as control). Collected mosquitoes were identified morphologically and sibling species identified by PCR.

### Results

Mean mortality on all wall surface types was above the 80% WHO threshold for eleven months post-IRS with clothianidin. All p-methyl-sprayed wall surfaces had a mean mortality above 80% post-IRS for seven consecutive months. There was no significant variation among different wall surfaces ($p>0.05$). A total of 39,686 female *Anopheles* mosquitoes were collected and morphologically identified as *An. gambiae* s.l. (71.9%), *An. funestus* s.l. (21.7%), *An. coustani* (3.7%), *An. pharoensis* (1.8%) and *An. rufipes* (0.9%). Molecular identification conducted on 23,961 mosquitoes revealed the local malaria vector population was predominated by *An. funestus* s.s. (40.9%), *An. arabiensis* (37.6%), *An. gambiae* s.s. (15.7%) and *An. parensis* (1.1%). In sprayed sites, *An. funestus* were predominant before IRS and *An. arabiensis* after IRS. *An. funestus* s.s. was predominant in unsprayed control sites. The average pre-IRS sporozoite rate was 1.6 and reduced to 0.9 after spraying. Sporozoite rate remained higher (1.8%) in unsprayed sites ($p<0.01$).

### Conclusion

Clothianidin and p-methyl remained efficacious on all types of sprayed wall surfaces post-IRS during peak transmission season. IRS with these insecticides has significantly reduced sporozoite rates in *Anopheles* vectors.

**ABS-141**

## Assessing the Preferred Resting Site of Anopheles mosquitoes inside houses in Southern Malawi

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**Background:** Malaria vector control in Malawi relies on indoor residual spraying (IRS) and insecticide-treated nets (ITNs). IRS is applied in specific districts and targets mosquitoes resting on walls and ceilings. There is a dearth of information regarding mosquito resting behaviours inside houses. The study assessed the resting behaviours and identify preferred resting surfaces of mosquitoes inside three common house types in Chikwawa district, southern Malawi.

**Methods:** Mosquito collection was done inside 80 houses including: 28 with thatched roofs and mud walls, 28 with thatched roofs and un-plastered brick walls and 24 with metal roofs and un-plastered brick walls, across four villages between August and November 2020. In each house, resting mosquitoes were sampled between 6am – 8am using Prokopack aspirators from multiple surfaces (roofs, wall above 1m. wall below 1m, floors, furniture and clothing).

**Results:** A total of 5226 female Anopheles mosquitoes were captured of which Anopheles funestus s.l. (n=3423, 65.4%) was predominant followed by An. gambiae s.l. (n=1792, 34.2%). Blood-fed mosquitoes accounted for majority of Anopheles mosquitoes captured, regardless of house type (53% - 62%). An. funestus mosquitoes were twice as likely to be found resting on the underside of roofs compared to other surfaces in grass-thatch roof mud wall (OR = 2.81, 95% CI 2.48 – 3.18, p=<0.001) and grass-thatch brick wall houses (OR = 2.26, 95% CI 2.03 – 2.56, p<0.001). A large proportion of vectors were also captured on the underside of iron roofs of brick wall houses (54 – 56%). Overall, less than 10% of Anophelines were found resting on non-sprayable surfaces (hanging clothes, furniture and floors).

**Conclusion**: Majority of malaria vectors rest on the underside of grass-thatched roofs followed by walls which underpins the application of insecticides on these surfaces. There is an opportunity to exploit this resting behaviour and earmark roofs as potential surfaces to deploy novel vector control tools.

**ABS-97**

## Comparative efficacy of six different types pyrethroid piperonyl butoxide (PBO) against pyrethroid resistant malaria vectors in West and Central Africa

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**Abstract**

Pyrethroid-PBO nets have become available for malaria vector control and are being deployed in Africa. Several brands of these nets with varying characteristics and technical specifications have been developed presenting extra choice to vector control programs. Studies investigating the comparative performance of these different types of pyrethroid-PBO nets in different settings are essential. We performed a series of experimental hut trials to compare the efficacy and wash resistance of six types of pyrethroid-PBO nets (Olyset Plus, PermaNet 3.0, Duranet Plus, Duranet Plus 2.0, Veeralin and Tsara Boost) against wild pyrethroid resistant malaria vectors (*Anopheles gambiae* sl and *Anopheles funestus*) in experimental huts in Cameroon, Cote D'Ivoire and Benin. Comparisons were also made with pyrethroid-only nets. Susceptibility bioassays showed that the vector populations in all three study sites were highly resistant to pyrethroids and resistance could be mitigated by pre-exposure to PBO. Mosquito mortality was higher in huts with pyrethroid-PBO nets compared to pyrethroid-only nets in all study sites (20-40% vs. 10-25%). The levels of improved effect observed varied between sites and between the different types of pyrethroid-PBO nets and were substantially low compared to other newly developed types of dual insecticide ITNs tested in these sites. Wash resistance depended on the type of pyrethroid and the initial dose of both active ingredients on the net. DuraNet Plus, DuraNet Plus 2.0, Veeralin and Tsara Boost showed non-inferiority in terms of mosquito mortality and/or blood-feeding inhibition to at least one of the two brands which have so far demonstrated an improved epidemiological impact in community randomised trials (Olyset Plus and PermaNet 3.0). The laboratory bioassays (cone bioassays and tunnel tests) and chemical analysis results corroborated the findings in the experimental huts. Considering the low levels of improved effect observed, it is not clear whether either of these nets would have the same epidemiological impact against malaria demonstrated with pyrethroid-PBO nets in trials in East Africa.

**ABS-161**

## Mark, release and recapture experiments reveal seasonal changes in population size of *Anopheles coluzzii* target populations in two villages in Mali

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**Abstract**

Mosquito surveys are usually carried out to understand the composition, structure and abundance of vectors. However, they do not generate estimates of the size of local vector populations. Instead, one of the most common method of estimating population size is the "mark-release and recapture" method.

Here, we performed mark-release-recapture experiments in the villages of Tieneguebougou and Ouassorola in Mali for two consecutive years in July 2017 (start rainy season, August 2016, and November 2017 (dry season) to assess how seasonality affects the size of malaria vector populations. For each experiment, approximately 5,000 adult males of a locally-colonized *Anopheles coluzzii* strain were marked and released.

Swarm sampling was the most productive method for re-capturing male mosquitoes in the field. In Tiénéguebougou, the size of the population estimated in August 2016 (106,103) was greater than that observed in July 2017 (11,546) and November 2017 (29,227). The same was observed in Ouassorola, where the population estimated for August 2016 (90,674) was higher than that observed in July 2017 (19,046) and November 2017 (19,559). The results of the three mark-release-recapture experiments also showed significant difference between the recapture rates obtained in August 2016 (0.52%), July 2017 (2.07%) and November 2017 (1.09 %); this difference was also observed in Ouassorola during the months of August 2016 (1.78%), July 2017 (1.60%) and November 2017 (0.75%).

The estimated daily survival rate for Tieneguebougou is 0.26 in August 2016; 0.35 in July 2017 and 0.22 in November 2017 and that of Ouassorola: 0.35 in August 2016; 0.38 in July 2017 and 0.29 in November 2017. The average distance covered by males varied from 40 m to 100 m.

The combination of high survival rates and small target population sizes at the start of the rainy season (July) is the best for interventions based on mosquito releases.

**Keywords**

Mark, release and recapture, *Anopheles coluzzii,* Population size, Survival, Dispersion, Male mosquitoes.

**ABS-272**

## Chemical ecology of Zebra-Tsetse interactions and the control of African trypanosomosis

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Tsetse flies (Diptera: Glossinidae) vector trypanosome pathogens which cause African trypanosomosis, negatively impacting sustainable development in sub-Saharan Africa. Recent interventions focus on employing repellents from non-preferred hosts, such as waterbuck and zebra, to limit tsetse-host contact and disease transmission rates. Here, we hypothesized that zebra skin odour contains repellents which contribute to their avoidance by tsetse flies. Crude skin odours of zebra were evaluated for repellency on savannah tsetse flies *Glossina pallidipes* compared to a known tsetse repellent (waterbuck repellent compounds, WRC) in field trials. Electrophysiologically-active compounds in the crude skin odour were identified in the laboratory using coupled gas chromatography-electroantennographic detection (GC/EAD) and GC-mass spectrometry (GC/MS). Identified compounds were evaluated individually and in blends on field populations of *G. pallidipes* in Nguruman and *G. fuscipes fuscipes* on four Islands of Lake Victoria, Kenya following series of Latin square-designed experiments. Crude zebra skin odours significantly reduced trap catches of *G. pallidipes* similar to the known repellent WRC. GC/EAD and GC/MS analyses of the crude skin odours identified seven compounds which were consistently detected by tsetse; heptanal, 6-methyl-5-hepten-2-one, octanal, acetophenone, nonanal, decanal and geranyl acetone. A blend of all the identified compounds according to their natural ratio of occurrence in zebra skin odour significantly reduced field catches of *G. pallidipes*. Results from further field evaluation showed that the observed repellency of the crude skin odour and seven-component blend is attributed to the three ketones 6-methyl-5-hepten-2-one, acetophenone and geranyl acetone. A three-component blend of these ketones significantly reduced trap catches of wild *G. pallidipes* (62.7%; $P < 0.001$) and *G. fuscipes fuscipes* (25.6%; $P < 0.01$), and compares favourably with the repellency of WRC (58.1%– 59.2% and 20.7%, respectively). This study revealed the repellent effect of zebra skin odours on tsetse flies and their role in the bioecology of these flies. The identified three-component repellent blend represent an innovative control tool for tsetse flies, particularly *G. fuscipes fuscipes* whose chemical ecology has mostly been understudied, and potential effective tool in the integrated management of African trypanosomosis.

**ABS-94**

## First release of a genetically-modified strain of the malaria mosquito, *Anopheles coluzzii,* in Burkina Faso, West Africa: Dispersal, survival and swarm participation of sterile Ac(DSM)2 males

Franck Adama Yao, Abdoul-Azize Millogo, Patric Stephane Epopa, Ace North, Florian Noulin, Koulmaga Dao, Mouhamed Drabo, Charles Guissou, Souleymane Kekele, Moussa Namountougou, Robert Kossivi Ouedraogo, Lea Pare, Nourou Barry, Roger Sanou, Haida Wandaogo, Roch K. Dabire, Andrew McKemey, Frederic Tripet, Abdoulaye Diabate

**Background:** Every year, malaria kills approximately 405,000 people in Sub-Saharan Africa, most of them children under the age of five years. In many countries, progress in malaria control has been threatened by the rapid spread of resistance to antimalarial drugs and insecticides. Target Malaria, is a research consortium that aims to develop and share new genetic mosquito control tools for integrated malaria control strategies. In July 2019, in Burkina Faso (BF), the consortium proceeded with the first release of a genetically modified (GM) strain of *Anopheles coluzzii* called Ac(DSM)2.

**Methods:** The Ac(DSM)2, was created through backcrossing Ag(DSM)2 transgenic females from a previously-established early dominant embryo lethality-inducing strain. In June 2019, a large cohort of the strain was produced, sexed, and males dusted with fluorescent powder. A single release of 6,428 hemizygous Ac(DSM)2 males and 8,422 non-transgenic male siblings was conducted in the village of Bana (BF).

**Results:** After 17 days, 527 dusted males were collected from swarms and houses and Polymerase Chain Reaction analysis revealed 145 of these to be Ac(DSM)2 males. GM males were recaptured 50.8 - 497m and siblings 50.8 – 1,678m from the release point. A Bayesian approach showed, that GM males were found to have significantly shorter daily survival rates than their wild type siblings (0.55 - 0.63 vs 0.73-0.77 survival $day^{-1}$) and were also less mobile (diffusion rates 11,200 - 20,100 $m^2day^{-1}$ vs 28,800 - 75,700 $m^2day^{-1}$). The male population size at the time of the release was estimated to be in the range 28,000-37,000.

**Conclusions:** These results provide information about the fitness and behaviour of GM males released at the start of the rainy season. The first release of genetically modified mosquitoes in Sub-Saharan Africa is an important milestone towards future releases of more effective strains targeting the sibling species of the *A. gambiae* complex.

### Key words

malaria, release, genetically-modified, *Anopheles coluzzii*.

**DAY 2: Poster session 2: 2:30 – 3:300 pm UTC**

**ABS-153**

## Measurement of oocyst and sporozoite infection rates in *An. gambiae s.l.* under natural conditions in Bancoumana, Mali

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The dynamics of mosquito infections play a central role in *P. falciparum* transmission and human infection rates, and can be considered as an endpoint in trials of transmission-interruption interventions like vaccines. Here we measured natural oocyst and sporozoite infection rates in wild-caught *An. gambiae s.l.* Every month (Mar 2018-Jul 2019), a team collected mosquitoes in 63 households comprising 503 rooms, for 7,435 collections total (372-494 collections per month). Live mosquito collections using mouth aspiration were followed by pyrethrum spray collections of killed mosquitoes. Live *Anopheles* mosquitoes with recent bloodmeal were separated from unfed mosquitoes and kept seven days; midguts were dissected and oocyst infections were counted. Killed *Anopheles* mosquitoes were preserved in 80% ethanol and retained for ELISA-CSP (sporozoite infection rates) and PCR (*Anopheles* speciation).

Collections yielded 4,089 live female *Anopheles* with an average density of 0.55 (SD = 0.84) per hut; 3,164 (77.4%) mosquitoes survived to dissection, of which 84 (2.7%) were infected with mean of 2.1 oocysts [range 1-15]. Among 3,143 killed mosquitoes identified morphologically as *An. gambiae s.l* (mean 0.42 mosquitoes per hut), 25 (0.79%) were positive for CSP infection by ELISA. As expected, the highest number of infected mosquitoes (n=21) were collected during peak transmission season (Aug-Oct). A subset of mosquitoes underwent PCR analysis that identified two predominant species, *An. coluzzii* and *An. arabiensis*, at frequencies of 61.5% and 8.6% respectively. These large-scale collections provide an estimate of the incidence of malaria infection in circulating mosquito populations and can be a valuable tool to measure the impact of any malaria control measures tested or implemented in communities.

**Keywords:** Malaria, oocyst, sporozoïte, live catch, pyrethrum catch.

**ABS-237**

## The African mosquito-borne diseasosome: Geographical patterns

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### Abstract

Global mosquito-borne diseases have originated from Africa in disproportionally larger number than from any other continent begging for explanation and identification of future risks. Surprisingly, mosquito-borne diseases (MBD) of Africa or any other continent have not been subjected to biological system analysis despite its cohesive nature and local and global importance. Here we apply this approach to the MBD of Africa, from a One Health perspective to provide, a comprehensive biogeographic description of the African mosquito fauna and the pathogens they transmit to vertebrates. After construction of a dedicated database, we address the following questions. Is African mosquito composition especially diverse or unique? How are mosquito and pathogen diversity structured across the continent in terms of species richness, endemicity and composition and what are the main factors that might have shaped these structures? What is the typical area occupied by a mosquito and pathogen species and how variation in their range size is structured? Addressing these questions allow us to assess to what extent has mosquito organization shaped that of the pathogens and compare geographical affinities of pathogens and mosquito vectors that pose a greater risk within and beyond the continent. Finally, we evaluate if these affinities can be used to rank the risk for future emergence of mosquito borne pathogens or their vectors locally and globally.

**ABS-168**

## INSECTICIDE RESISTANCE PROFILE OF *AEDES AEGPYTI* (CULICIDAE) IN SOME SITES IN URBAN ACCRA, SOUTHERN GHANA.

**GODWIN KWAME AMLALO**, JEWELNA AKORLI, MILLICENT OPOKU, KWADWO FREMPONG, SELLASE PI-BANSA, ETORNAM NUKUNU AKYEA-BOBI, HELENA A. BOAKYE, JOANNITTA JOANNIDES, JOSEPH HAROLD NYARKO OSEI, REBECCA PWALIA, SAMUEL SOWAH AKPORH, DOMINIC ACQUAH-BAIDOO, ESINAM ABLA AKORLI, MUFIZ ABUDU, SERAPHIM N.A TETTEH, JOSEPH ABRAHAM, ALEXANDER MANU, SAMUEL K. DADZIE

**Background:** Arboviral diseases are increasing becoming important public health diseases globally. These diseases are transmitted by arthropods, mainly *Aedes* mosquitoes, however due to the lack of effective drugs and vaccines, insecticide-based vector control has become the most effective control measure during outbreaks. However, insecticide-based vector control is threatened by the rapid spread of insecticide resistance among vector populations. Regular monitoring of vector populations is therefore essential for vector control programs. This study investigated and compared the species composition, insecticide susceptibility and the resistance mechanisms in a forest and domestic *Aedes* mosquito populations in urban Accra, Ghana.

**Methods:** Immature *Aedes* mosquitoes were sampled from Achimota forest and Madina (forest and domestic sites) and raised to adults. Non-blood-fed female adult *Aedes* mosquitoes were exposed to deltamethrin, permethrin, DDT, fenitrothion, bendiocarb, permethrin + PBO and deltamethrin + PBO using WHO tube assays. Melting curve analyses were performed for F1536C, V1016I and V410L genetic mutations in surviving and dead mosquitoes following exposure to pyrethroids. Microplate assay was used to access enzyme activity levels in unexposed samples from the two populations.

**Results:** *Aedes aegypti* was the dominant species from both populations. The susceptibility test result revealed high resistance to all the insecticides except fenitrothion. Deltamethrin and permethrin recorded mortality rates of 56% and 66%, and 23% and 67% in the domestic and forest populations respectively. The synergist assay indicated the involvement of mixed function oxidases in the resistance to pyrethroids. A high frequency of F1534C, V1016I and V410L gene mutations was observed in both populations.

**Conclusion:** We conclude that *Aedes* vectors are prevalent in urban Accra and have developed resistance to the commonly used insecticides including deltamethrin and permethrin. However, the study populations are susceptible to fenitrothion. This information is important for the formulation of insecticide-based vector control strategies for *Aedes* control in the study sites.

**ABS-61**

## Practical and exposure-free methods for monitoring biting time phenotypes by the malaria and filariasis vectors:

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**Background**: Although, the original version of Mosquito Electrocuting Trap (MET), has been demonstrated to be effective and consistently replicate key mosquito human-feeding behaviours as human landing catch gold standard, its complete safety to the users with respect to participant's exposure to mosquito bites remain questionable. Despite the user wearing protective clothing during collection, the face remains uncovered, and sometimes the use of protective clothing makes the user uncomfortable especially, during hot seasons. A modified prototype which offers complete protection to the collector has been developed, but the impact of such modification on the performance of trap remained unknown, and its established here for the first time. On the other hand, barrier screen trap has proven its reliability in South East Asia and Madagascar for outdoor sampling, but yet to be tested in ecological settings of Tanzania.

**Method**: Field evaluation of mosquito sampling sensitivity and biting time phenotypes estimates from three traps: original MET, modified MET and barrier screens were conducted in south eastern Tanzania, for 12 nights using 3x3 Latin square experimental design.

**Results**: **Results**: Modified MET (METc) and Barrier Traps caught similar number of Anopheles gambiae sensu stricto as the original MET (RR [95% confidence interval(CI)]= 0.79[0.44-1.43], P = 0.44, and 0.80[0.27-2.35], P = 0.68 respectively. Similarly, no significant difference was detected for sampling the Culex sp relative to the MET (RR[95%CI]= 0.94[0.65-1.34], P = 0.73) and 0.83[0.39-1.79], P = 0.64) respectively. Biting time proportion estimates from METc and Barrier screen of three ordered time of the night: before bedtime (18:00-22:00), during bedtime (22:00-05:00) and awake time 05:00-07:00) were statistically not different from those based on MET for the An gambiae and Culex.

**Conclusion**: The modification made for the MET did not strongly affect its performance. This prototype is recommended for use over the original design, as it offers complete protections for users against mosquito bites. Similarly, to southeast Asia, the Barrier screen has also demonstrated potential for monitoring malaria and filariasis transmitting mosquitoes in these settings, and perhaps in other African settings.
**Keywords**: Monitoring, Malaria vectors, Biting times, mosquito sampling, *Anopheles gambiae*

**ABS-246**

## Binomics of mosquitoes in Umunze, Anambra State, Nigeria

Dennis Aribodor

Mosquito borne diseases have a great impact on human and animal health throughout the world. An entomological survey was conducted in Umunze, Orumba South Local Government Area, Anambra State, in 2018 to identify the mosquito larvae and investigate different breeding habitats preference, species abundance, ecological parameters of breeding habitats, indoors and outdoors biting mosquitoes. Mosquito larvae were collected with ladle and pipette. A total of 750 mosquito larvae were collected from 48 sampling sites made up of ground pools (20.3%) 152/750), domestic containers (18.3%) 137/750, used vehicle tyres (17.1%) 128/750, clay pots (15.5%)116/750, broken bucket/tins (14.7%) 110/750 and the least was reservoir tanks (14.3%) 107/750. There was no significant difference in larvae breeding habitats (P=0.626). Four mosquito species belonging to three genera were recorded, namely: *Aedes* (*Ae.*), *Culex* (*Cx.*) and *Anopheles* (*An.*) The species identified were *Aedes albopictus*, *Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles gambiae*. Among the collected larvae, *Aedes albopictus* (29.9%) 224/750 was most abundant followed by *Aedes aegypti* (28.55%) 214/750, *Culex quinquefasciatus* (26.5%) 199/750, and *Anopheles gambiae* (15.1%) 113/750. There was no significant difference in species abundance (P=0.395). It was also found that Ugwunano village (17.7%) 133/750 had the highest number of mosquitoes reared from larvae and the least was Amuda village 78 (10.4%) and there was significant different in the larvae mosquitoes collected from different villages (p=0.010).The ecological parameters of mosquito breeding habitats showed that the temperature of water from various mosquitoes breeding habitats varied between 20.4 °C and 26.3 °C with the highest value recorded in (26.3°C) recorded in reservoir tank and the lowest in used tyres (20.4°C). There was no significance difference in temperature of the

breeding habitats (P= 0.586) as well as in total suspended Solid (TSS). (P=0.15). Of the 172 adult mosquitoes caught indoors using Pyrethrum Knockdown Collection (PSC), there was no significant difference (P = 0.123) but there was significance difference in the species abundance indoors (P= 0.00). 194 adult mosquitoes were caught outdoors using Human Bait Collection (HBC) and there was significant difference in the species abundance of adult mosquitoes biting man out doors (P=0.004). The blood feed female *Anopheles gambiae* were identified and dissected to observe the salivary gland for sporozoites and (54.1%) 46/85 had sporozoites while (45.9%) 39/85were without sporozoites. Since *Aedes*, *Culex* and *Anopheles* can breed in all available breeding habitats, the survey will help us to conduct future mosquito control activities and provide useful information to schedule larvicide and adultiside application to control mosquito borne diseases in the study area.

**ABS-52**

Modelling the potential impact of supplementary tools for malaria vector control in Kilombero valley, Tanzania

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**Background:** Despite significant progress against malaria, our core interventions, insecticide-treated nets (ITNs) and indoor residual spraying, are becoming increasingly vulnerable as outside mosquito bites and insecticide resistance increase. Even in the Kilombero valley, where over 80% of the population uses ITNs to protect themselves from mosquito bites, transmission continues. For effective malaria control, additional tools should be designed, tested, and used together with ITNs in the area.

**Methods:** The vector control optimization model (VCOM) was adapted and extended to first simulate the impact of different coverage levels of eave ribbons treated with spatial repellents when combined with ITNs on the reduction of entomological inoculation rates (EIR) by Anopheles arabiensis and Anopheles funestus separately. In the second scenario, the impact of endectocide-treated cattle intervention was also simulated in combination with ITNs on EIR mediated by either An. arabiensis or An. funestus, and finally, the impact of these interventions on the combined EIR for An. arabiensis and An. funestus was simulated to determine the best coverage level.

**Results:** Only twenty percent eave ribbon coverage, paired with eighty percent ITNs was enough to reduce An. funestus-mediated EIR to below one in the area. In the case of An. arabiensis, lower coverage of endectocide-treated cattle was sufficient to drop the EIR to the level considered relevant for the control. To achieve malaria interruption, however, a high coverage level of roughly 60% for both endectocide-treated cattle and eave ribbons was necessary for combination with ITNs for the combined transmissions by An. funestus and An. arabiensis.

**Conclusion:** Despite the significant impact of eave ribbon and endectocide treated cattle when combined with ITN on controlling malaria transmission by An. funestus and An. arabiensis, high coverage of these supplementary tools is required in areas such as the Kilombero valley where all these species contribute to malaria transmission together.

**Keywords:** Eave ribbon, endectocide treated cattle, Anopheles funestus, Anopheles arabiensis, Kilombero valley, malaria

**ABS-206**

## Plausible pathways to potential harm systematically identified via problem formulation for investigational releases of a population suppression gene drive to control the human malaria vector *Anopheles gambiae* in West Africa

John Connolly, Senior Regulatory Science Officer, Target Malaria.

### Abstract

Population suppression gene drive has been proposed as a strategy for malaria vector control. A CRISPR-Cas9-based transgene homing at the *doublesex* locus (*dsxF*$^{CRISPRh}$) has recently been shown to increase rapidly in frequency in, and suppress, caged laboratory populations of the malaria mosquito vector *Anopheles gambiae*. Building on consultative workshops in Africa that previously identified relevant environmental and health protection goals, problem formulation, an initial step in environmental risk assessment (ERA), was performed for simulated field releases of the *dsxF*$^{CRISPRh}$ transgene in West Africa. Eight potentially harmful effects from these simulated releases were identifiedm which were stratified into 46 plausible pathways describing the causal chain of events that would be required for potential harms to occur. Risk hypotheses to interrogate critical steps in each pathway, and an analysis plan involving experiments, modelling and literature review to test each of those risk hypotheses, were developed. Most potential harms involved increased human (n=13) or animal (n=13) disease transmission, emphasizing the importance to subsequent stages of ERA of data on vectorial capacity comparing transgenics to non-transgenics. Although some of the pathways (n=14) were based on known anatomical alterations in *dsxF*$^{CRISPRh}$ homozygotes, many could also be applicable to field releases of a range of other transgenic strains of mosquito (n=18). This analysis revealed that the efficacy of population suppression caused by the *dsxF*$^{CRISPRh}$ transgene should itself directly affect most pathways (n=35). Modelling will therefore play an essential role in subsequent stages of ERA by clarifying the dynamics of this relationship between population suppression and reduction in exposure to specific potential harms.

**ABS-111**

## Addressing transmission of dengue, and chikungunya by *Aedes aegypti* in the tropica Africa context.

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### Abstract

Dengue fever has been endemic in South East Asia and South America for a long time. In recent times the disease has spread to a large number of countries in Africa. In addition, Chikungunya a disease largely confined to Africa, has spread to Asia Southern Europe and South America. It also appears to be spreading widely in Africa. The two viral diseases are transmitted by *Aedes aegytai* and *Aedes albopictus*. Ae. aegypti is a container breeder with a strong tendency for urban transmission while *Ae. albopictus* can breed in rural areas. Increasing urbanization in Africa, puts more people at a risk of urban transmission while climate change may create more stable breeding habitats in both urban and rural environments.

While vector control has been undertaken during dengue outbreaks, little attention had be placed on larviciding. In Kenya, larval control for malaria vectors has been tested although the transmission impact was low due to the a abundance of anopheles habitats. It has been proven that larvicides such as long lasting *Bacillus thurigiensis var insraliensis*, *Bacillus sphericus*, surface monolayers, (Arosurf MSF, Aquatain) and insect growth regulators (IGR) have strong larvicidal effects on mosquito larvae and pupae.

These larvicides have the potential to control vectors breeding in containers in urban areas where the habitats can be easily identified and targeted. Studies are required to determine the feasibility of aedes vectors control.

**ABS-113**

## Seasonal variation of Arthropods of medical, veterinary and agricultural interest in different eco-climatic zones of Mali

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### Abstract

Arthropods are vectors of many diseases in humans, animals and plants. Arthropods identification is critical to assess the role of particular species in disease transmission. This is a basic knowledge to set and improve vector disease control operations. This study was conducted in 3 villages of different eco-climatic zones of Mali, in order to see the seasonal variation of Arthropods of medical, veterinary and agricultural interest in general.

The sampling was done by trapping in the villages of Bia, Thierola and Kenieroba. Two types of traps were used: the emergence trap and T-trap. Arthropods were identified morphologically and also by PCR. Their medical, veterinary and agricultural interest was determined base on their ecological and biological behavior. The seasonal variation was determined by the densities of each arthropod through the study period. This study allowed having an overview of the qualitative and quantitative variations of the different Arthropods of medical, veterinary and agricultural interest in Mali.

The data allowed to identify 20 species of Arthropods belonging to three classes, namely Arachnids, Insects and Myriapods and thirteen orders (Araneids, Coleoptera, Dermaptera, Dictyoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Neptroptera, Odonata, Orthoptera and Plecoptera) Of these orders, 11 were collected in Bia, 10 in Thiérola and 12 in Kéniéroba. It is noted that the most frequent orders of Arthropods collected in the three different sites were Diptera, Coleoptera, Hymenoptera, Hemiptera, Orthoptera, Lepidoptera and Odonata and also Araneids. Diptera are better represented in Bia and Thirola and Coleoptera in Kenieroba.

### Keywords

Arthropods, medical, veterinary, agricultural, eco-climatic zones, Mali.

***ABS - 52***

## HumBug – An Acoustic Mosquito Monitoring Tool for use on budget smartphones

**Marianne Sinka1**

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**Background and Objective:** Mosquito surveys are time consuming, expensive and can provide a biased spatial sample of occurrence data; the data often representing the location of the surveys, not the occurrence of the mosquitoes. To increase the quantity and quality of mosquito occurrence data as well as access locations that are more difficult to survey by traditional means, we present the HumBug project, an acoustic system that can turn any Android smartphone into a mosquito sensor.

***Materials and Method:*** Using traditional mosquito sampling methods such as human baited nets and CDC-Light traps, we describe how we have built our database of species-specific wild-captured mosquito fight tone data and outline the mosquito detection algorithms that these data train. We also present our MozzWear App, designed to work on budget smartphones, which, together with our HumBug Net (an adapted traditional bednet), facilitates data collection and allows the user to record and directly upload mosquito flight tones from

the field.

***Results and Discussion:*** Our acoustic database now holds over 6900 recordings of individual wild captured mosquitoes from six genera (*Aedes, Anopheles, Armigeres, Coquillettidia, Culex* and *Mansonia*) and includes dominant Asian (*An. barbirostris, An. dirus, An. harrisoni, An. maculatus, An. minimus*) and African (*An. arabiensis, An. coluzzi, An. funestus, An. pharoensis*) malaria vector species. These data train our mosquito detection and species classification algorithms the latter of which achieves an average ROC-AUC (Receiver Operating Characteristic-Area Under Curve) of 0.927 across eight species of individual mosquitoes captured in the wild.

***Conclusion and Recommendation:*** Our HumBug system has the potential to vastly increase our understanding of the distribution of mosquito species in space and time and greatly improve surveys needed to assess the success or failure of ongoing vector control measures.

**ABS-277**

**A microsporidian impairs *Plasmodium falciparum* transmission in *Anopheles arabiensis* mosquito populations**

**Lilian Ang'ang'o**

The present malaria control strategies are promising but equally inefficient. A case in point is the indoor residual spraying limited by resistant mosquito populations, which renders the approach expensive to maintain in many sub-Saharan countries. Additionally, there is currently no effective chemotherapy in place due to the looming resistance in the different parasite strains. Hence, a rising need for alternative and sustainable solutions such as protective symbiotic interactions.

Symbiotic microbes are beneficial micro-organisms that coexist with their host enhancing their survival at the expense of improved host fitness. In this study, we discovered that a microsporidian – a symbiotic fungus - called *Microsporidia MB* blocks malaria transmission from mosquitoes to humans.

The study was conducted in different geographical locations of central and western Kenya. Wild-caught mosquitoes were screened for *Microsporidia MB* using molecular assays and determined to have a moderate prevalence of the symbiont. Fluorescent *in situ* hybridization. In addition, laboratory-reared progenies from infected field *Anopheles* females were fed on *Plasmodium* gametocyte-positive blood from donors and later dissected and screened for both *Microsporidia MB* and *Plasmodium* using quantitative PCR assays. *Plasmodium* development was effectively arrested at the oocyst stage in mosquitoes harbouring this new symbiont. Concurrently, the infected colony was actively monitored to confirm the effect of *Microsporidia MB* on the development and survival of these mosquitoes. No adverse side effects to the host's survival, fecundity and development were recorded. Moreover, *Microsporidia MB* showed efficient vertical transmission from infected mother to offspring. Conclusively, this work reported a new microsporidian naturally occurring within the *Anopheles gambiae* complex with the capacity to completely limit *Plasmodium* development.

There is great potential in harnessing the power of microbes that block the transmission of diseases by insects. *Wolbachia*-based control strategies have been proven effective because the bacterium solely spreads within the mosquitoes limiting antiviral dissemination. Furthermore, the bacterium benefits the mosquito's fitness enabling generational transfer from mother to offspring. Similar symbiotic traits have been identified in *Microsporidia MB* making it a superior transmission blocker that can be potentially harnessed in malaria control.

**Keywords:** *Anopheles, malaria, Microsporidia, mosquito, Plasmodium, symbiont, vector-borne disease*

**ABS-147**

**Title: Transcriptomic data analysis of resistant mosquitoes' reveals new insight for vector control**

**program.**

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## Abstract

**Introduction:** Mosquitoes resistance to insecticide is one of the major threat to malaria vector control program in Africa. To investigate mosquitoes' population resistance toward an insecticide, researchers and the National Malaria Controls programs use known markers such as mutations in the *ace-1* and the *kdr* genes to determine if populations are resistant to carbamates and pyrethroids compounds, respectively. Though those mutations and those genes might not be the only ones encountering the resistant phenomenon in field resistant mosquitoes. The importance of finding new markers that will be helpful to develop new tools for the surveillance of mosquitoes' resistance becomes needed. Using whole transcriptome sequencing, we characterized genes deferentially expressed during an exposure to insecticide.

**Methodology:** Larvae were collected from Bassila and Djougou, two sites of Benin. They were reared to adult stage to establish F1 progeny. Four to five day-old adult non-bloodfed female mosquitoes from F1 progeny were phenotyped as either deltamethrin, pyrimiphos-methyl or alpha-cypermethrin resistant using CDC bottle bioassays test. RNA from resistant, unexposed, and susceptible laboratory strain of *An. gambiae* was extracted, sequenced and analyzed using RNA-Seq and bioinformatics tools respectively to find differential expressed genes (DGE).

**Results:** This study showed that, Djougou mosquitoes' were more resistant to deltamethrin 5x (48.21%) and alpha-cypermethrin 2x (52.54%) than Bassila mosquitoes' (0% and 17.39% respectively); while the later were more resistant to pyrimiphos-methyl 1.5x (51.61%) compare to Djougou's mosquitoes (24.14%). RNAseq data analysis reveals a list of up regulated genes within resistant mosquitoes compare to unexposed and laboratory strain mosquitoes among the 5 families of genes known to be involved in the resistant mechanism of mosquitoes.

**Conclusion:** Overall, this study brings to light new genes not found in the literature that can be more investigated and look up to when developing new techniques for malaria vector surveillance.

**Keywords: Resistance, vector-surveillance, bioinformatics, DGE.**

**ABS-83**

## Mind the gap: Understanding human-vector interaction and malaria prevention strategies in rural Malawi.

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**Background**
Insecticide Treated Nets (ITNs) represent the main domestic tool of vector control worldwide, and the primary malaria prevention strategy adopted by National Malaria Control Programmes (NMCPs) in sub-Saharan countries. Since 2012, following guidelines from the World Health Organisation, the Malawian government has implemented national distribution campaigns of ITNs to ensure sufficient coverage of the population. These campaigns distribute bednets every three years in a ratio of one bednet every two individuals. Nonetheless, similarly to other sub-Saharan countries, malaria infection rates in Malawi have remained high with 95% of the country endemic to malaria and the prevalence at 36%.
Drawing on a qualitative and in-depth approach, this work contextualises bednet use in rural Malawi, offering actionable insights into how the efficacy of national distribution strategies can be implemented.
**Methods**
Participant observation and in-depth interviews were conducted between November 2020 and January 2021 in Chikwawa, Chikwansa Village.
**Results**
Participants engaged in activities that intersected within Anopheles mosquito feeding time (18:00-06:00). Bednet sharing was limited to relatives of the same gender or in (grand)parent/(grand)child relationships. Defeating the one-bednet-per-two-individuals ratio endorsed by bednet distribution campaigns, these practices resulted in a relatively lower availability of bednets than imagined at the planning stage. Seasonal cycles of activity further affected bednet durability and availability, prompting the participants to seek other—often less effective or lasting—forms of prevention.
**Conclusion**
Bednet distribution policies do not account for sleeping arrangements and sleep patterns, whose predictability is essential to adequate national distribution campaigns planning and bednet procurement. Such circumstances, appropriately documented and understood, can be used to crucially inform cost-effective distribution policies and vector control strategies.

**Keywords**
human-vector interaction; national distribution; malaria intervention; bednet procurement

**ABS-240**

## Impact of IRS on the mitigation of possible malaria outbreak after the floods caused by the idai

**cyclone in Sofala, Mozambique**

Nelson Cuamba

**Background:** In March 2019, parts of Mozambique were hit by cyclone idai resulting in floods. The city of beira was hit by a windstorm that reached 175 km/h. With fears of malaria outbreak, as the waters receded, epidemiological surveillance before and after the introduction of preventive measures, was seen as important in assessing the impact of these measures. We present the results of the impact of indoor residual spraying (irs) in containing a possible outbreak of malaria after cyclone idai.

**Methodology**: The study was carried out in the municipality of Beira and Nhamatanda district, in Sofala province. In beira it was conducted in Manga-estofo (urban) and Ceramica (rural) and in Nhamatanda in the bairro-7 (urban) and Metuchira (rural). Malaria incidence data were collected from the dhis only in rural areas. Additional data were collected in two non-sprayed rural localities for comparison. Wilcoxon test were used to compare incidence before and after irs. Mosquitoes were monitored through cdc light traps collections. Three to five days old mosquitoes reared from larvae collected from breeding sites and reared to adults were used for susceptibility tests. Irs was done in may using pirimiphos-methyl.

**Results and discussion:** *Anopheles funestus* s.l was the predominant species and found exclusively in rural areas. In urban areas, *an. Gambiae* s.l was found in low densities or was at undetectable levels. The vectors were susceptible to 0.25% pirimiphos-methyl in both areas and to bendiocarb in nhamatanda. The incidence of malaria, which was rising after the cyclone decreased after irs. Although the difference between before and after irs is not significant ($p = 0.07$), the results suggest that irs had an impact on incidence when compared to unsprayed areas ($p = 0.96$).

**Conclusion:** The results suggest irs can help to suppress possible outbreaks of malaria in situations of natural disasters involving floods.

**ABS-159**

**Blood meal sources for major and minor anophelines in Malawi**

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**Introduction**

Blood fed *Anopheles* mosquitoes provide information on blood feeding patterns of *Anopheles* species in an area. Knowledge of feeding behavior is crucial for incriminating potential malaria vectors. There is a paucity of data regarding blood feeding patterns of anophelines in Malawi. This study was carried out to determine blood meal sources for major and minor anophelines in the country.

**Methods**

Adult mosquitoes were collected using 20-metre-long Barrier screens (BS), and netting around Cow pens (CP) outdoors and Prokopack (PR) indoors. Collections occurred for 3 days each month during the rainy season from January till March 2020 in malaria-endemic villages in Chikwawa and Dedza districts. *Anopheles* mosquitoes were morphologically and molecularly identified and sorted based on species and abdominal status. We estimated the sources of blood from fed anophelines by employing a polymerase chain reaction assay to

amplify mammalian mitochondrial DNA from engorged anophelines.

**Results**

A total of 11,655 anophelines were collected representing eight species comprising *An. gambiae s.l* (83%), *An. funestus s.l* (8%), An. pharoensis (4.1%), *An. tenebrosus* (3.8%), *An. coustani* (0.6%), *An. pretoriensis* (0.07%), *An. squamosus* (0.03%) and *An. maculipalpis* (0.02%). 2817 blood fed *Anopheles* were collected of which 158 *Anopheles* representing 3 species were collected indoors whilst 2,640 representing 8 species were collected outdoors. A total of 117 anophelines comprising of eight species were assayed for blood meal sources. The recorded blood meals were majorly from bovine (86%), humans (10%), pigs (2%) and dogs (2%). The Human Blood Index (HBI) and Bovine blood index of *An. gambiae* s.l. was 8% and 72%, respectively.

**Conclusion**

Findings show the opportunistic behavior of *An. gambiae s.l.* populations. The study expands knowledge on blood meal hosts for anophelines that rest both indoors and outdoors. There is a need for routine surveillance of vectors to monitor changes in host preference in areas of high malaria transmission settings with wide coverage of vector control tools.

## ABS-135

## Trends in *an. Gambiae* s.l. insecticide resistance in the democratic republic of congo

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The U.S. President's Malaria Initiative (PMI) VectorLink Project conducted resistance monitoring in the Democratic Republic of Congo (DRC) in 2019 and 2020 in 10 and 13 sentinel sites, respectively. To inform the National Malaria Control Program's (NMCP's) choice of insecticides for future insecticide-treated net (ITN) distribution campaigns, insecticide susceptibility tests were conducted in all sites.

Resistance intensity bioassays using *Anopheles gambiae* s.l. were conducted with permethrin, deltamethrin, and alpha-cypermethrin at one, five, and 10 times the diagnostic concentration, according to World Health Organization (WHO) protocols. The project used piperonyl butoxide (PBO) synergist bioassays with pyrethroids and bottle bioassays to determine vector susceptibility to chlorfenapyr. Molecular analyses were conducted at the Institut National de Recherche Biomédicale (INRB). Data collected were used to design resistance maps

and propose ITNs that could potentially help manage resistance and improve the efficacy of interventions.

Insecticide susceptibility tests showed that pyrethroid resistance is widespread. In all sites, *An. gambiae* s.l. were resistant to permethrin, deltamethrin and alpha-cypermethrin. Resistance intensity varied by site and by insecticide but was usually moderate or high. For example, in 2020, permethrin resistance intensity was low in two sites (Mweneditu and Dibindi); moderate in three sites (Kabondo, Mbandaka and Lisala); and high (<98% mortality at ×10 dose) in eight sites (Katana, Kingasani, Inongo, Kimpese, Mikalayi, Kapolowe, Kalemie, and Lodja). Despite uncertainty regarding the impact of pyrethroid resistance on efficacy of ITNs, WHO states that, "When resistance is confirmed at the 5× and especially at the 10× concentrations, operational failure is likely." Throughout DRC, resistance to the three most common pyrethroids used on ITNs was common at the 5× and 10× concentrations, therefore making it likely that pyrethroid-only ITNs are no longer providing optimal protection against malaria. The high intensity of pyrethroid resistance indicates that the NMCP should consider alternative types of ITNs for future distribution campaigns. In all sites, bioassays with permethrin following pre-exposure to 4% PBO in WHO tube tests showed an increase in mortality compared with permethrin alone. Despite this, mortality was still <90% in six sites. There was a significant increase in mortality with deltamethrin and alpha-cypermethrin following pre-exposure to 4% PBO in all sites; increases in deltamethrin mortality were particularly high in Buta, Aketi, Kimpese, Nebobongo, Pawa, Katana, Kingasani, Mweneditu, Dibindi, and Mbandaka. Despite an increase in mortality after pre-exposure to PBO, alpha-cypermethrin mortality was still <90% in five sites (Inongo, Mikalayi, Kapolowe, Lodja, and Lisala).

Molecular analyses revealed that *An. gambiae s.s.* was the predominant species of the *An. gambiae* complex across all sites, with *An. coluzzii* identified only in Lodja, Mbandaka, Dibindi, and Kingasani. The Vgsc-L1014F mutation was detected at fixation in all sites and is likely to contribute to pyrethroid resistance together with other metabolic mechanisms that were implicated in the PBO bioassays.

The general increase in mortality when the PBO synergist was used indicates that ITNs containing PBO may provide greater control, although susceptibility was not fully restored following PBO pre-exposure. A better option may be Interceptor G2 ITNs, as susceptibility to chlorfenapyr was recorded in all sites where testing was conducted (Aketi, Buta, Pawa, Nebobongo, Mikalayi, Tshikaji, Kinshasa, Binza Meteo, Muanda, Kimpese, Mweneditu, Dibindi, Inongo, Mbandaka, and Lisala). However, the increased cost may be prohibitive.

**Keyswords**

Democratic Republic of Congo, resistance, pyrethroids, PBO synergist, Interceptor G2 ITNs

**ABS-195**

## Susceptibility of *Aedes* larvae from two urban localities in Accra To Vectobac®12as (*Bacillus Thuringiensis* Var *Israelensis)* and Abate® (Temephos).

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**Introduction:** *Aedes* mosquitoes remain a continuous public health problem because they can spread a vast number of viral diseases such as Zika fever, chikungunya, yellow fever, and dengue. Larvicides have been used as important vector control tools to control *Aedes*-borne diseases globally. However, the effectiveness of this larvicides within the context of the development of insecticide resistance remains a challenge. This study evaluated the effectiveness of Vectobac®12AS and Abate® (Temephos) against *Aedes aegypti* from some localities in Accra.

**Methods:** *Aedes* larval sampling was carried out from the Achimota Forest and Madina between August and September 2020. Laboratory bioassays were conducted using standard WHO methods with Vectobac®12AS and Abate® (temephos) as selected insecticide. A target concentration of 0.0075 ITU/mg, 0.015 ITU/mg, 0.03 ITU/mg, 0.06 ITU/mg, and 0.12 ITU/mg was used for Vectobac® 12AS as well as 0.0014mg/l, 0.003mg/l, 0.006mg/l, 0.0125mg/l and 0.025mg/l for Temephos. Mortality was recorded for the first 30 minutes and then every hour until 24 hours. Modified microplate method was used to detect enzymatic activity of Mixed Function Oxidase (MFO), Glutathione-S-Transferase (GST), insensitive acetylcholinesterase (AChE), non-specific elevated (α- and β-) esterases and total proteins in the mosquitoes using pyrethroid susceptible *Aedes aegypti* strain as standard.

**Results:** The study found *Aedes aegypti* to be the most predominant mosquito in the two sites. Bioassay results indicated that VectoBac® 12 AS produced 100% mortality after 24hrs with the highest concentration (0.12 ITU/mg) giving a mortality of 50% between 30-40 minutes in both areas. All concentrations of Abate® larvicide produced 100% mortality after 24hrs. The highest concentration (0.025mg/l) was able to kill 50% of the larvae in 1hr at both study areas. There was elevated activity of all enzymes tested especially GSTs in both areas.

**Conclusion:** This study confirms the effectiveness of Abate® (temephos) and VectoBac® 12AS (*Bacillus thuringiensis israelensis*) as larvicides for vector control in reducing the *Aedes eagypti* vector as a strategy to control the transmission of arboviral diseases.

**ABS-203**

## Assessing the behavioural and physiological effects of piperonyl butoxide (PBO) exposure on *Anopheles gambiae*

Rosheen Mthawanji

**Background:** Long lasting insecticidal nets (LLINs) remain one of the frontline tools in malaria vector control, however due to insecticide resistance, Piperonyl butoxide (PBO) has been incorporated into LLINs. These LLINs have been deployed around Africa and have proven to be efficient in areas that have resistant vectors. However, a knowledge gap exists when it comes to the interactions between the vectors and PBO LLINS. This project assessed the impacts of exposure to PBO-LLINs and PBO-alone on *Anopheles gambiae* s.l. with focus on longevity, host-seeking behaviour, and reproductive capacity in a laboratory environment.

**Methods:** A baited-box video assay was used to assess the behavioural responses of susceptible lab reared *Anopheles gambiae* to three different net types: untreated, deltamethrin only and PBO- deltamethrin. The mosquitoes were then observed post assay for longevity. The sublethal effects of PBO alone on both male and female mosquitoes was observed using the WHO tube assay. The effects of PBO on blood-feeding and longevity were characterized. An Olfactometer was then used to quantify host seeking behaviour.

**Results:** There were no differences in the response rates of each strain to untreated, deltamethrin only and the PBO-deltamethrin nets ($P = 0.38$). Behavioural responses to the untreated nets and ITNs were similar in both the resistant and susceptible strain, the total net contact time was the shortest on the PBO-LLINs and longest on the untreated nets. There were significant differences between the time spent blood feeding on both the strains. However, no differences were seen for the time taken before the mosquito appears in the box. For both the Kisumu and Banfora strains, longevity significantly differed between the net types (Kisumu, $X^2=128.0$, df=2, $P < 0.0001$; Banfora $X^2=114.3$, df=2, $P < 0.0001$). WHO tube assay results showed that where blood-feeding was

allowed immediately after exposure there was a significant reduction in feeding ($X^2$=429.0, df=7, P <0.0001). Male mosquitoes lived nearly three times as long if exposed to control papers rather than those treated with PBO ($\chi 2$ = 66.1, df = 1, p = 0.0001). The Olfactometer assay confirmed that mosquitoes that are exposed to PBO are less likely to seek a host successfully.

**Conclusion:** The PBO LLINs show efficacy against both resistant and susceptible mosquitoes in lab-based assays. This study highlights that PBO remains an important compound in the fight against resistance in malaria vectors.

**ABS-176**

## Investigating the ecology of *Anopheles funestus* in relation to seasonality and its implication on malaria transmission

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### Abstract

Malaria is the most significant mosquito-borne disease of humans, causing approximately 229 million cases and 409 000 deaths. Most of these deaths and cases occur in children under-five and pregnant women with the highest burden in sub-Saharan Africa. Since 2000 to 2015 there had been dramatic reduction due to upscaling of vector control interventions such as Insecticide Treated Nets (ITNs), Indoor Residual Spraying (IRS) and effective case management. Despite of these interventions the region still faces a substantial amount of "residual transmission"; defined as the amount of transmission remaining when populations have high coverage of insecticide treated nets. In many sub-Saharan African countries including Tanzania, most of the residual transmission is mediated by one vector species: *Anopheles funestus*. In comparison to other major African vector species (e.g. *Anopheles. gambiae s.l.*), understanding of the ecology and behavior of *An. funestus is* much more limited. This presents an obstacle to tackling transmission by *An. funestus* and assessing which supplementary vector control tools will be most effective against it. To address this knowledge gap, I am initiating a PhD study to elucidate the ecology of larval and adult *An. funestus* in the southern Tanzania. In this area, *An. funestus* is responsible for more than 80% of residual malaria transmission. I will focus on investigation of seasonal variation in the habitat use (both larval habitat, and house types used by adults); with the goal of identifying where and when supplementary vector control interventions could be most effectively targeted. I will carry out longitudinal surveillance of larval and adult *An. funestus* across a full year within ten villages in southern Tanzania. Aims will be to quantify variation in the availability and types of larval habitats used by *An. funestus*, as well as the house types used by adults. Additionally, I will assess the survival and fitness (body size and fecundity) of adult females emerging from different larval habitat types and seasons, with the aim of assessing which are most important for population growth and vectorial capacity. These findings will highlight on where and when additional vector control interventions will be most effective against *An. funestus*.

**ABS-80**

## Influence of the agrochemicals pesticides on the development of resistance of *Anopheles gambiae s.l.* in M'bé (Côte d'Ivoire).

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Previous studies have demonstrated the role of agriculture on the development of insecticide resistance in malaria vectors. Here, we assess this study to understanding how uncontroled agriculture pratice can impact insecticide resistance development in *Anopheles gambiae s.l., the* main malaria vectors .

Study of knowledge attitude practice (KAP) in addition of susceptibility bioassays and High performance liquid chromatography (HPLC) was performed with breeding site water and sediment from larval site in M'bé (central Côte d'ivoire) area were malaria vectors exhibits high intensity of resistance to public health insecticides .

Results from KAP survey have shown that three quarters of repondents are illiterate, 75 % (P< 0,001) do not respected the recommended dose and prepared their own mixtures of agrochimical. High resistance to pyrethroids, carbamate, organochlorine insecticides was detected according to WHO cylinder test. HPLC system found residues of lambdacyhalothrin a pyrethroid insecticide from larval study site (water and sediment).

These results suggest that the use of pesticide in agriculture has important implication for public health in particular for malaria mosquito control. Hence coordination with the agricultural sector is crucial.

**ABS-209**

## Prevalence of filarial lymphoedema and associated factors in lindi district, Tanzania

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**Background:** Lindi is among lymphatic filariasis (LF) endemic settings in Tanzania has remained a hotspot of transmission with circulating filarial antigen (CFA) prevalence of 7.5% after eleven rounds of mass drug administration (MDA)(1). Despite the achievement in reducing transmission, lymphoedema has remained a public health problem. Though lymphoedema management known to alleviate suffering and exacerbation of elephantiasis. Little has been done to address this morbidity. Community knowledge, attitudes and practices regarding lymphoedema management has not fully established. There is a paucity of data on the burden of lymphoedema and its management in Lindi.

**Objective:** This study sought to determine the prevalence of filarial lymphoedema and associated factors in

the Lindi district.

**Methodology:** A quantitative cross-sectional study was conducted in July 2020. A total of 954 individuals who are 18years and above were screened for the lymphoedema and interviewed on their knowledge, current practices and attitude on the management of lymphoedema, MDA by using an interview schedule. Moreover, patients were examined for the presence of entry lesions and staging of disease. Data were analyzed by using SPSS and prevalence, community knowledge, attitudes and practices were summarized into proportion and Pearson chi-square was used to compare proportion. Logistic regression analyses were performed to determine the association between dependent and independent variables.

**Result:** Community participation on MDA rounds was higher (82.4%) and more than three quarters of respondents (78.5 %) had participated up to 5 rounds. The overall prevalence of filarial lymphoedema was 7.8% with most of them in the early stage of lymphoedema (78.4%). The large majority of the patients had lower limb lymphoedema.

The presence of entry lesions among those with lymphoedema was (46%). More than a half (61.3%) of those lymphoedema had experience ADLA attacks; close to two third (64.8%) had less than three attacks in the past six months.

Generally, community members had a low level of knowledge on MDA, filarial lymphoedema and its management, inappropriate practices for lymphoedema and negative attitudes toward MDA, filarial lymphoedema and its management.

Inappropriate practice for lymphoedema management was associated with an increased risk for the development of advance stage of lymphoedema (AOR=7.379 95%, CI: 3.535-16.018, P 0.04).

**Discussion:** The prevalence of lymphoedema in Lindi district was higher compared to other areas. Furthermore, it was lower compared to the prevalence observed in Tanga(2).

In this study, most had lower limb oedema which was similar to the study done in Mali(3). The number of patients with advance stage of lymphoedema was similar to the studies done in other areas (4,5). A highly appropriate practice for lymphoedema management was associated with decreased risk of progression to advance stage of lymphoedema which was similar to other done (6).

**Conclusion:** Though LF transmission has drastically been reduced, chronic manifestations in the form of lymphoedema has persisted, conceivably due to lack of a programmatic focus on the management of LF chronic manifestations. This is compounded by negative attitudes and a low level of knowledge towards lymphoedema management; as well as inappropriate practices towards lymphoedema management, that calls for a programmatic approach for lymphoedema management.

**ABS-132**

## ***Wolbachia* infections and avian malaria prevalence in *simulium* blackflies**

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**Background:** Some strains of the endosymbiotic bacteria *Wolbachia* can interfere with pathogens in arthropod vector species, in certain cases inhibiting pathogen development. While the arbovirus-blocking capacity of *Wolbachia* is well-documented, interactions between *Wolbachia* and haemosporidian parasites remain poorly understood. Artificial transfections of *Wolbachia* have been found to interfere with *Plasmodium* parasites in mosquitoes, but results have been inconsistent and indicate that the parasite-blocking effect may depend on complex ecological and genetic factors. To investigate the conditions under which Wolbachia-mediated parasite-blocking occurs, we are studying natural Wolbachia infections in the blackfly genus *Simulium*, the primary vector of the avian haemosporidian parasite *Leucocytozoon*.

**Methods:** We sampled adult and larval blackflies over five consecutive years at a single site in south-west Scotland. Blackfly species were identified using a restriction fragment length polymorphism assay. Adult blackflies were individually screened for *Leucocytozoon* using PCR. *Wolbachia* was detected and quantified in adults and larvae using a qPCR assay that amplified the *coxA* gene.

**Results:** A total of 450 adult blackflies and 981 blackfly larvae were collected. The predominant taxa captured at the adult stage were *Simulium cryophilum* (39.3%), *S. vernum* complex (29.6%) and *S. aureum* complex (18.5%). 48.1% of all adult blackflies sampled were positive for *Leucocytozoon*. *Wolbachia* was detected in 24.6% of adults and 22.3% of larvae. Blackfly abundance and species diversity were affected by ambient temperature at the adult and larval stage. Preliminary results suggest that temperature is also negatively associated with *Wolbachia* prevalence in both adults and larvae, and positively associated with *Leucocytozoon* prevalence in adults.

**Conclusions:** The findings offer new insights into blackfly ecology in Scotland and indicate that *Wolbachia* infections in blackflies can be influenced by environmental variables. The study system should open avenues for further study of endosymbiont interactions with haemosporidian parasites and the role of *Wolbachia* in blackfly-borne disease.

**ABS-262**

## Assessment of urban malaria transmission in the city of Ouagadougou, Burkina Faso

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### Background

Urban populations are growing rapidly, particularly in West Africa and this has a major implication for the risk and control of malaria. In the city of Ouagadougou, knowledges about malaria transmission and its vector ecology is not sufficient for appropriate vector control measures.

### Methods

Three districts of the city of Ouagadougou were selected using a geographical approach that took into account the city heterogeneity. This approach was based on the analysis of the level of urbanization leading to urban and peri-urban sites. Timely adult mosquitoes and larva collection were done. Collected mosquitoes were identified and sorted by physiological status and genus. Blood meals sources and *Plasmodium* circumsprozoite Protein were assessed for anopheline mosquitoes.

### Results

In total, 10158 mosquitoes including 7555 adults and 2603 larvae were caught. The population was composed of 71.9% of *Culex* spp., 22.2% of *Aedes* spp., 5.7% of *Anopheles* spp. and 0.2% of *Mansonia* spp. The majority of *Anopheles* specimens were caught in peri-urban area (84.2% while only few anophelines were found in

central part of the city (15.8%). Puddles and metal dishes were found to be the productive breeding sites for anopheline mosquitoes. The most important part of blood meal source was human (66.7%) with some being mixed blood meal. A large amount of undetermined sources (21.1%) were found in peri-urban area leading to some animals' sources not recognized in our antigen set. *Plasmodium* infection rate was 08.05% with the infectious mosquitoes found to be more prevalent in peri-urban setting (91.7%) compared to urban area (8.3%).

**Conclusion**

These results provided some useful information on anopheline distribution, breeding site, blood meal sources and sporozoite rate in the city of Ouagadougou. Such data will provide with a better management strategic for urban malaria control.

**Keywords**

Urbanization, Anopheline, Malaria, Blood meal, *Plasmodium*, Burkina Faso

**ABS-101**

## Flying in-formation: a machine learning method for classifying vector movement patterns

Mt fowler, aj abbott, gd murray, e bandason, dp towers, pj mccall.

**Background & objective**

The rational design of effective vector control tools requires detailed knowledge of vector behaviour, yet the observations, evaluations and definitions by even the most experienced researcher are constrained by their potential subjectivity and inevitable perceptual limits. Seeking an objective alternative to 'expertise', we developed and tested an unsupervised method for the automatic identification of vector behaviour: *machine learning for behavioural classification-vectors* (malbec-vec).

**Materials & method**

Malbec-vec unites path-segmentation and machine learning in an innovative workflow and is implemented using a combination of r and python. This new method entails: (1) recording movement trajectories (using basic video tracking software); (2) path-segmentation; (3) unsupervised clustering; and (4) interpreting results. The method's external validity was tested by comparing its results with those from similar settings analysed by existing methods.

**Results & discussion:** Malbec-vec analyisis of flight patterns of *anopheles gambiae* responding to human-baited insecticide-treated bednets (itns) identified four distinct behaviour modes, with higher non-contact modes (i.e. 'swooping') predominant at itns, and higher contact modes (i.e. 'visiting' and 'bouncing') at untreated nets. Overall activity was higher at treated nets. Remarkably, the results virtually replicate prior, expert derived interpretation, essentially validating the accuracy of the method.

**Conclusion & recommendation:** Researcher-defined behaviours are inherently subjective with numerous shortcomings: they are inefficient, nonreplicable, difficult to validate and overly domain-specific; subject to cognitive bias, and limited by perceptual abililty. In contrast, malbec-vec's mathematical method is objective, automatic, repeatable and a validated alternative for dismantling complex vector behaviour. With research on mosquito behaviour at an all-time high, this analytical tool is available to all interested researchers.

**ABS-151**

## Seasonal variation of microbiota composition in *Anopheles gambiae* and *Anopheles coluzzii* in two different eco-geographical localities in Cameroon

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**Background**

Understanding the factors affecting the bacteria composition in malaria vectors could help inform the design of novel vector control interventions, such as those based on a paratransgenis. This study evaluated seasonal and geographical variations in the microbial community of the two major malaria vectors, *An. gambiae* and *An. coluzzii* from Cameroon.

**Methods**

Adult mosquitoes (*An. gambiae* and *An. coluzzii*) were collected across two different eco-geographical settings in Cameroon, forest (Bankeng) and sahelian (Gounougou), during the dry and wet seasons. DNA was extracted from the whole mosquito and the V3-V4 region of the 16S RNA gene was targeted and sequenced using Illumina Miseq (2 x 250 nt) and analyses performed using QIIME2 and R software programs.

**Results**

A total of 120 mosquitoes were selected randomly corresponding to 30 mosquitoes per season and locality. Overall, 97 bacterial taxa were detected across all the samples, with 9 bacterial taxa unique to the dry season and four unique to the wet season. There were significant differences in bacterial composition between both seasons, with a clear separation observed between the dry and wet seasons (PERMANOVA, Pseudo-F = 10.45; q-value = 0.01). Furthermore, QIIME2 analysis of the composition of microbiomes (ANCOM) on ASVs (Amplicon Sequences Variants) showed that 9 ASVs were found to be differentially expressed in the dry season compared to the wet season, with two (*Listeria* and *Meiothermus*) more abundant in the dry season, and seven (*Serratia*, *Dermacoccus*, *Pantoea*, *Klebsiella*, *Comamonas, Eubacterium* and *Acinetobacter*) more abundant in the wet season.

**Conclusion**

This study highlights the influence of seasonal variation on microbial communities in mosquitoes with potential impact on their biology and vectorial role that should be further investigated.

**Keywords**

Mosquito microbiome, *Anopheles gambiae ss*, *Anopheles coluzzii*, Seasons, Localities, 16S rRNA gene amplicon

sequencing, Metabarcoding

**ABS-241**

## Insecticide susceptibility of *Aedes aegypty* in three ecological zones in Benin

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### Abstract

In order to implement effective and sustainable arbovirus vector control measures in Benin, the susceptibility of *Aedes aegypti* adults from three different ecological zones (urban, peri urban and forest) to DDT (4%), permethrin (0.75%;), deltamethrin (0.05%), and bendiocarb (0.1) was determined using WHO standard procedures. Results from the bioassays shows that all the populations were fully susceptible to bendiocarb. However, all the populations of *Ae. Aegypti* developed a strong resistance to DDT with an average of 16%, 20% and 26% of mortality respectively in urban, peri-urban and forest area. Moderate resistance was found with permethrin from all the 3 study sites with an average mortality of 48% and 54% and 62% respectively. With deltamethrin, only the populations from forest area were fully susceptible to this insecticide. Moreover, the values of the Knockdown time (KDT50 and KDT95) of *Ae. aegypti* populations from the 3 study sites during the 1hour exposure to pyrethroids and organochlorines of the resistant populations were considerably higher compared to the control ($P<0.05$). However, there is no significant difference in the KdT50 and KdT95 values of the wild population of *Ae. aegypti* from the forest area with deltamethrin compared to the control ($P>0.05$).

Data generated from the susceptible of all the 3 wild populations of *Ae. Aegypti* to bendiocarb in this study could serve as baseline to fight against this vector in case of outbreak in these regions.

### Key words

*Aedes aegypti*, insecticides, resistance, peri urban, urban, forest, Benin

**ABS-149**

## Relationship between practices and intestinal parasitic infections in Yaoundé, Cameroon

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**Background:** Intestinal parasitic infections are emerging health problem in sub-Saharan African countries. Adults are still affected despite the mass drug administration. Therefore, the status of their practices is one key social factor to assess for good disease management.

**Methodology:** From October to December 2019, KAP investigations were conducted within inhabitants of thirteen areas of the Yaoundé city in order to check the levels of knowledge, attitudes and practices of local communities. Human stools samples were analyzed for parasite identification using Kato Katz and formalin ether methods.

**Results:** In total, 390 respondents were recruited for interviews and samples were checked for parasite identification. Regarding practices and attitudes, the majority of respondents drank tap water, washed their hands after toilet and before eating, and took chemoprophylaxis against worms during the last 12 months. Parasite species recorded in stool samples were predominantly helminthes (*Ascaris lumbricoides, Hymenolepis nana)* and protozoans (*Cryptosporidium sp.)*. High parasite burden in study sites varied significantly with ages of participants, though those above 50 years old were unexpectedly more infected than other groups.

**Conclusion:** Our finding suggests that intestinal parasites are widely distributed in human, despite the good knowledge and practices recorded from respondents of the studied areas.

**Key words:** Human practices, intestinal parasites, Yaoundé

**ABS-162**

## Comparison of two types of diet, Koi® et TetraMin®,used for Anopheles coluzzii feeding in the insectary in Mali

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### Background

One crucial element in rearing mosquitoes in the insectary is the feeding of the larvae. Due to the high cost and the problem of availability of this diet it became necessary to identify an alternative type of diet. This study compares the quality of mosquitoes fed with Koi® and TetraMin® for feeding larvae in the insectary.

### Method

Females (~ 750) *Anopheles coluzzii* from the insectary were blood fed. Eggs were collected. After hatching, 2000 larvae were divided into two batches of five trays each. Each batch was assigned a type of diet. The quantities of diet were 0.05g for larvae stage 1-2 and 0.1g for larvae stage 3-4. The larval development time, pupation and hatching rate were determined. Feeding rate, fecundity, fertility, longevity and adult size were determined.

### Results

The maximum time of larval development observed was 10 days for both diet. Pupation rates were 97.8%

[96.69; 98.54] and 93.9% [92.24; 95, 27] for Koi® and TetraMin®® respectively. The mean pupae hatching rate was 98.46% [97.48; 99.07] for Koi®, and 99.14% [98.33; 99.57] for TetraMin®. The average rate of feeding rate was 73% [63.57; 80.73] for Koi, those ofTetraMin® was 76% [66.77; 83.31]. As for fecundity of Koi® was 1901 compared to 2166 for TetraMin®. Fertility were 1878 (98.79% [98.19; 99.19]) for Koi® and 1994 (92.05% [90.84; 93.12]) for TetraMin®. The mean of longevity was 17.64 ± 8.58 and 14.12 ± 5.69 for females and 19.40 ± 6.36 and 8.74 ± 4.75 for males. The males from TetraMin® were larger than Koi® with 3.06 ± 0.13 versus 2.55 ± 0.12.

**Conclusion**

Koi food had a higher hatching rate and longevity than TetraMin® but both were comparable on other parameters. TetraMin® could therefore replace Koi® food for larvae feeding in the insectary.

**Key words**: Koi®, TetraMin®, larvae feeding, *Anopheles coluzzii*

**ABS-116**

## Association between species diversity and insecticide resistance in *Anopheles gambiae s.l.* in Côte d'Ivoire

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**Background**

Despite the spread of insecticide resistance in *Anopheles* mosquitoes, insecticide-based vector control tools are still effective even areas of high pyrethroid resistance, whilst their threat have been predicted for malaria control. We investigated the diversity of local *An. gambiae s.l.* species, their insecticide resistance and resistance intensity to insecticides associated with vector species distribution.

**Methods**

Bioassays were carried out using either World Health Organization (WHO) susceptibility test kits or CDC bottle bioassays. Larvae collected in the field and reared to 3-5-day-old adult female *An. gambiae* s.l. were tested against deltamethrin (0.05%), permethrin (0.75%), pirimiphos methyl (0.25%), clothianidin (13.2 mg/m$^2$) and chlorfenapyr (100 and 200 µg/bottle). When pyrethroid resistance was detected, resistance intensity and synergist assays using 4% piperonyl butoxide (PBO) were conducted. Furthermore, subsamples were identified to species and then genotyped for resistance mechanisms using quantitative polymerase chain reaction (qPCR). Species distribution, insecticides dose-response and mechanisms were compared between sites.

**Results**

A spatial variation of insecticide resistance, resistance intensity and species distribution were observed across sites, with *An. coluzzii* expressing the highest resistance intensity. Whereas resistance mutation alleles were most common in *An. gambiae*.

**Conclusion**

*An. coluzzii* was the predominant species showing higher resistance to pyrethroids than *An. gambiae* collected mostly in low endemic areas. These findings could be of interest for vector control decision making.

**Keys words:** Species diversity, *Anopheles coluzzii*, *Anopheles gambiae*, Insecticide resistance intensity

**ABS-220**

## Antimalarial Drug resistance in the Central and Adamawa regions of Cameroon: prevalence of mutations in *Pfcrt*, *Pfmdr1*, *Pfdhfr* and *Pfdhps* genes.

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### Background

The spread of *Plasmodium falciparum* resistant parasites remains one of the major challenges for malaria control and elimination in Sub Saharan Africa. Monitoring of molecular markers conferring resistance to different antimalarials is important to track the spread of resistant parasites and to optimize the therapeutic and lifespan of current drugs. *This study aimed to evaluate the prevalence of known mutations in the drug resistance genes Pfcrt, Pfmdr1, Pfdhfr and Pfdhps in two different epidemiological settings (Mfou and Tibati) in Cameroon.*

### Methods

A cross-sectional study was carried out in 2018 and 2019. Dried blood spots from asymptomatic individuals were used for DNA extraction and *Plasmodium* infection status was determined by qPCR. *P. falciparum* positive samples were genotyped by nested PCR followed by restriction digestion for the detection of SNPs in *Pfcrt* (K76T), *Pfmdr1* (N86Y, D1246Y), *Pfdhfr* (N51I, C59R, S108N, I164L) and *Pfdhps* (A437G, K540E, A581G). The prevalence of each genotype was compared between study areas using the Chi square and Fisher's exact tests.

### Results

A total of 1,655 *P. falciparum* isolates (859 from Mfou, and 796 from Tibati) were included for genotyping. For *Pfcrt*, a high prevalence of K76 wild type allele was found in both sites (88.5 and 62.29% respectively; P < 0,0001). The prevalence of *Pfmdr1* mutations 86Y and 1246Y was respectively 55.83 and 1.45% in Mfou and 45.87 and 5.97% in Tibati. Distribution of *Pfmdr1* genotypes was significantly different between the studied areas (p< 0.0001). For *Pfdhfr*, the overall prevalence of mutations 51I, 59R and 108N were 96.66, 98.34 and 99.75%, respectively. However, we did not report any mutation at codon 164 of *pfdhfr.* In *Pfdhps*, an increased prevalence of isolates carrying the 437G mutation (>90%), with a significantly higher in Mfou (P< 0.0001). Overall, the *pfdhps* mutations 540E and 581G were found at very low frequencies (0.33 and 3.26%, respectively). The IRN triple-mutant haplotype which confers resistance to pyrimethamine was the most prevalent (>96%). The quadruple mutant (*Pfdhfr* 51I/59R/108N+*Pfdhp*437G), also called partially resistant haplotype was found in 87.43% of isolates. The quintuple mutant (*Pfdhfr* 51I/59R/108N+*Pfdhp*437G/540E) known as fully resistant haplotype was found in 0.33% and the sextuple mutant (*Pfdhfr* 51I/59R/108N+*Pfdhp*437G/540E/581G) also called super resistant haplotype, which has been linked to SP failure, appeared in two samples from Tibati.

## Conclusion

These findings demonstrate declining trends in the prevalence of mutations conferring resistance to 4-aminoquinolines, especially to chloroquine, although it differs between the areas. By contrast, a high level of mutations in *P. falciparum* genes related to SP resistance was detected and raises concerns about the future efficacy of IPTp-SP and SMC in Cameroon.


## Keywords

Malaria, *Plasmodium falciparum*, Antimalarial Drug Resistance, Cameroon


## ABS-75

## Assessing the tsetse fly microbiome and the potential role of some bacteria taxa in trypanosome establishment


BOUAKA Calmes Ursain


## Background

Tsetse flies are cyclic vectors of trypanosomes which cause African trypanosomiasis. No vaccine is available, and drugs are toxic with increasing emergence of resistance. Reducing vector competence can be most effective in preventing disease reemergence. Some bacteria have been shown to be used as paratransgenic organisms capable of blocking trypanosome's development in flies. Therefore, understanding the role of tsetse microbiome in vectorial competence and in disease transmission could improve knowledge in initiatives to develop new vector control strategies. This project aims to determine the microbiome composition of tsetse flies and their association with trypanosome establishment.

## Methods

Tsetse flies were collected from Campo, southern Cameroon and total DNA was extracted from fly bodies and heads separately. Trypanosome species were identified by PCR. Amplification of the V3-V4 region of the 16S rRNA gene followed by sequencing on Illumina miseq with subsequent metagenomic analyses were performed to identify the different bacteria communities.

## Results

PCR analysis of 2186 *G. p. palpalis* revealed 20.08% trypanosome infections with *T. congolense* (13.73 %,) the predominant species; 0.17 % were *T. b. gambiense*; 21.27% of infected flies produced mature infections. From 192 samples randomly sequenced, a total of 31 bacteria genera were identified; the primary symbiont *Wigglesworthia* displayed 47.29% relative abundance and seem to be replaced by *Burkholderia* in some *G. tachinoides* flies used as out group. A significant difference was observed in microbiome diversity between flies displaying or not mature infections. In addition, differential abundance testing shown *Serratia*, *Staphylococcus* and *Ralstonia* significantly more present in flies with unmatured infections.

**Conclusion:** This study has shown that African trypanosomiasis remain an important problem in Campo, Cameroon. Some bacteria seem to be associated with flies not harbouring mature trypanosome infections, which therefore need further studies to determine whether they could become targets for controlling tsetse competence.


## Keywords

Tsetse flies; Trypanosomoses; Microbiome; Vector Control.


## ABS-266

## Pyrethroid susceptibility in *Culex quinquefasciatus* Say. (Diptera: Culicidae) populations from Delta State, Niger-Delta region, Nigeria


Ojianwuna CC, Omotayo AI, Enwemiwe VN



## Abstract

The development of insecticide resistance in different species of mosquitoes to pyrethroids is a major challenge for vector-borne diseases transmitted by mosquitoes. In anticipation of a country-wide deployment of pyrethroids-treated nets for control of mosquito-borne diseases in Nigeria, this study assessed susceptibility of *Cx. quinquefasciatus* in Owhelogbo, Ejeme and Oria-Abraka communities in Delta State, Niger-Delta, Nigeria to pyrethroids. Two to three days old *Cx. quinquefasciatus* were exposed to Deltamethrin (0.05%), 0.75% Permethrin (0.075%) and Alphacypermethrin (0.05%) using WHO bioassay method and mortality after 24 hours was recorded. Polymerase chain reaction (PCR) was used in identification of species and characterization of kdr gene. Results revealed that, *Cx. quinquefasciatus* were generally susceptible (98-100%) to Deltamethrin, Permethrin and Alphacypermethrin in the three communities with the exception of Owhelogbo where resistance is suspected (97%) to Deltamethrin. Knockdown time to Deltamethrin (11.51, 11.23 and 12.68 minutes), Permethrin (28.75, 13.26 and 14.49 minutes) and Alphacypermethrin (15.07, 12.50 and 13.03 minutes) were considerably low for Owhelogbo, Ejeme and Oria-Abraka *Cx. quinquefasciatus* populations respectively. Species identification result using PCR showed that all amplified samples were positive for *Cx. quinquefasciatus,* however, no *kdr* allele was found in the three populations. The deployment of pyrethroid-treated net for control of mosquito-borne diseases in Niger-Delta region of Nigeria is capable of reducing the burden of diseases transmitted by *Cx. quinquefasciatus* as well as addressing the nuisance value of the vector.



## Keywords

*Culex quinquefasciatus*, Permethrin, Deltamethrin, Alphacypermethrin, Niger-Delta region.


## ABS-150

## Evaluation of malaria prevention and treatment at the Universities in Bamako, Mali

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### Abstract

Malaria is an endemic infectious disease caused by parasites of *Plasmodium* genus and transmitted to human by the bite of female *Anopheles*. This disease is blamed for being the pathology that causes the most absenteeism at work. The purpose of this study is to evaluate the prevention and treatment of malaria among people at the Faculty of Sciences and Techniques of the University of Sciences, Techniques et Technologies of Bamako (USTTB). A prospective study with a survey carried out at universities in Bamako with 1511 volunteers whose ages varied between 16 and 65 years (458 women and 1053 men) distributed between faculties or institutes of Sciences and Techniques (FST, FMOS, FAPH, ISA) and the Faculties of Letters and Economics (FHG, FSEG). The female sex represented 30.31% and 69.69% for the male sex. Out of all the volunteers, 41% visited health centers. Men volunteers with 59% visited more health center than women volunteers (41%), but malaria cases were higher in women compare to males. During this study, the majority of universities workers, believe that malaria is caused by mosquitoes in general, but associated with other things. Women volunteers used more protective measures compare to males volunteers. But in contrast women get sicker from malaria than men in the universities despite taking more protective measures. This study show that, reinfection of same person causing repeated malaria episodes can happen among the universities workers in Mali. Only, few volunteers knew that malaria was transmitted by female mosquitoes of the genus *Anopheles* sp.

### Keywords

Malaria episodes, universities, protection, Bamako-Mali

### ABS-258

## To mitigate the emergence and re-emergence of tsetse fly as a vector of zoonotic disease.

Carren Kamau

*Kenya Tsetse and Trypanosomiasis Eradication Council*

### Abstract

Kenya is one of the countries in Africa which is tsetse fly infested. Tsetse flies are vectors of trypanosoma parasites which cause Human African Trypanosomiasis (HAT) and Animal African Trypanosomiasis (AAT). The tsetse and trypanosomiasis control programmes began during the colonial period which was characterized by epidemics in human and their livestock. HAT cases have declined to almost zero cases in Kenya but AAT

which is zoonotic is still a threat to livestock. KENTTEC has been using insecticide spraying, trap and target technology, livestock protective fence and in combination of visual and odour cues as attractant as control strategies.

In Narok county, the Mara region is mostly affected by Glossina pallidepes which is a vector of trypanosomiasis. The reservoir host are the wild animals which share the grazing land with the livestock. G.pallidepes transmit the trypanosomes to livestock when feeding. The following objectives should be carried out to in order to get a clear distinct strategy on how to curb the emergence and re-emergence of tsetse flies.

1. To carry out a genetic study on G.pallidepes.
2. To study the behavioural patterns of G.pallidepes and their habitats
3. To examine the effectiveness of the baits and odour attractants.

The results obtained will for a baseline for future G.pallidepes and tsetse fly control methods guidelines.

**ABS-146**

**Characterization and inactivation of DNA methylation in the major malaria vector *Anopheles gambiae*.**

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## Background

Post-transcriptional histone modifications and DNA methylation are the main mechanisms responsible for epigenetic phenomena. DNA methylation, methyl-group transfer at C5 position of cytosine, regulates biological and chromatin-dependent processes fundamental to any organism development. In vertebrates, enzymes responsible for DNA methylation are encoded by genes from different families (*Dnmt1*, *Dnmt3a*,b and *Dnmt3L*). However, in insects, specifically in Diptera, only *Dnmt2* is present, leading to the statement that species belonging to this order featured a lack of DNA methylation although the presence of other genes involving in the epigenetic dynamics of DNA methylation such as Ten-eleven Translocation dioxygenases (*TET*) and Methyl-CpG-binding domain (*MBDs*) has been reported. The current work aims at characterising the DNA methylation system by evaluating the expression level of the *Dnmt2*, *TET2* and *MBDs* genes and the effect of its inactivation in *An. gambiae*.

## Method

The *An. gambiae* susceptible strain (Kisumu) was used. Quantitative Reverse transcription PCR was used to evaluate the relative expression of the three target genes from eggs from the different larvae developmental stages. First instar larvae were also treated with azacytidine and decitabine to determine the effect of DNA methylation inhibition. The fecundity of the resulting adult females was evaluated.

## Results

*Dnmt2* expression was very low at each larval developmental stage while important expressions of *MBD* and *TET2* were recorded. Also, there was no significant impact on the fecundity of adult female mosquitoes resulting from larvae treated with each of the inhibitor.

## Conclusion

The findings suggest that DNA methylation is active but occurs at very low level in *Anopheles gambiae.* DNA methylation may not directly involved in biological process regulation in this mosquito species. This provides background for further investigations in *An. gambiae* epigenome for the characterization of novel targets for the implementation of alternative vector control strategies.


## Keywords

DNA methylation, gene expression, malaria, *Anopheles gambiae*


## ABS-37

## Molecular bases of native fungi *Metarhizium* and their virulence against malaria mosquitoes in Burkina Faso


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## Background

Malaria control efforts are under threat today due to widespread insecticide resistance in mosquito populations. It is therefore necessary to develop and implement new complementary vector control strategies. The use of wild entomopathogenic fungi is a promising alternative as they are effective in controlling *Anopheles* populations and eco-friendly. We hypothesize that the virulence of the fungus might be positively correlated with the adhesion of the fungus to the mosquito cuticle, although this has not yet been confirmed. This study aimed to isolate strains of wild fungi in Burkina Faso to test their killing efficiency and assess the link between adhesion and virulence of these fungi.

**Materials and method:** Plant and insect root collections were carried out over a period of two months (October and December 2019) in the village of Soumousso (11 ° 04'N, 4 ° 03'W). We collected approximately 1600 species distributed in 201 insects (dead and alive) and 1399 plants (roots and barks). Then we isolated fungi on Petri dishes, prepared the fungal suspensions of 4 Promising strains of *Metarhizium* and performed survival bioassays by infecting 3-day old female *Anopheles coluzzi* mosquitoes with two different concentrations ($10^6$ and $10^8$ spores / mL). Survival of mosquitoes was measured for 14 days to quantify fungal killing efficiency. Additionally, to assess adhesion of the different fungal strains on mosquito cuticle, we quantified fungal growth on mosquito after 1 and 24 hours.

**Results and Discussion:** All four strains significantly increased mortality of the mosquitoes compared to the

control at both concentrations (Cox proportional hazards model, $p < 2.2^{-16}$). Additionally, at both concentrations all strains were observed to adhere to the mosquito cuticle after 24 hours, however, while at $10^8$ spores / mL all mosquitoes were infected, at $10^6$ spores / mL fungal adherence was present only in a proportion of females (10-30% of mosquitoes). Interestingly, the most virulent strain was also the only strain observed to adhere to the mosquito cuticle immediately after 1 hour upon infection (at $10^8$ spores / mL), suggesting that killing efficiency and adhesion rate might be associated.

**Conclusion:** These results show that native *Metarhizium spp.* fungi are a promising tool for controlling malaria vectors. Some strains were effective enough to adhere to the mosquito cuticle at low concentration and showed high virulence. Further studies should screen additional native strains to establish the link between adhesion and virulence to ultimately select fungi with high virulence that can be implemented in the field.

**ABS-188**

## Assessment of water quality in Anopheles coluzzii larval habitats in urban areas in Cape Coast, Ghana using water quality indices

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### Abstract

The expansion of Anopheles coluzzii, a major Africa malaria vector into polluted habitats could affect vector control. To understand the full effect, an accurate assessment of water quality at larval habitats is needed. Larval habitats are usually categorized into clean or polluted habitats based on individual physicochemical parameters. However, several parameters are sometimes difficult to interpret, especially when comparing different habitats. In this study, we addressed the problem by exploring the use water quality index, which integrate physicochemical parameters into a single value to determine the quality status of each habitat. Water quality was evaluated in breeding habitats of Anopheles coluzzii and Culex in Cape Coast. Eight physicochemical parameters were measured and used to develop three water quality indices; Canadian water quality index (CCME-WQI), Water Pollution Index and Weighted Arithmetic Water Quality Index. The Our study demonstrated the ability of water quality indices to simplify the several physicochemical parameters measured in breeding habitats into water quality categories that are easier to interpret or compare among different habitats. Such classification could make it easy to study the impact of different levels of water quality in breeding habitats on the life history traits of mosquito vectors under field settings.

**ABS-212**

## Diversité, source de repas sanguin et taux d'infection des anophèles collectés dans le village de Kodougou, à proximité du fleuve Mouhoun : Burkina Faso

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### Abstract

Le paludisme demeure une préoccupation majeure de santé publique dans les pays d'Afrique tropicaux. Au Burkina Faso, trois principales espèces d'anophèles appartenant aux complexes gambiae et funestus sont responsables de la transmission du paludisme. Le but de ce présent travail est d'étudier l'occurrence des anophèles dans la transmission du paludisme dans le village de Kodougou, riverain du fleuve Mouhoun où les conditions environnementales sont favorables à une diversité anophèlienne.

Des collectes d'anophèles adultes à l'intérieur des maisons d'habitations par les pièges lumineux CDC ont été réalisées pendant la période de Septembre à Décembre 2018 dans la localité de Kodougou. Les moustiques ont été identifiés jusqu'au niveau espèce par PCR. Les ADN extraits des pattes-ailes, des têtes-thorax ont servis respectivement à l'identification moléculaire et la recherche des marqueurs de l'infection. Le sang contenu dans l'abdomen des anophèles a été analysé par PCR pour déterminer l'origine du repas sanguin. Sur un total de 6214 d'anophèles collectés, 96,95% étaient du complexe gambiae 2,68% du groupe *nili*, 0,2% de *pharoensis* de 0,1% du groupe *funestus et 0,01% d'Anopheles coustani*. L'identification moléculaire du complexe gambiae a donné quatre espèces dont, *Anopheles. colluzi* 84%, *Anopheles gambiae* 11%, forme hybride (M/S) 2% et *Anopheles arabiensis* 2%. Les membres du groupe *nili* sont tous sensu stricto. Les membres du complexe gambiae ont un d'infection de 7,4% et une anthropohilie de 82% ; *Anophèles nili*, un taux d'infection de 1,2% et une anthropophilie de 100%. Chez *Anopheles pharoensis*, le taux d'infection était de 15,5% et une anthropophilie de 100%. La Recherche de marqueurs de l'infection chez *Anophèles funestus* et *Anopheles coustani* était négative.

Dans cette étude, trois espèces contribuent à des degrés divers à la transmission du paludisme dans la localité de Kodougou. Même si *An gambiae* demeure le principal vecteur du Plasmodium de la localité, il est nécessaire de considérer l'occurrence non négligeable des autres groupes, surtout dans la lutte anti vectorielle

**Keywords**

Diversité, Anophèles, source de repas de sang, taux d'infection, Kodougou

**ABS-251**

## Venereal transmission of the symbiont *Microsporidia* MB in *Anopheles arabiensis*

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**Abstract**

The recently discovered Anopheles symbiont, *Microsporidia* MB, has a strong malaria transmission-blocking phenotype in Anopheles arabiensis, the predominant *Anopheles gambiae* species complex member in many active transmission areas in eastern Africa. The ability of *Microsporidia* MB to block Plasmodium transmission together with vertical transmission and avirulence makes it a candidate for the development of a symbiont-based malaria transmission blocking strategy. We investigate the characteristics and efficiencies of *Microsporidia* MB transmission between *An. arabiensis* mosquitoes. We show that *Microsporidia* MB is not transmitted

between larvae but is effectively transmitted horizontally between adult mosquitoes. Notably, *Microsporidia* MB was only found to be transmitted between male and female *An. arabiensis,* suggesting sexual horizontal transmission. In addition, *Microsporidia* MB cells were observed infecting the *An. arabiensis* ejaculatory duct. Female *An. arabiensis* that acquire *Microsporidia* MB horizontally are able to transmit the symbiont vertically to their offspring. Notably, *Microsporidia* MB infections were found in another primary malaria African vector, *Anopheles funestus* s.s. The finding that *Microsporidia* MB can be transmitted horizontally is relevant for the development of dissemination strategies to control malaria that are based on the targeted release of *Microsporidia* MB infected *Anopheles* mosquitoes.

Keywords: Symbiosis, Anopheles, Malaria, Vector, Microsporidia

**DAY 3: Poster session 3: 1:45- 2:45 pm UTC**

**ABS-46**

## Inter-observer agreement during morphological identification for malaria vector surveillance, Zimbabwe

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Malaria continues to be a major public health problem in Zimbabwe. Morphological identification of the vector mosquitoes is an important step in the implementation of effective vector control. The aim of the study was to ascertain inter-observer agreement between two morphological identification persons, using polymerase chain reaction (PCR) as reference standard. A total of 778 adult *Anopheles* mosquitoes were collected in Burma Valley in 2018 and 2019, Makakavhule in 2019 and Manjolo in 2019 by VectorLink staff. Collection methods: (CDC) light trap, pit trap and HLC proxy. Mosquitoes were identified morphologically by an entomologist in the field (observer F) using hand lenses and dichotomous keys of Gillies and Coetzee (1987), followed by a second entomologist in the laboratory (observer L) using a microscope and dichotomous keys of Gillies and Coetzee (1987).Thereafter, the samples were further identified in the laboratory using confirmatory sibling species differentiation PCR assay. The observer F and observer L read 72% and 79% of the specimens as *An. funestus* s.l. and 20.2% and 12.8%, respectively, as *An. gambiae* s.l. When observer F identification was compared to PCR there was significant difference ($\chi^2$ = 936.9, p < 0.001) between morphology identifications of *An. funestus* s.l. and *An. gambiae* s.l. species and PCR. There was also a significant difference between observer L identification and PCR ($\chi^2$ = 845.8, p < 0.001) between morphology identifications of the same species and PCR. The receiver operating characteristic (ROC) diagnostic accuracy for observer F was 0.73 and 0.89 for *An. funestus* s.l. and *An. gambiae* s.l. respectively. Observer L had ROC value of 0.67 and 0.9 *An. funestus* s.l. and *An. gambiae* s.l. The study showed that the two observers were generally in agreement mainly on *An. gambiae* s.l. and *An. funestus* s.l. species. However, the results showed that the probability of both observer F and L detecting *An. gambiae* as *An. gambiae* was low, observer L having a slightly higher chance of picking a true *An. gambiae*. The chance of observer F identifying *An. funestus* that was confirmed by PCR was higher than that of observer L. This may negatively impact vector control programmes since intervention measures will possibly be focused on incorrect identifications. There is need for regular training of vector entomologists to enhance accuracy, with proper handling and storage of mosquitoes collected in the field if malaria elimination is to be attained.

**ABS-143**

## Mosquitoes nuisance at the Faculty of Sciences and Technics of the University of Sciences, Technics and Technologies of Bamako, Mali

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### Abstract

Mosquitoes are potentially harmful and vectors of pathogens. They compromise the rest and well-being of humans and animals. The main goal of this study is to determine the composition of mosquitoes responsible of human biting in night and day time at the Faculty of Sciences and Technics (FST) of the University of Sciences, Technics and Technologies of Bamako (USTTB) in Mali.
Longitudinal monitoring with monthly cross sectional visit was carried out from September to December 2019, in order to collect the endophilic and endophagic mosquitoes. The *spray-catch* was used as method to collect in 21 rooms selected randomly at the FST (rooms of students, security team, other workers, etc.), where few studies were known before. Mosquitoes were identified morphologically and also by PCR technic for molecular identification of *Anopheles* species. ELISA CSP test was used for *Plasmodium* infection index infection and the ELISA "blood-meal" to determine mosquitoes blood origin.
In total, 802 mosquitoes were collected, 200 males (196 *Culex* and 4 *Anopheles*) and 602 females (598 *Culex* and 4 *Anopheles*). Female mosquitoes were separated by gonotrocic stages: 231 unfed, 223 fed, 80 semi-gravid and 68 gravid. Up to 34 % of *Culex* and 67 % of *Anopheles* had a preference for human blood, but no female tested positive for *Plasmodium* infection by the CSP ELISA. The small number of *Anopheles* collected does not allow us to conclude the absence of infection in the academia. PCR identification of members of the *An. gambiae* complex revealed that *An. coluzzii* is the only specie collected in the academic environment of the FST-USTTB. Human blood preference by mosquitoes demonstrates that people in the workspace are at risk of malaria.
This study shows that *Culex* species are more common, but *Anopheles* are also present among aggressive mosquitoes and they highly prefer to feed on human host. The mosquitoes are linked to serious problems of nuisance and risk of pathogens transmission and action should be taken by authorities to improve health and wellbeing of workers in the academia.

**Keywords :** Academia, FST, USTTB, mosquitoes, nuisance, Mali

**ABS-160**

## Anopheles mosquito longevity post-exposure to insecticides in three districts, Lake zone, Tanzania.

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## Introduction

In order for a malaria vector to transmit malaria parasites, it has to live long enough to allow the development of parasites. The development of malaria parasites in mosquitoes mostly takes 7 to 9 days under optimal conditions. Various vector control interventions such as the use of long lasting insecticide treated nets (LLINS) and the use of indoor residual spray (IRS) have focused on shortening the life span of malaria vectors. Information on malaria vectors longevity is limited. This information is very important with regard to vector control. Therefore, this study aimed to determine how long Anopheles mosquitoes live after exposure to insecticides.

## Methods

This study has covered four villages from three districts. Mwagagala Located at Mwisungwi district, Ishingisha located at Kwimba district and Igekemaja and Igunga located at Magu district. A total of 1034 F1 generation Anopheles mosquitoes (42 replicates) were exposed to three insecticides. 343 mosquitoes (14 replicates) were exposed to Alphacypermethrin (0.05% dose), 348 mosquitoes (14 replicates) were exposed to Deltamethrin (0.05% dose), 343 mosquitoes (14 replicates) were exposed to Permethrin (0.75% dose). Every single replicate contained 25 mosquitoes, were exposed to each of the three insecticides for 1 hour. 1hr KD mosquitoes was recorded, then 24 hrs mortality and the survived mosquitoes were followed on weekly basis up to three weeks.

## Results

Percentage mortality was highest within 24 hrs post-exposure to insecticides. About 90% of anopheles died with 24hrs after being exposed to Alphacypermethrin (0.05%) and Deltamethrin (0.05%). For Permethrine (0.75%), the mortality was 84% with 24hrs. Less than 10% of the mosquitoes survived up to 3 weeks post-exposure to insecticides.

## Conclusion

Our findings have shown the longevity of Anopheles mosquitoes all three types of insecticides. Furthermore, it has been revealed that, even after exposure to insecticides, Anopheles Mosquitoes can still live long enough to transmit malaria. These finding indicate the possibility of insecticide resistant in anopheles mosquitoes in the study area hence call for alternative research on non-pyrethroid insecticides for malaria vector control. Agricultural activities such as livestock, use of insecticides to control ticks, cotton spraying for pest control, may be one of the reasons for possible resistance.

## ABS-41

## Persistence of High Malaria Burden in Chipinge and Umbe Gokwe North districts of Zimbabwe despite Vector Control.

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## Background

Indoor residual spraying (IRS) and long-lasting insecticidal nets (LLINs) are the key malaria vector control interventions in Zimbabwe. The success of these interventions relies on their efficacy to repel or kill indoor feeding and resting mosquitoes. The entomological inoculation rate (EIR) estimates the level of exposure to *Plasmodium falciparum*-infected mosquitoes and is the most favored measure for assessing malaria endemicity and transmission intensity. Chipinge District recorded a total of 34,879 confirmed malaria cases and 17 malaria deaths while Umbe Gokwe North had 1,977 confirmed malaria cases and 1 malaria death (PMI FY2018 report). The aim of the current study was to ascertain responsible malaria vectors and their relative contribution to *Plasmodium falciparum* transmission in Chipinge District (Manicaland) and Umbe Gokwe North District (Midlands), Zimbabwe, in order to inform strategies for effective control.

## Methods

An entomological study on vectors of malaria and their relative contribution to Plasmodium falciparum transmission in the semi-urban area of Ifakara, south-eastern Tanzania, was conducted. A total of 32 houses were randomly sampled from the area and light trap catches (LTC) performed in one room in each house every 2 weeks for 1 year. A total of 147 448 mosquitoes were caught from 789 LTC; 26 134 Anopheles gambiae s.l. An entomological study on vectors of malaria and their relative contribution to Plasmodium falciparum transmission in the semi-urban area of Ifakara, south-eastern Tanzania, was conducted. A total of 32 houses were randomly sampled from the area and light trap catches (LTC) performed in one room in each house every 2 weeks for 1 year. A total of 147 448 mosquitoes were caught from 789 LTC; 26 134 Anopheles gambiae s.l Mosquitoes were sampled from households using the following methods, Centers for Disease Control (CDC) Light Traps indoor hung near a person sleeping under a net, Pyrethrum Spray Catches(PSC) and Prokopack Aspirations(PPA) indoor. Morphological identification was done followed by dissection of mosquito into head-thorax and abdomen parts. Species identification of the *An.gambiae sl* complex was performed following the Wilkins et al protocol of 2016. The CSP ELISA was performed to measure *Plasmodium falciparum* infection using the Robert Wirtz 2016 protocol. Malaria burden data including malaria outbreaks was obtained from the District Health Information System Version 2 (MoHCC 2018).

## Results

A total of 147 mosquitoes collected from using CDC indoor were 124 (84.4%), PSC were 16 (10.9%) and PPA indoor were 7 (4.8%). All the mosquitoes (100%) were morphologically identified as *An. gambiae sl* (n=335). Molecular identification showed 100% *An.arabiensis* (n=147) from Chipinge collections; and 86.7 %( n=163) *An.arabiensis*, 1.6 %( n=3) *An. quadrianulatus* and 11.7% (n=22) *An. species* from Umbe District. Mosquitoes were analysed by CSP ELISA for *Plasmodium falciparum* infection and all samples were negative (0% infection rate).However, 41 bloodfed mosquitoes showed 16/41(39%) had human DNA, 3/41(7.3%) had dog DNA, and 22/41(53.3%) did not amplify.

## Discussion and Conclusion

*An.arabiensis* was found to be in very high abundance in both Chipinge and Umbe Gokwe, attributing to high malaria burden despite the *Plasmodium falciparum* sporozoite infection rate being zero. Therefore, the persistence of malaria burden and sporadic outbreaks in Chipinge District and Umbe District may be due to the presence of *An.arabiensis* which is an efficient malaria vector. Catching *An.arabiensis* inside houses implies that the malaria control approaches being used in these areas are proving ineffective in reducing malaria burden.

## Seasonal dynamics of insecticide resistance in urban malaria vectors

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Pyrethroid resistance in malaria vectors is threatening the effectiveness of insecticide-based tools such as long-lasting insecticidal nets in reducing malaria prevalence. To improve the management of resistance, it is important to well appreciate the molecular drivers of resistance, their evolution, and fluctuations along the year. Here, we investigated the seasonal dynamic of resistance in malaria vectors of urban and peri-urban areas of Yaoundé, Cameroon. Larvae were collected every season for two years and reared adults used for insecticide susceptibility tests to pyrethroids and LLINs. A synergist test was performed with permethrin to assess the implication of metabolic resistance. Molecular identification to confirm the species were followed by the assessment of *kdr* mutation frequency. Data were analysed using R software.
The observed resistance level was high for all insecticides used with mortalities rates: DDT=19.1% (±10.7), Deltamethrin=25.5% (±5.23), Permethrin=11.5% (±1.64), with a partial recovery of susceptibility (30%) for PBO+Permethrin, suggesting an involvement of cytochrome-P450 base resistance. Resistance extends to permethrin 5x (68% ±4.44) and 10x (87.5% ±2.27) revealing a marked escalation of resistance compared to previous results. *Kdr* mutation L1014 is nearly fixed in this population (frequency: 0.9). If there is a strong resistance to Olyset® insecticide net, the OlysetPlus® containing a synergist remains well efficient. Seasonal study of permethrin resistance showed a slightly different profile for tested insecticides between seasons, the highest difference being between long-dry season and short-rainy season (cor=0.95, Pval: 0.049). Short-dry season shows the lowest mortalities (2.1% ±0.73) and long-rainy season the lowest resistance (18.9% ±1.52). The highest restoration with synergist appears during long-dry season (50.1%) confirming the link between overexpression of metabolic genes and pollution in breeding sites.
This study reveals the worsening of resistance to pyrethroids in major malaria vectors with seasonal variations. Increase in metabolic detoxification genes production stimulated by urban pollution can explain the observed escalation of resistance. These information are crucial for the implementation of vector control programmes, precisely in the choice of techniques to be implemented, the effective LLINs to deploy, the compounds to be used and the best periods of action for the IRS or other vector control activity in order to have the best possible results.

**ABS-169**

## Transfluthrin Eave Positioned Targeted Insecticide (EPTI) reduces human landing rate of pyrethroid resistant and susceptible malaria vectors in a semi-field simulated peridomestic space

### Affiliations

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**Abstract**

**Introduction:** Volatile pyrethroids (VP) are proven to reduce human-vector contact for mosquito vectors. With increasing resistance to pyrethroids in mosquitoes, the efficacy of VP such as transfluthrin may be compromised. Therefore, experiments were conducted to determine if the efficacy of transfluthrin Eave Positioned Targeted Insecticide (EPTI) is dependent on the resistance status of malaria vectors.

**Methods**: EPTI treated comprised of hessian strips treated with 5.25g of emulsified concentrate (EC) transfluthrin or untreated controls. The emanator were fixed around the eaves of an experimental hut inside the semi field system. Mosquito strains with different levels of pyrethroid resistance were released simultaneously and recaptured through human landing catches (HLC) conducted 2.5m outside the experimental hut and monitored for 24-hours mortality. Generalized linear mixed models with binomial distribution were used to determine the effect of transfluthrin and mosquito strain on mosquito landing rates and 24-hour mortality.

**Results:** EPTI significantly reduced HLR of all susceptible and resistant *Anopheles* mosquitoes (Odds Ratio (OR) ranging from 0.17 (95% Confidence Interval (CI) [ 0.14-0.20], P < 0.001) to 0.57, (CI [ 0.42-0.78] *P* < 0.001). EPTI had less impact on landing for the resistant *Anopheles arabiensis* (Mbita strain) compared to the susceptible *Anopheles gambiae* (Ifakara strain) (OR 1.67 [95% CI 1.29-2.17] *P* < 0.001). The EC EPTI also had less impact on the resistant *An. arabiensis* (Kingani strain) (OR 2.29 [95% CI 1.78-2.94] *P* < 0.001) compared to the *Anopheles gambiae*. The emanator was equally effective against the susceptible *An. gambiae* (Kisumu strain) and the resistant *An. gambiae* (Kisumu-kdr strain) (OR 0.98 [95% CI 0.74-1.30] *P* = 0.90).

**Conclusions**: This study confirms that the efficacy of EPTI was not dependent on the pyrethroid resistance status of the mosquito. Overall, these findings suggest that transfluthrin treated EPTI could be useful in area with low or high pyrethroid resistant mosquitoes. At this dosage transfluthrin EPTI cannot be used to kill exposed mosquitoes.

**Keywords**: volatile pyrethroid, transfluthrin, pyrethroid resistance, Eave Positioned Targeted Insecticide, EPTI, *Anopheles gambiae* s.s. *Anopheles arabiensis,* Semi field system

**ABS-92**

## Spatial targeting of a house-based malaria control intervention

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**Abstract**

New vector malaria control tools are needed to reduce the malaria burden and meet global goals. Equally important are advances in the tailoring of malaria vector control interventions to local contexts so that current and new tools can be deployed to be greater effect. Housing modification in the form of household screening plus a targeted house-based insecticide delivery system called the In2Care® Eave Tubes, has recently been

shown to reduce clinical malaria in a large cluster randomised controlled trial in central Côte d'Ivoire. However, the widescale suitability of this approach more widely is unknown. We aimed to predict household suitability and define the most appropriate locations where Screening + Eave Tubes (SET) could be implemented across Côte d'Ivoire. We used a geostatistical model to predict suitability of SET across the country to define priority locations and to calculate the impact. Based on currently available data on house type and malaria infection rate, SET could protect 31% of the total population and 17.5% of the population in areas of high malaria transmission. Suitable areas are concentrated in urban and peri-urban areas in the centre of the country. The estimated cost of implementing SET in suitable high malaria transmission areas would be $46m ($13m – $108m). As with other key malaria control interventions, financing constraints compel further (spatial) targeting and demand innovative public and private investment. Ground-truthing and more studies should be conducted to evaluate the efficacy and feasibility of SET in these settings. The study provides an example of how to optimise implementation strategies to reflect local socio-economic and epidemiological factors, and move beyond blanket, one-size-fits-all strategies.

**ABS-107**

## Evidence-based tsetse control for elimination of Rhodesian Human African Trypanosomiasis in Malawi

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### Introduction

A recent surge in Rhodesian Human African Trypanosomiasis (rHAT) in communities at the interface of Vwaza Wildlife Reserve in Malawi underscores need to strengthen vector control in high risk areas. However, with little knowledge about vector dynamics in the area, deployment of vector control tools would be haphazardly applied resulting in a less effective, more costly and unsustainable intervention. A monitoring and evaluation project in communities surrounding the reserve is underway to inform a spatially targeted tsetse control strategy.

### Methodology

Field and laboratory studies are being undertaken to answer questions pertaining to tsetse ecology, trypanosome infection rates and species in tsetse, and tsetse bloodmeal origins.

### Expected results

Primarily the study will characterise tsetse habitats, incriminate vertebrate host species and, reveal trypanosome species and extent of infection in vectors.

### Conclusions and recommendations

The findings of the study will inform targeted deployment of tsetse control efforts in productive habitats on basis of ecology and vertebrate host species incriminated in the bloodmeal analyses. Where resources are scarce it will be recommended to prioritise application of the tsetse control interventions in the more productive sites.

**Funding**

Partnership for Increasing the Impact of Vector Control (PIIVeC) through funding from the UK Research and Innovation Global Challenges Research Fund (GCRF).

**ABS-228**

## Fungal attraction - Introducing the BG-$CO_2$ Generator

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**Introduction:** Carbon dioxide is the most important long-range attractant for almost all blood-sucking insects and is widely used in traps to collect host-seeking adult mosquitoes. Yeast-generated $CO_2$ does not suffer many of the other $CO_2$ sources' drawbacks and has been successfully established as a method to produce attractive amounts of $CO_2$ on site in the past. Biogents AG has developed the BG-$CO_2$ Generator, a standardized $CO_2$ source based on ethanolic fermentation by *Saccharomyces cerevisiae*.

Material and Methods: The BG-$CO_2$ Generator's production rate was quantified over time using a custom-made infrared cell flow meter and compared to other commonly used yeast strains under laboratory conditions. The BG-$CO_2$ Generator's performance was also tested in Latin Square design tests using commercially available mosquito traps (BG-Sentinel, BG-Pro). Experiments were conducted with 24h capture intervals in three separate rural to semiurban locations in Germany (n= 10, 21 and 34). Collection efficacies of traps equipped with the BG-$CO_2$ Generator were compared to a constant flow rate of 200 ml/min of pure $CO_2$ from gas cylinders.

Results and Conclusions: Using a unique combination of different yeast strains, the BG-$CO_2$ Generator reliably produced approximately 120 liters of $CO_2$ from 500 g of household sugar for at least 24 hours. The production profile was semi-linear, resulting in a constant, continuous and near immediate supply of 50-140 mL/min $CO_2$ from start to end of the intended cultivation time. Traps supplied with $CO_2$ from the BG-$CO_2$ Generator reached 62 to 74% of the capture efficacy of traps supplied with 200 mL/min from gas cylinders.

**ABS-95**

## Fitness cost of a biolarvicide VectoMax G on the life-traits of *Anopheles coluzzii*, a major malaria vector in Cameroon

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## Introduction

The widespread of resistance highly impede insecticides-based intervention tools widely used in malaria control program such as Insecticide Treated Nets and Indoor Residual Spraying. Therefore, World Health Organization (WHO) strongly encourages the implementation of integrated control approaches for better controlling malaria. Larviciding is a promising complementary method, but its role in insecticide resistance management is still to be explored. Here we checked if a biological larvicide could efficiently help reducing insecticide resistance prevalence within anopheline populations.

## Methodology

Anopheline larvae collected from different district of the city of Yaoundé and pooled were selected to the biolarvicide VectoMaxG and/or deltamethrin 0.05% for many generations. Different field situations have been simulated in laboratory yielding 4 colonies following these designs; colony 1: adult selected to deltamethrin 0.05%, colony 2: larvae selected to VectoMax only. Colony 3: larvae selected to VectoMax and adult to deltamethrin 0.05%. Colony 4: larvae selected to VectoMax, adult to deltamethrin 0.05% and the survivor mixed to susceptible mosquito at the proportion 5%. The control was the Ngousso susceptible laboratory strain. The insecticides resistance status of each colony and the fitness cost of each selection mode was evaluated. A hundred females of each strain were blood fed and allowed for individual eggs laying, and then different life traits parameters were measured on the progeny.

## Results

The first generation (F0) of anopheline collected from the field shown a mortality rate of 2.05% for DDT, 34.16% for permethrin and 50.23% for deltamethrin. After many generations of selection, the resistant colony shown a mortality rate of 30.48% for deltamethrin, 1.25% for permethrin and 0% for DDT in colony2. While it was 14% for DDT, 45% for deltamethrin, 8% for permethrin in colony3. Then 45% for DDT, 93.75% for deltamethrin, 60% for permethrin in colony4. All the life-trait assessed were significantly different between strains selected to the VectoMax. Some greats changes in life-traits have been recorded in the VectoMax selected colonies compared to the non-selected. The larval time as decrease from 10.61±0.33 days for resistant strain to 7.1±0.74 days for the colony2 and 8.60±0.15days for the colony4.

## Conclusion

Using VectoMax as complementary tool could help reversing the resistance status of anopheline population and then improve effectiveness of vector intervention.


## Keywords

Biolarvicide, pyrethroid resistance, Fitness cost, *An. coluzzii,* Cameroon.


## ABS-156

**The determinants and barriers to use of long-lasting insecticidal treated nets among mothers/ caregivers of under-five children in southwest, nigeria.**


O.O Onasanya, M. S Ibrahim.

## Background

Malaria a debilitating disease affects the socioeconomic growth of communities in Nigeria. The national malaria elimination program has distributed several LLIN over the years in spite; malaria prevalence remains high in Southwest Nigeria. The study aimed to identify the determinants and barriers to net use among mothers/ caregivers of under-five children in southwest Nigeria.

## Methods

A cross-sectional study was conducted from April to July 2018. Five hundred and thirty-six mothers/caregivers of under-five children were interviewed. Using a pre-tested questionnaire, socio-demographics, utilisation, factors influencing the use and barriers to LLIN use were extracted. Frequencies, means and proportions were calculated. Chi-square test was used to assess the association. Statistical significance was at a p-value <0.05.

**Results:** One hundred and sixty-seven (31.2%) under-five children in Lagos and 175 (32.6%) in Oyo state sleep inside LLIN every night (p<0.001). Major barrier to use of LLIN among mothers/caregivers of under-five children was that LLIN generates heat [Oyo 447 (83.4%); Lagos 446 (83.2%)] (p=0.94). expensive [Oyo 62 (11.6%); Lagos 59 (11.0%)] (p=0.77).

**Conclusion:** Their major sources of LLIN were from the mass media (radio and television), health facilities and friends/ families. The utilisation of net among respondents was high, and most of them slept under the net every night. Barriers to LLIN use were discomfort from heat, suffocation. The relevance of these findings lies in the reinforcement of the collaborative roles of mothers, health workers, and government in eliminating malaria.


## ABS-255

### Efficacy of Royal Guard, Interceptor G1 and Interceptor G2 a new treated mosquito net, against pyrethroid-resistant *Anopheles gambiae* using video cone test


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## Abstract

## Background

With increasing reports of insecticide resistance undermining malaria prevention activities across Africa, WHO recommends the use of new generation insecticide-treated nets with combinations of molecules from different insecticide families. The Interceptor (Alphacypermethrin + Chlorfenapyr) and Royal Guard (Alphacypermethrin + Pyriproxyfen) nets are among these nets. The objective of this study was to evaluate the efficacy of Interceptor (IG1 & IG2) and Royal Guard (RG) nets on malaria vector mosquitoes in southern Benin.

## Methodology

Larvae of Anopheles gambiae sl. were collected in southern Benin and reared at the insectarium. A first batch

of 3–5-day old adult females were exposed for 3 minutes to IG2 and RG nets using the cone test protocol. The ability of the mosquitoes to take a blood meal at one hour and at 24 hours was assessed. Longevity, fecundity and fertility of the mosquitoes were measured. A second batch was exposed 24 hours after blood sampling to pyriproxyfen using the CDC Bottle test protocol. Mortality 24 hours after exposure and the ability of the mosquitoes to lay eggs were evaluated.

**Results**

Our results show highest 24 hours mortality rate with Royal Guard compared to others treated nets and a variation of median survival according to nets with a high risk of death when females are exposed to RG (HR=269, P<2e-16). Their fecundity also varied with nets with IG2 inducing higher inhibition of fecundity (IRR=0.74, P<0.001). In addition, there is a significantly high inhibition of fertility in IG2 exposed mosquitoes (IRR=0.58, P=0.038). The exposure to pyriproxyfen show 100 % inhibition of egg laying in mosquitoes exposed to insecticide.

**Conclusion**

The results show a significant negative impact of RG and Interceptor nets on the life span and reproductive potential of mosquitoes.

**Key words**

Fecundity, fertility, survival, Interceptor G2, Royal Guard, *Anopheles gambiae s.l.*

**ABS-121**

**Infestation rates and seasonal distribution of ticks in livestock in Yaoundé's markets, Cameroon**

**Background**

Ticks are highly efficient vectors of pathogens to humans and animals and the most important vectors of disease in domestic animals. Indeed, 80% of the world's cattle populations are at risk of tick-borne diseases (TBDs) with economic losses estimated at US$13.9-18.7 billion per annum. In Cameroon, little is known on the impact of ticks and TBDs on the livestock industry.

**Objectives**

Determine the prevalence, and seasonal activity of hard or Ixodid tick species infesting domestic livestock in two-markets in Yaoundé, Cameroon. This cross-sectional survey was conducted from July 2019 to March 2020.

**Results**

In total, 3728 adult hard ticks and 26 nymphs were collected on 9123 animals including 6332 cattle, 1863 goats and 928 sheep with infestation rates of 39.18%, 2.74% and 11.53% respectively. Ticks were preserved in RNAlater and identified to species by microscopy using morphological identification keys. Three genera of Ixodid ticks were identified, *Rhipicephalus, Hyalomma, and Amblyomma* comprising respectively 71.29%, 15.74% and 12.97% of species. Furthermore, 11 species of ticks were identified and the most common were *Rhipicephalus (Boophilus) decoloratus* (30.30%) (Koch, 1844), *Rhipicephalus (Boophilus) microplus* (24.37%) (Canestrini, 1888), *Rhipicephalus (Boophilus) annulatus* (10.90%) (Say, 1821), *Rhipicephalus sanguineus* (5.48%) (Latreille, 1806), *Hyalomma truncatum* (4.00%) (Koch, 1844), *Hyalomma nitidum* (4.00%) (Schulze, 1919), *Hyalomma impeltatum* (3.99%) (Schulze & Schlottke, 1930), *Hyalomma rufipes* (1.60%) (Koch, 1844), *Hyalomma dromedarii* (1.33%) (Koch, 1844), *Hyalomma detritum* (1.06%) (Schulze, 1919), and *Amblyomma variegatum* (12.97%) (Fabricius, 1794). In terms of numbers, ticks were most commonly found during the long rainy season (45.71%), followed by the long dry season (36.52%), short dry season (11.45%), and short rainy season (6.32%). Furthermore, *Rhipicephalus* was predominant during the rainy and *Hyalomma* during the dry season.

**Conclusion:** These results provide baseline information on tick diversity and seasonal abundance, essential for building an evidence base to enable sustained control and prevention of outbreaks of TBDs.

**Keywords:** Ticks-species, infestation rates, seasonal distribution, Yaoundé-Cameroon

**ABS-119**

## Assessing the effect of larval diet on the life-history traits and pyrethroid resistance phenotypic expression in *Anopheles gambiae s.s.*

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### Background

The success of vector control in reducing the malaria disease burden is threatened by vector resistance to insecticides. To improve vector control strategies, it is important to better understand the non-genetic factors that determine the evolution of vector resistance. Exposure to dietary stress during larval developmental stages could have secondary effects on adult life history trait. The aim of this study was to assess the effect of the larval nutrition on the expression of pyrethroids resistance in laboratory colonies of *Anopheles gambiae*.

**Methods:** Larvae from pyrethroid susceptible and resistant strains of *An. gambiae s.s.* were fed with three different regimes of cat food termed Low, Medium, and High. Larval developmental time and mortality were monitored daily until pupation. Adult mosquitoes emerged were exposed to the PermaNet 2.0, PermaNet 3.0 and untreated net. The adult wing length and longevity were also measured.

**Results:** Larval diet regime was positively correlated with the emergence rates (Df= 2, F= 1054.2, P<2e-16), mosquito wing length (Df= 2, F= 970.5, P<2e-16), and the duration of post-exposure survival (Df= 2, $\chi$2= 173, P<2e-16), but negatively correlated with larval mortality (Df= 2, F= 1318.8, P<2e- 16) and the duration of the larval development cycle (Df= 2, F= 1468.4, P<2e-16). In addition, there are significant differences in the duration of post-exposure between strains, diets, and types of mosquito nets. Overall, the survivorship of mosquitoes exposed to untreated net within the larval diets was longer than those exposed to treated nets (PermaNet 2.0 and PermaNet 3.0).

**Conclusion**: This study indicates that larval diet has a significant impact on larval development in An. gambiae s.s., It also indicates that a high larval diet significantly increases the survival of adult mosquitoes after pyrethroid exposure. Larval diet is an important factor in the management of resistant malaria vectors.

**Keywords:** Larval diet, pyrethroid resistance, *Anopheles gambiae s.s.*

**ABS-271**

## Current status of insecticide resistance intensity among malaria vectors in Africa.

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A decline in malaria incidence and plasmodial prevalence has been observed in sub-Saharan Africa during the last decade, owing to the widespread use of anti-malarial drug therapies and scaling up of insecticide-based vector control interventions. However, there is an increasing spread of insecticide resistance frequencies in the major malaria vectors, e.g. species of the *Anopheles (An.) gambiae* complex and *An. funestus* group, which is alarming. To date, although resistance is widely distributed among malaria vectors in Africa, piecemeal information is available on its intensity and impact on the dynamics of *Plasmodium* parasite transmission.

In 2018, bioassays conducted with 5X and 10X insecticide diagnostic concentrations between 2013 and 2016 indicated mosaic patterns of insecticide resistance intensity in eight countries in Africa (Burkina Faso, Ethiopia, Kenya, Mali, Nigeria, Uganda, United Republic of Tanzania and Zambia), including high, moderate and low resistance intensity, as well as susceptible status. Pyrethroid resistance intensity was high in two malaria vector complex/group from the African countries (*An. gambiae* s.l. and *An. funestus* s.l.). However, these patterns were not indicative of the broader situation of resistance intensity in Africa, because the tested mosquito samples were from areas where high insecticide resistance was previously confirmed or suspected. Furthermore, no data on resistance intensity were available for countries in Central Africa. Subsequently, further testing was performed in additional sites in Uganda, Guinea Conakry, Ghana, Kenya, etc. The collected data mostly indicated moderate to high pyrethroid resistance intensity in *An. gambiae* s.l. and *An. funestus*, suggesting wide distribution of high insecticide resistance intensity in Africa during the next coming years.

This review provides an up-to-date overview of spatial and temporal distribution of insecticide resistance intensity throughout Africa based on published data, in order to guide the deployment of existing and new vector control tools in this Region. The research prospects so assess the operational impact of different levels resistance intensity (low, moderate and high), as well future actions to be taken for insecticide resistance manage are also discussed.

**ABS-234**

## Multiple insecticide resistance and *Plasmodium* infection in the principal malaria vectors *Anopheles funestus* and *Anopheles gambiae* in a forested locality close to the Yaoundé airport, Cameroon

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**Background:** Reducing the burden of malaria requires better understanding of vector populations, particularly in forested regions where the incidence remains elevated. Here, we characterized malaria vectors in a locality near the Yaoundé international airport, Cameroon, including species composition, abundance, *Plasmodium* infection rate, insecticide resistance profiles and underlying resistance mechanisms.

**Methods:** Blood-fed adult mosquitoes resting indoors were aspirated from houses in April 2019 at Elende, a locality situated 2 km from the Yaoundé-Nsimalen airport. Female mosquitoes were forced to lay eggs to

generate $F_1$ adults. Bioassays were performed to assess resistance profile to the four insecticides classes. The threshold of insecticide susceptibility was defined above 98% mortality rate and mortality rates below 90% were indicative of confirmed insecticide resistance. Furthermore, the molecular basis of resistance and *Plasmodium* infection rates were investigated.

**Results:** *Anopheles funestus* s.s. was the most abundant species in Elende (85%) followed by *Anopheles gambiae* s.s. (15%) with both having similar sporozoite rate. Both species exhibited high levels of resistance to the pyrethroids, permethrin and deltamethrin (<40% mortality). *An. gambiae* s.s. was resistant to DDT (9.9% mortality) and bendiocarb (54% mortality) while susceptible to organophosphate. *An. funestus* s.s. was resistant to dieldrin (1% mortality), DDT (86% mortality) but susceptible to carbamates and organophosphates. The L119F-GSTe2 resistance allele (8%) and G119S *ace*-1 resistance allele (15%) were detected in *An. funestus* s.s. and *An. gambiae* s.s., respectively. Furthermore, the high pyrethroid/DDT resistances in *An. gambiae* corresponded with an increase frequency of 1014F *kdr* allele (95%). Transcriptional profiling of candidate cytochrome P450 genes reveals the over-expression of *CYP6P5*, *CYP6P9a* and *CYP6P9b.*

## Conclusion

The resistance to multiple insecticide classes observed in these vector populations alongside the significant *Plasmodium* sporozoite rate highlights the challenges that vector control programs encounter in sustaining the regular benefits of contemporary insecticide-based control interventions in forested areas.

**ABS-51**

## Characterization of genetic diversity from msp2 and glurpgenes, and resistant marker s108n of dhfr gene of *plasmodium falciparum* in tropical area: case of Moundou/Chad

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## Background

Parasite diversity in areas of high transmission results in a distribution of different types of genotypes. In the context of control programs for decreasing the malaria prevalence, maintaining a diverse parasite population would continue to be a significant public health problem. In order to establish a reference database for antimalarial interventions, we determined the genotype of certain P. *falciparum* isolates to determine the antigenic diversity of the *msp2* and *glurp* genes and to characterize the S108N mutation of the *DHFR* gene in MOUNDOU, CHAD.

## Method

To get there we extracted the DNA by the chelex-100 method of the parasites from the blood and saliva samples of the patients with malaria this following the acquisition of the authorization of the regional hospital of Moundou and the ethical clearance obtained from the national ethics committee of Chad. Subsequently, we studied the diversity of plasmodium falciparum from the *Msp2* and *Glurp* genes by PCR and characterized the S108N mutation of the DHFR resistance marker by PCR-RFLP. In addition, we introduced the data in Excel and Mega for the determination of genotypic frequencies and the construction of the phyllogenic tree respectively.

## Results

At the end of the analysis, we obtained a diversity of p. *falciparum* of 18.18% (10/55)and an infection multiplicity of 1.38 (55/40) with *MSP2* gene and 34.15% (14/41) and 1.14 (41/36) with the *GLURP* gene, beside 457bp allele of the MSP2 gene was predominant like 1135 and 1195 pb alleles of GLURP gene. Thus, following the phylogenetic

analysis, we had 6clades with GLURP and 4 clades with the Msp2 gene. As far as the characterization of the S108N mutation, we obtained 53% mutant strains of 108N genotype and 47% wild type S108 strains.

**Conclusion:** It emerges from this study that the *Glurp* gene is more diverse than *Msp2* and could be the most discriminatory gene for Plasmodium *falciparum* diversity in Chad and couldbe responsible for the induction of 108N mutant strains.

**Keywords:** Diversity DHFR; *Plasmodium falciparum,* Clades, *MSP2*, *GLURP*.

**ABS-218**

## Larvicidal Efficacy and GC-MS analysis of Hyptis suaveolens leaf extracts against Anopheles Species

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### Abstract

Mosquitoes are the most important group of insects in terms of public health importance, transmitting serious human diseases. The continuous application of synthetic insecticides to control these mosquitoes causes development of resistance in vector species, and an adverse effect on environmental quality and non-target organisms including human health. Therefore, the use of active agents from plant extracts as alternative mosquito control strategy cannot be over emphasized, as these are non-toxic, easily available at affordable prices, biodegradable and show target - specific activities against different species of vector mosquitoes. The aim of the study was to evaluate the larvicidal efficacy of the aqueous and methanolic leaf extracts of H. suaveolens against the fourth instars larvae of Anopheles species and the GC-MS analysis of methanolic leaf extract of H. suaveolens. Standard WHO protocol was adopted for the larvicidal bioassay. Larvicidal activity was evaluated at concentrations of 200, 400, 600, 800 and 1000 mg/L of the plant extracts and larval mortality was observed 24 and 48 hours post exposure. The bioassays were replicated three times and the mortalities recorded were subjected to chi-square test and probit analysis to determine median lethal concentrations (LC50). The GC-MS analysis of the methanolic extract of the H. suaveolens was carried out on GCMS- QP 2010 plus. REF TEK column was used for the analysis. The LC50 values estimated were 316.22 mg/L for methanolic extract and 323.59 mg/L for aqueous extract. The differences between the two extracts were however not significantly different at P>0.05. The findings also revealed that mortality was concentration dependent and both extracts showed larvicidal activity against Anopheles species larvae. The GC-MS analysis of the methanolic leaf extract of the plant revealed the presence of twelve compounds on the chromatogram. Among the major compounds are Oleic Acid (33.33%), Octadecanoic acid (13.52%), 1,3-Cyclohexadiene-1-methanol,alpha.,2,6,6-(10.42%), 1,3-Cyclopentanediol, trans (9.60%), n-Hexadecanoic acid (9.01%) and 4-Hepten-3-one, 4-methyl (7.0%).The phytochemical screening of the aqueous and methanol leaf extracts of the plant revealed the presence of Tannins, Terpenoids, Flavonoids, Steroids, Carbohydrates, Cardiac glycoside and resins. Therefore, the crude leaf extracts of the plant can be used as larvicides. Further research is needed to test the activity of the plant against synthetic larvicides and trials should be done under natural conditions to further ascertain the plant efficacy.

**ABS-63**

## Rapid ageing and species identification of natural mosquitoes for malaria surveillance

Roger Sanou

Vector surveillance is essential to monitor and optimize adult mosquito control to prevent vector-borne diseases.

Specifically, accurate and high-resolution estimation of both the mosquito abundance of morphological identical species and their longevity are essential for the assessment of the impact of vector control measures. Up to date no simple and precise method allows measuring these mosquito traits. The current tools in use are expensive and time-consuming. So, our new approach underway development is based on the amount of light absorbed by the different molecules of the mosquito cuticle through mid-infra-red spectroscopy (MIRS), which changes between different mosquitos' species and during ageing. By applying convolutional neural networks to MIRS spectra, we have been able to predict with an unprecedent accuracy of up to 95% the age and species of lab and semi-field mosquitoes *Anopheles gambiae, An. coluzzii* and *An. arabiensis* from Bobo-Dioulasso, Burkina Faso and Ifakara, Tanzania. To account for the genetic and ecological variation, mosquitoes were collected from the field and then reared under lab standard conditions and in semi-facilities. We then validated our model on wild mosquito species. First, we collected wild mosquitoes from different villages and gonotrophic cycles assessed upon dissection and microscopic analysis of the ovaries, then measured by MIRS. Here we will present the age and species prediction model of wild mosquitoes based on convolutional neural networks. This new approach is easy-to-use, cost-effective, robust and high-throughput and presents several advantages by predicting simultaneously the age and species which could be of great value in vector surveillance programmes.

**ABS-112**

## Use of natural microbiota from *Aedes* and *Culex* breeding sites for *Aedes* and *Culex* larvae rearing under laboratory condition in Bamako, Mali

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### Abstract

*Aedes* and *Culex* mosquitoes are involved in the transmission of several pathogens agents of multiples arboviruses and parasitic diseases among other, Yellow fever, dengue, lymphatic filariasis, etc. According to WHO, biological and genetic control is an important component of vectors borne disease control. This has been successfully demonstrated in the control of tsetse flies and *Anopheles* in some area across the world. The aim of this study is to test the possibility of using microbiota as basic food for rearing *Culex* and *Aedes* larvae in insectary. This is to verify if microbiota can be used for genes or organism introduction in vectors to modify characters or genes preventing their vectors competence. Four repliquat of each type of breeding site water were used to rear larvae of *Culex* and *Aedes* genus mosquitoes with natural microbiota culture used as basic food. The micobiota identified were mainly composed of bacteria and protozoa in all cultures, but with a particular presence of algae in *Aedes* breeding sites during the first week of cultures. The emergence rate of adults was 83% for control; 63%, 61%, 84% and 84% respectively for repliquat 1 to 4 in the *Culex* breeding sites. In *Aedes* breeding sites, the emergence rate was 100% for the control and repliquats 3 - 4, but very low in repliquats 1 and 2 (4%) and (15%). This study showed that the culture of microbiota from natural breeding sites under laboratory conditions is possible. Feeding *Culex* larvae exclusively with microbiota has been shown to be possible, but *Aedes* larvae need an additional food supply to the microbiota for their full development. The option of using natural microbiota in the perspective of biological/ genetic control is therefore possible.

**Keywords**: microbiota, culture, larvae, *Aedes*, *Culex*

**ABS-59**

## Lethal response of dengue vector (Aedes aegypti) to the plant extract of Dioscorea sansibariensis

Anitha Philbert

*Aedes aegypti* is the primary vector of dengue and other arboviral infections. The use of synthetic chemicals to control disease vectors has created several problems including development of resistance, toxicity to non-targeted species and environmental issues. Botanical products may be an alternative tool since they contain rich source of bioactive compounds, are considered much safer to the environment and biodiversity and are also readily available in resource poor countries. The larvicidal activity *Dioscorea sansibarensis* leaf extract has been tested against the I, II, III and IV instars of *A. aegypti* mosquitoes. The leaf extract *D. sansibarensis* was prepared using ethanol and the larvae mortality was recorded after 24 hours and 48 hours of exposure. The lethal concentrations (LC50 and LC90) were determined by Probit analysis. Larvae mortality increased with increasing concentration. The best larvicidal activity was exhibited by the III larvae instar at the concentrations of 241.647 ppm and 299.898 ppm for LC50 and LC95 respectively after 24 hours of extract exposure. Nevertheless, the extract was less potent against the I larvae instar with the lethal concentration of 311.18 ppm and 426.338 ppm for LC50 and LC95 respectively after 24 hours of crude extract exposure. These findings suggest that *D. sansibarensis* which is used by local people against crop pests in Tanzania, is a good candidate for search for new and natural anti-mosquito agents.

**ABS-148**

## Urban malaria vectors transmission in bamako

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Malaria is a real public health problem in Mali. The number of malaria cases recorded in cities proves the need to understand the potential routes of transmission in urban areas. The purpose of this study is to determine the parameters of malaria vector transmission in Bamako. It was a longitudinal study with monthly cross-sectional passages that was conducted from January to December 2018. Mosquitoes were captured by spraying insecticide (Premium Insect Killer) in 360 randomly selected rooms in both urban and peri-urban neighborhoods in the six communes of Bamako. After identification of the mosquitoes by PCR, *An. coluzzii* predominated over *An. gambiae*. The ELISA test of the 184 captured female Anopheles mosquitoes did not reveal any positive Plasmodium falciparum. On the other hand, these females had a clear food preference for humans over animals.

In the light of this study, it is clear that Anopheles vectors of malaria in Mali are present in the peri-urban and urban areas of Bamako. They have a preference for human blood, which proves that the risk of infection is obvious. A large-scale study over several transmission seasons would be necessary to assess the true extent of

urban malaria vector transmission in Bamako.

**Keywords:** Bamako, vectorial transmission, urban malaria**.**

**ABS-60**

## Competitive adaptation of *Aedes albopictus*, Skuse 1894 in the presence of *Aedes aegypti* Linné 1862 in temporary larvae breeding sites and in the context of pyrethroids resistance in Douala (Cameroon)

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### Introduction

*Aedes albopictus* and *Aedes aegypti* are two potential vectors of arboviruses in Douala. Knowing their breeding behaviour and insecticide resistance status would allow for better design of control activities.

**Methods:** Mosquito larvae and nymphs were captured from breeding sites from July to September 2017, in Ndogbong, PK21 and Yassa, three neighbourhoods of the city of Douala, with ecological peculiarities. They were reared to adults, then identified to species. Female mosquitoes aged 3 to 5 days, not fed on blood, were tested for pyrethrinoid sensibility. **Results**: Overall, 144 breeding artificial and natural sites were identified in the 3 neighbourhoods. *Ae. albopictus* was the single species found in most of the breeding sites (64.6%) whereas *Ae. aegypti* was found alone in 4 sites (2.8%). Both species lived sympatrically in 47 sites (32.6%). Morphological identification of 8160 adults revealed a significantly higher abundance of *Ae. albopictus* compared with *Ae. Aegypti* (88.8% versus 11.2%). Insecticide resistance test with deltamethrin and permethrin revealed resistance in female *Ae. aegypti* and *Ae. albopictus* from Ndogbong and Yassa (mortality rates <92%).

**Conclusion:** *Ae. albopictus* shows better adaptation to artificial breeding sites in Douala and their resistance to recommended insecticides calls for new insecticidal molecules.

**ABS-49**

## Blood-meal sources of malaria vectors found in endemic areas of Zimbabwe

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Understanding vector behaviour is critical to informing effective vector control decisions. Zimbabwe has a comprehensive vector control programme spanning several decades, using indoor residual spraying (IRS) and, more recently, longlasting insecticidal nets (LLINs). Long term exposure to insecticides on IRS and LLINs can lead to shifts in the biting or resting behaviour of mosquitoes. The present study examined the blood meal preferences of mosquitoes collected between 2019 and 2020 from malaria endemic areas in Zimbabwe. A total of 428 mosquitoes were collected in Vumba (no vector control), Dendera, Arcturus, Burma Valley where IRS is done, and Makarara where LLINs are used. Mosquitoes were collected from CDC light traps, pit shelters, pyrethrum spray collections (PSC) and hand catch. The samples were identified morphologically and analyzed by molecular methods to determine species and source of blood meal. 32% of the anophelines were collected indoors and 67% collected outdoors. *An. funestus s.s.* constituted 57% of the samples collected indoors with a human blood index (HBI) of 36% observed on Vumba mosquitoes. The most common species found outdoors were *An. pretoriensis* (27%) and *An. parensis* (20%) and the primary vectors were found in very low proportions. 37% of the anophelines captured outdoors mostly fed on cow while those indoors had fed on humans. It was also observed that other anophelines found outdoors, especially *An. parensis,* fed on multiple hosts, exhibiting combinations of human and animal/s blood meals (25%). Multiple feeding was not observed in *Anopheles* species found indoors. *An. funestus s.s.* predominantly biting humans may reflect the effects of having no vector control in Vumba, indicating that there is need for vector control in that area. The abundance in the cow blood meal for exophilic anophelines might be influenced by the high availability of cattle in Zimbabwe. Vector control in secondary malaria vector species like *An. parensis* feeding on multiple hosts may prove to be a challenge in the control of malaria vectors.

**ABS-105**

## Snakebites frequencies and envenomation cases management in primary's health centers of Bobo-Dioulasso Health District (Burkina Faso) from 2014 to 2018

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**Background:** Envenomation caused by snakebite is a public health problem in Burkina Faso.

This study aimed to describe the epidemiological and therapeutic aspects of snakebite cases at primaries' health center level in the Houet Province located in the West part of Burkina.

**Methods:** We conducted a retrospective study of 664 snakebite cases encountered at a ten primary health centers in the Houet Province in the West part of Burkina from January 2014 to December 2018. Data were collected from the patient consultation recording database register system.

**Results:** The affected individuals had a male/female ratio of 1.31. The lowest annual incidences (0.02 [95%-CI: -0.01-0.05] and 0.24 [95%-CI: 0.05-0.43]) were observed in Bolomakoté and Sarfalao respectively, which are urban primary health centers. Rural primary health centers in Nasso 2016 and Soumousso 2014 had the highest annual incidence (13.80 [95%-CI: 7.59-20.00]) and 3.92 [95%-CI: 2.99-4.86] respectively. Out of 664 registered snakebite victims, no patient received etiological treatment with anti-venom immunotherapy. The treatment used was 100% symptomatic.

**Conclusion:** This study showed that snakebite envenomation accidents were common in the ten primary health centers in the Hauts-Bassins region and the lack of antivenom in primary health centers, which constitute the first reference for patients.

**Keywords**

ENVENOMATION, FREQUENCIES, HAUTS-BASSINS, MANAGEMENT, SNAKEBITES,

**ABS-93**

## Onchocerciasis along the Menchum valley, North-West Region, Cameroon: Dynamics of transmission and knowledge of local populations

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### Background

Onchocerciasis has recently been eliminated, by mass-distribution of ivermectin, in most countries of Latin America, but only in some isolated foci in Africa. The obstacles to elimination are severe and the success is still far. Human onchocerciasis continues to be a public health problem in Cameroon.

### Methods

To study the dynamics of onchocerciasis transmission and the knowledge of the local population about the disease vectors, we conducted a pilot study from November 2015 to April 2016 in two villages in the Menchum Valley, Northwest Region, Cameroon. Village Befang is located close to *Simulium* breeding sites at Menchum falls and Mawong is located along a small tributary river nearby. *Simulium damnosum* flies were caught at both sites and dissected for filarial infections. A questionnaire was aimed to test the knowledge of local people concerning the risks of transmission.

### Results and Conclusions

During 12 days per site, 1491 flies were caught (1169 at Befang, 322 at Mawong), 1384 dissected: 1062 at Befang

(62% parous) and 322 at Mawong (17% parous). Amongst these parous flies, 3, 1 and 2% from Befang and 1, 0 and 1% from Mawong carried *Onchocerca* L1, L2 and L3 respectively, resulting in an average number of 10 L3 per 1000 fly bites. These *Onchocerca* larvae were preserved for further examination.

All participants, 80 living at Befang, close to the Menchum falls, and 68 near the Mawong tributary, knew the bites of *Simulium*. Forty percent reported that flies bite in the evening near the Menchum falls and 41 % thought that they bite at any time. When asked where the larvae breed, 47% in Mawong maintained that they do develop in stagnant water, while 55 % from Befang thought that they develop in tree holes. 95% of those from Befang rightly observed that feet/legs are the preferred body parts for the blood meals of *Simulium*, while those from Mawong did not recognize any choice.

The lack of knowledge of the participants on certain aspects of the bio-ecology of *Simulium* larvae and adult flies poses a real problem in the control of transmission. Education of the population on self-protection should be advocated.

**Keywords**

*Onchocerca,* Menchum Valley, entomological, indices, Transmission.

**ABS-126**

## Pyrethroid Insecticides susceptibility status of *An. gambiae s.l.* and *An. funestus* and weather variables effects in Experimental huts located at an agricultural setting in Misungwi, Tanzania

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### Introduction

Malaria is a major cause of illness and deaths in sub-Saharan Africa. The use of IRS and LLINs have shown great impact in malaria control in Africa, but these indoors interventions are challenged by the rapid increase of insecticide resistance among malaria. Insecticide resistance profile among mosquito vectors and knowledge on the influence of weather variables on vectors are important in designing effective control measures and entomological surveillance systems. The insecticides susceptibility status and the impact of weather variables among malaria vectors in Mwagagala village are not well known. Therefore, this study aimed to determine the pyrethroids insecticides susceptibility status and influence of weather variables of *An. gambiae s.l.* and *An. funestus* mosquitoes in Experimental huts.

### Methods

This cross-sectional study was conducted at Mwagagala village between March and April, 2021 for the duration of 8 weeks. Adult female *An. gambiae s.l. and An. funestus* were collected inside the experimental huts by using hand-held aspirators. Susceptibility assays were done according to the WHO methods. Weather data were downloaded daily from Google weather. PCR was used to identify the sibling species of *An. gambiae s.l.* and *An. funestus.* ELISA technique was used to detect the sporozoites and blood meal source.

### Results

Despite the use of untreated nets in experimental huts, the densities of mosquitoes varied in terms of species and weeks. The results have indicated that, both *An. gambiae s.l.* and *An. funestus* are resistant to all insecticides tested. The variation in densities of mosquito species in the area have shown to be influenced by weather variables. Unexpectedly, *An. arabiensis* was found to prefer human blood meal while An. funestus s.s. preferred to feed on animals. Furthermore, 99.5% of *the An. gambiae s.l.* was *An. arabiensis* which predominantly is an

outdoor biting mosquito but was collected indoors. Our findings have also revealed that, *An. funestus s.s.* was a dominant sibling species in the An. funestus group. Both *An. gambiae s.l.* and *An. funestus* were sporozoites infectivity negative.

**Conclusion**

This study has demonstrated the insecticide resistance profile of *An. gambiae s.l.,* and *An. funestus* in Mwagagala village, Misungwi. Both species were resistant to all insecticides used. The present study has documented unexpected findings of *An. arabiensis* showing highly preference to human blood meal and *An. funestus s.s.* prefer animals as blood meal sources. The study also, has reported the influence of weather variables on variation in densities of mosquito species in the area. The finding on the insecticide resistance profile call for new or improved interventions such as new generation nets in highly resistance mosquitoes.

**ABS-268**

## Bio-efficacy of 4 selected long-lasting insecticidal nets against pyrethroid resistant *Anopheles gambiae s.l.* in Benin

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**Background**

The emergence and spread of insecticide resistance in the major African malaria vectors *Anopheles gambiae s.l.* may compromise control initiatives based on insecticide-treated nets (ITNs) or indoor residual spraying (IRS), and thus threaten the global malaria elimination strategy.

**Methods**

We investigated pyrethroid resistance (oxidase, esterase and glutathion-Stransferase) in some populations of *An. gambiae s.l.* from Benin and then assessed the bio-efficacy of four World Health Organization recommended long lasting insecticidal nets (LLINs) (Permanet 2, Permanet 3, Olyset and Olyset Plus) using these populations.

**Results**

Biochemical assays suggest that resistance in this population is mediated by metabolic resistance with elevated level of GST, MFO and NSE compared to a susceptible strain *An. gambiae Kisumu*. Biochemical tests have shown that the population of Akron 16,04 $10^{-2}$ nmol/min/mg has a strong enzymatic activity compared to the Kisumu strain 13,62 $10^{-2}$ nmol/min/mg.

The test results showed that the mortality rates vary from 6.81 to 29.41 respectively with Olyset and Olyset+ a mortality rates vary 25.42 versus 88.22 respectively with Permanet2 and Permanet3.

**Conclusions**

Elevated levels of enzymes de detoxification with *An. gambiae* populations suggest *Anopheles gambiae* population's resistance includes target-site mutation and metabolic mechanism. The nets incorporated with synergist have been more effective than the old nets but do not fully address the problem of pyrethroid resistance.

**Keywords**

LLINs, Efficacy, Oxidase, *Kdr* L1014F, *An. gambiae* s.l.

**ABS-217**

## First detection of F1534C knockdown resistance mutation in Aedes aegypti (Diptera: Culicidae) from Cameroon

Aurelie Yougang

### Introduction

*Aedes* borne viral diseases, notably dengue, are increasingly reported in Cameroon with *Aedes aegypti* being a major vector. Data on insecticide resistance of this vector and underlying mechanisms needed for outbreak preparedness remain scarce in Cameroon. Here, we present the nationwide distribution of insecticide resistance in *Ae. aegypti* and investigate the potential resistance mechanisms involved.

### Methods

Immature stages of *Ae. aegypti* were collected between March and July 2017 in 13 locations across Cameroon and reared until G1/G2/G3 generation. Larval, adult bioassays, and piperonyl butoxide (PBO) synergist assays were carried out according to WHO guidelines. F1534C mutation was genotyped using allele specific PCR in field collected adults (Go) and the polymorphism of the sodium channel gene was assessed.

### Results

Larval bioassay revealed that all the three populations tested with temephos were susceptible. Adult bioassays showed a good level of susceptibility toward both pyrethroids tested, 0.25% permethrin and 0.05% deltamethrin. However, two populations (Douala and Edéa) were resistant. The resistance to 4% DDT was observed in four out of 10 populations tested. Resistance was also reported to carbamates including 0.1% propoxur and to 0.1% bendiocarb. All populations tested were fully susceptible to 1% fenitrothion. A partial recovery of susceptibility was observed in the pyrethroid resistant population of Douala after pre-exposed to PBO suggesting the implication of cytochrome P450 monoxygenases permethrin resistance. Genotyping and sequencing detected the F1534C *kdr* mutation in the two pyrethroid resistant locations of Edéa and Douala, with allelic frequency of 3.3% and 33.3% respectively. However, the high genetic diversity of the sodium channel gene supports the recent introduction of this mutation in Cameroon.

### Conclusion

This study revealed the contrasting resistance profiles to insecticides of *Ae. aegypti* populations in Cameroon suggesting that, instead of a unique nationwide control approach, a regionally adapted strategy will be needed to control this vector.

**ABS-50**

## The effects of physicochemical properties of water on the abundance of anopheles mosquito larvae in various breeding sites of kapiri mposhi

Moses Musonda

Malaria is a global public health problem, caused by malaria parasites transmitted by a vector female *Anopheles* mosquitoes, belonging to the order Diptera. Their developmental cycle under goes a complete holometabolous with the larval stages associated with aquatic habitats. It is envisaged that the larval control measures are

intended to reduce malaria transmission when vector development is prevented. This due to the fact that for some reasons, most drug treatments coupled with other bed net insecticide treatments of adult mosquitoes are increasingly failing. In this study, it was important to determine whether the abundance of *Anopheles* mosquito larvae in different water sites was associated with the following parameters: (i) particular pH level, (ii) particular temperature (iii) the Total Dissolved Solids (TDS) (iv) or a particular electrical conductivity of water (IV). It was also essential in this study to establish the species composition of adult *Anopheles* mosquitoes in Kapiri Mposhi district of Zambia. Both larvae and adult mosquitoes were identified using a morphological key. To achieve relevant results, a variety of qualitative and quantitative analytical methods were involved, inclusive of Polymerase Chain Reaction (PCR) and numerous multivariate statistical analyses involving SPSS statistical package version 21.0. Out of the total of 489 *Anopheles* larvae that were collected from breeding sites and reared in the insectary, only 45% emerged into adults. It was observed that the *Anopheles* larvae was absent in Rivers and dam breeding sites. Further molecular results revealed that the most abundant mosquito species in Kapiri Mposhi were *An*. gambiae (60%) and breeds well in temporal water ponds, followed by *An. arabiensis* Paton (35%) and 5% were no amplified results. A positive significance was recorded on Pearson Correlation for physicochemical parameters of electrical conductivity ($p$ = 0.003), Total Dissolved Solids (TDS) (p =0. 004), temperature ($p$ =0.001) and pH ($p$ = 0.000).Consequently, it was, concluded that electrical conductivity, pH, temperature and Total Dissolved Solids (TDS) of water in various mosquito breeding sites of Kapiri Mposhi has an effect on the abundance of *Anopheles* larvae. This study has also shown that *Anopheles* mosquitoes thrive better in fresh mineral domestic water.

**Keywords: Malaria, *Anopheles* mosquito, Larvae, Physicochemical parameters, Kapiri Mposhi**

**ABS-178**

## Composition and insecticide susceptibility status of malaria vectors in three epidemiological transmission zones in Zambia

Mbanga Muleba

**Background:** Vector control by insecticides impacts on composition, density and distribution of mosquitoes. Insecticide resistance may negate the impact of control on vector populations. The purpose of this study was to determine the malaria vector species composition, distribution and susceptibility status to insecticides across three different malaria epidemiological settings in Zambia. Indoor residual spraying (IRS) and long-lasting insecticidal nets (ILLINs) are implemented in these sites.

**Methods:** Mosquitoes were collected from three districts, Nchelenge (high transmission), Ndola (moderate), Choma (low) by CDC light traps and prokopack aspirations. Collection was conducted once from each selected household at the start of wet season between November and December 2020. Larval collections were conducted in Ndola. Susceptibility testing by WHO tube and CDC bottle assays were conducted on five classes of insecticides.

**Results :** A total of 4978 mosquitoes were collected from 168 CDC light traps and 1094 from aspiration and larval collections. Trapped *Anopheles* were 75.89%, *Culex* 23.66% and *Aedes* 0.44%. *Anopheles funestus* s.l. was 84.5%, and *An. gambiae* s.l (15.5%). The density of *An. gambiae* s.l. was 8.0, 2.4 and 0.04 /trap/night in Ndola, Nchelenge and Choma respectively. *Anopheles funestus* s.l. only collected from Nchelenge had density of 56.7/ trap/night. *Anopheles rufipes* was trapped in Choma. Susceptibility to insecticides ranged from 3% to 100%.

**Conclusions:** *Anopheles funestus* s.l. was more predominant than *An. gambiae* s.l. Density of *An. gambiae* s.l. was 3.4 times higher in Ndola than Nchelenge and about 199.5 times higher than in Choma. *Anopheles funestus* s.l and *An. gambiae* s.l. showed susceptibility to Neonicotinoids and organophosphates. There was resistance to carbamates and organochlorides for *An. gambiae* s.l in Ndola. *Anopheles funestus* was susceptible to DDT but resistant to pyrethroids. This diversity in species composition, varied densities and varied insecticide susceptibility across epidemiological settings require evidence-based integrated approach to planning and implementing vector control in Zambia.

**ABS-215**

## Use of Ovitraps for effective *Aedes* eggs collection in Kadiolo, Mali

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### Abstract

Across the world, *Aedes* are known to be the main vectors of yellow fever, zika disease, dengue, Chikungunya. Sub-Saharan African countries like Mali are very suitable for *Aedes* bio ecology because of their eco-climatic conditions. The increase of arboviruses in sub-Saharan Africa like malaria will also increase the number of death. The purpose of this study is to test the effectiveness of OviTraps for *Aedes* mosquitoes density control in Mali. After checking for indicators of the presence of Aedes in different places in Kadiolo (Sikasso, Mali), the CSREF, the livestock service, the water and forestry directorate, the agricultural center, and the camp were chosen as the setting sites of the OviTraps. Ovitraps are devices of attraction of *Aedes* mosquito. They are made with black cups containing filter paper and 200ml infusion of dry mango leaves. The OviTraps were placed as traps under vegetation or other attractive places for *Aedes.* The number of positives was counted daily during three consecutive days. A total of 5-10% of OviTraps were positive the first night, 20-60% the second night, and 80-95% the third night. The number of eggs per OviTraps ranged from 15 to 250. Nearby vegetation and host availability were considered to be favorable factors for the OviTraps effectiveness. Base on these results, OviTraps can be used as a complementary tool in the strategy for controlling Arboviruses vectors in Mali.

**Keywords:** *Aedes*, arbovirus, OviTrap, Mali

**ABS-235**

## Malaria dry season transmission evidence although the reduction of EIR in Malian endemic villages

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### Abstract

The use of insecticide-treated mosquito nets and ACTs has contributed to greatly reducing the prevalence of malaria in endemic countries. This is justified by the gradual reduction in the entomological inoculation rate. But despite this, the observation is that there are still cases of malaria recorded in the dry season. The aim of this study is to determine the mosquito infection rate during the dry season in malaria-endemic villages in Mali. The sampling was based on collections of *Anopheles* in human dwelling, either by mouth aspirator or by spray-catch during the years 2012, 2013 then in 2016, 2017 and 2018. The *Anopheles* were sorted and tested by ELIZA and by PCR to determine entomological parameters such as: human bating rates, infection rates and the entomological inoculation rates (EIRs). Infection rates were higher in the rainy season. Entomological inoculation rates varied monthly: 2.39 in October 2012; 0.56 in April 2013. A few years later the peaks of EIR were 0.16 in July 2016, 0.5 in September 2017 and 0.14 in October 2018. Infected *Anopheles* were encountered

in the dry season of different years in December, March and May. The eradication of infected *Anopheles* during the dry season may contribute to greatly reduce malaria vector transmission in endemic villages.

Key words: Dry season malaria, vector transmission, EIR reduction, Mali

**ABS-238**

## Malaria *anopheles* mosquito vector bionomics and transmission of *plasmodium falciparum* in savannah, Côte D'ivoire

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### Background

In Côte d'Ivoire, malaria is still a leading cause of mortality, with variable epidemiological landscape. We assessed the bionomics of malaria *Anopheles* mosquito vectors and the transmission of *Plasmodium falciparum* in the savannah areas, northern Côte d'Ivoire.

### Methods

We sampled *Anopheles* mosquitoes in rural and urban areas in the health districts of Bouna and Odienné, northern Côte d'Ivoire, from February to December 2019. Mosquitoes were collected using human landing capture and indoor spraying methods. The blood-meal source and *P. falciparum* infection were molecularly analysed using enzyme linked immuno-sorbent assay (ELISA). *Anopheles gambiae* s.l. subspecies were also identified using polymerase chain reaction (PCR).

### Results

In total, 15 mosquito species belonging to four genera were identified. *Culex* genus was predominant in urban, while *Anopheles* genus dominated in rural areas. The three main malaria vectors in Côte d'Ivoire, *An. gambiae* s.l., *An. funestus* s.l. and *An. nili* s.l., were present. All vectors showed a tendency to biting humans outdoors. They displayed a preference to feed on humans and domestic animals. *An. gambiae* s.l subspecies were *An. coluzzii* and *An. gambiae s.s.*, with dominance of the former in rural, and the latter in urban areas. *An. gambiae* s.l. and *An. funestus* s.l., were found infested with *P. falciparum* in Bouna, while only *An. gambiae* s.l. was found infected in Odienné. The annual entomological inoculation rates (IERs) were particularly higher in Bouna than Odienné, with values of 439.8 and 72.4 infected bites/man/year, respectively. However, malaria transmission was observed in both health districts during the rainy season, only.

### Conclusions

This study showed strong diversities in malaria *Anopheles* mosquito species, behaviour and capacity to transmit

*P. falciparum* to humans, thus high heterogeneity in this disease distribution in the savannah areas in northern Côte d'Ivoire. These data may guide the national malaria control programmes in Côte d'Ivoire.

**Keywords**

Malaria, *Anopheles gambiae, Anopheles funestus,* Côte d'Ivoire.

**ABS-70**

## Progress towards the tsetse fly control in Campo sleeping sickness focus, South Cameroon

Tito tresor melachio tanekou

**Background**

Sleeping sickness transmitted by tsetse flies, is still prevalent in Campo, southern Cameroon. The efforts made by the World Health Organization and the National HAT Control Program, in screening and treating the patients, have significantly reduced the impact of this disease, but many new cases are still detected every year. Controlling tsetse fly populations is thus necessary to limit the transmission of the disease. Here, we show the importance of insecticide impregnated screens "Tiny Targets" in tsetse control.

**Methods**

After setting experiment and control areas in Campo, preliminary tsetse densities were determined in December 2018 and July 2019, by tsetse captures with pyramidal traps. Around 2000 "Tiny Targets" were installed in January 2020 and replaced every six months (July 2020 and January 2021) after tsetse densities monitoring with new captures. These densities were compared over the time and mapped.

**Results**

Preliminary data showed high dominance of *Glossina palpalis palpalis*, the targeted subspecies in Campo (1789/1915 flies captured), among four species collected, with high densities, i.e. 5.95 and 10.30 flies/trap/day in the experiment and control areas respectively in December 2018. The 6 first months of vector control showed a 76% reduction in tsetse densities in the experiment area that continued to decrease by 83% in the 6 following months whereas a non-significant 18% drop was observed in the control area.

**Conclusion**

This study highlights the effectiveness of insecticide treated screens in reducing tsetse fly population densities in Campo. Nevertheless, the effects of this reduction in the transmission of sleeping sickness remain to be studied in the second part of the study.

**Keywords**: Tsetse flies; Sleeping sickness; Vector Control; Cameroon.

**ABS-122**

## Entomological surveillance of malaria vectors and study of the potential impact of indoor residual spraying in two settings of Sakassou district, Centre Côte d'Ivoire

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## Background

The strategic plan of the National Malaria Control Programme (NMCP) in Côte d'Ivoire includes indoor residual spraying (IRS) as a complementary method to long-lasting insecticidal nets (LLIN) for vector control. However, mosquitoes resistant to the public health insecticides used for LLINs and IRS are of growing concern in Africa because they threaten the efficacy of these interventions. It is therefore, crucial to understand the ecology of malaria vectors and to monitor their susceptibility to public health insecticides.

## Objectives

The overall aim of the present study is to assess the evolution of mosquito bionomics and malaria transmission patterns in association with the implementation of IRS by comparing samplings before and after the interventions in two settings of Sakassou district in Central Côte d'Ivoire by addressing the following three specific objectives:

1. Assess the potential entomological impact of IRS and characterise the mosquito species composition in two settings of Sakassou district
2. Determine the phenotypic insecticide resistance levels of *Anopheles gambiae* and its associated molecular resistance mechanisms
3. Measure the potential epidemiological impact of IRS on malaria transmission patterns in two settings of Sakassou district

## Methods

We will carry out a longitudinal monitoring of malaria vectors and collect mosquitoes with the human landing catch method (HLC), pyrethrum spray catches (PSC) and CDC light traps (CDC-LT), both in urban and rural areas in Sakassou district before and after the IRS campaign. Using World Health Organization (WHO) insecticide susceptibility test we will determine the insecticide resistance status and strength in the local *Anopheles gambiae* s.l. population. With additional molecular diagnostics, we will measure the frequency of known insecticide target-site mutations and the expression of loci previously associated with detoxification of insecticides. In order to determine the *Plasmodium* infection rates in the collected mosquitoes we will screen the mosquito head and thorax for the presence of parasites using ELISA-CSP assay. For the identification of possible hosts on which mosquitoes could feed, we will screen the blood meal (abdomen of blood-fed female mosquitoes) using ELISA-Blood meal assay.

## Relevance

Results from study will guide entomological interventions of the National Malaria Control Program in Côte d'Ivoire


## Keywords

Côte d'Ivoire, *Anopheles gambiae,* malaria transmission, Indoor Residual Spraying, resistance


## ABS-114

# Evaluation of the hatching rate of *Anopheles coluzzii* eggs under ecological conditions of the *Culex* and *Aedes* roost in urban and peri-urban areas of Bamako.


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Malaria still remains a major public health problem in Mali, both in rural and urban areas. The mechanisms of transmission in rural areas are better understood, but the causes of transmission in urban conditions are still fully unknown. The phenomenon of adaptation of Anopheles to urban conditions for their biological cycle of development is strongly mentioned by specialists. The purpose of this study is to assess the outbreak rate of *An. coluzzii* (potential vector of malaria in any season and anywhere in Mali) to be able to complete its biological cycle under the ecological conditions of *Culex* and *Aedes* mosquitoes which usually live in urban conditions. Three-replicate of experiments were conducted in the lab to follow the hatching of *An. coluzzii* eggs in of *Culex* and *Aedes* larval sites water collected in natural breeding site in urban conditions (Bamako). Chemical conditions of the different larval sites were measured. Mosquitoes larvae rearing was done in insectary under conditions of 26 to 27°C of temperature and 80-95% relative humidity. The mean hatching rates of *An. coluzzii* in *Aedes* breeding site were 22% but very low in *Culex* breeding site (2%). This study showed that *An. coluzzii* does not have the ability to survive in *Culex* larval site, but there are very susceptible to grow in *Aedes* breeding site with low successful hatching rate.

**Keywords**

Hatching, *An. Coluzzii, Aedes*, *Culex*, gites

**ABS-244**

## Malaria Entomology Indices Suggest The Need To Curb Outdoor Transmission At Three Ecological Zones In Nigeria

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### Background

Entomological indices are crucial to the success of malaria control interventions in-country. In Nigeria, the use of LLIN is being scaled up with resultant effect on malaria vector bionomics. Here we provide information on entomological indices as risk factors for indoor and outdoor malaria transmission in three ecological zones in Nigeria.

## Methods

Anopheline mosquitoes were collected indoors and outdoors monthly from October, 2018 to September, 2019 using modified Baited CDC light traps in three zones: Kano (Sudan Savannah), Niger (Guinea Savannah) and Osun (Rainforest). Anophelines were identified morphologically and through PCR. Sporozoite infectivity and blood meal source was determined using ELISA. Human Biting Rate (HBR), Sporozoite Infection Rate (SIR) and Entomological Inoculation Rates (EIR) were calculated as entomological risk factors indoors and outdoors. Statistical analyses were conducted using t-test to compare variables at a significant level of $P < 0.05$.

## Results

A total of 1955, 1717 and 159 Anopheline mosquitoes were collected in Kano, Niger and Osun States respectively. Ten anopheline species were found in Kano, four species in Niger and six in Osun. Indoor and outdoor human biting rate ratio were 1.02 : 1 ($P> 0.05$), 1 : 1.04 ($P>0.05$), and 5.7 : 1 ($P<0.05$) for Kano, Niger and Osun States respectively. The mean sporozoites infection rate ratio for indoor and outdoor across the three States were Kano; 1.64 : 1 ($P> 0.05$) and Osun; 2.49 : 1 ($P <0.05$) and consistent with the EIRs at each of the site.

## Conclusion

Considering the similar indoor and outdoor biting rates for malaria vectors in the study locations, it is important for vector control interventions to also develop and scale-up on measures targeting outdoor control of *Anopheles* species. Though, results from this shows that transmission of malaria still largely occurs indoor, it is imperative to constantly keep monitoring the trends of malaria transmission in the country, to have a targeted and efficient vector control programme.


## Keywords

Anopheles, sporozoites infection rates, indoor, outdoor transmission, Nigeria


## ABS-85

## Malaria patient cost and treatment seeking behaviour in Burkina Faso


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**Introduction:** Despite improved reduction in malaria prevalence and mortality through preventive and treatment strategies, malaria remains a major public health issue in Burkina Faso. The successful impact of these strategies depends on policy implementation and accessibility and affordability of healthcare. The study aimed at examining patient costs and treatment methods in relation to wealth quintiles of households, to inform policy on equitable malaria reduction strategies.

**Methods:** We interviewed 1186 selected individuals on household assets and characteristics, treatment method and treatment costs. We analysed assets and house characteristics using Principal Component Analysis, then assigned wealth quintiles to households using study specific and separately, nationally

representative factor scoring. We analysed and compared costs by wealth quintile and treatment method. We assessed the relationship between independent variables (age, sex, treatment, wealth quintiles) and patient costs using Generalised Linear Model (GLM). and the burden of costs across the wealth quintiles using concentration indices.

**Results :** Of the 1186 participants, 83 (7%) had fever over the preceding fortnight with 10 confirmed malaria cases out of the 83 fever cases (12%). All cases (100%) had a treatment method and costs. Total median cost was $6.66 for fever and $0.84 for confirmed malaria. Median cost at health facilities was $7.31 and $3.06 for self-treatment. GLM showed a significant negative relationship between wealth quintiles and patient costs, implying higher wealth quintiles paid relatively lower patient costs. The concentration index showed significant burden of costs on lower quintiles.

**Conclusions**

There were significant differences in treatment seeking behaviour between wealth quintiles, leading to higher costs burden being incurred by fever patients in lower wealth quintiles. Poorer people were more likely to use government health facilities where treatment was free with higher transport and other indirect costs. Thus, equitable health policy decisions should focus on improving financial protection for these households.

**ABS-221**

## Insecticide resistance in *Anopheles gambiae s.l* and *Anopheles funestus* Populations in Tibati (Adamawa, Cameroon)

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**Background**

Insecticide resistance in major malaria vectors is an increasing threat to vector control tools currently deployed in Cameroon.The establishment of an effective resistance management plan require regular monitoring of mosquito insecticide susceptibility in different epidemiological facies.

**Objectives:** The present study assessed susceptibility of *Anopheles* population of Tibati to four insecticides classes.

**Methodology:** Blood-fed resting mosquitoes were collected in the houses and were identified morphologically to species level. Eggs were obtained from this F0 generation using the forced egg laying method. After to obtain de F1 generation, adults females ages to 2-5 days old were exposed to the papers impregnated with insecticide (DDT 4%, Permethrin 0,75%, Delthametrin 0,05%, Bendiocarb 0,1% et Malathion 5%) at the lethal dose for

a susceptible reference strain. Mortality scored 24h post-exposure according the WHO standard Protocol. In addition, the effect of synergist piperonyl butoxide (PBO) was evaluated on the resistance of vectors to pyrethroid.

**Results:** Both vectors were highly resistants to DDT, permethrin and deltamethrin in with low mortality rates in *A. gambiae s.l* are 1%, 1% and 8% respectively compared to 89%, 69% and 39% in *A. funestus.* Addition of PBO restores the susceptibility of *A. funestus* to permethrin and deltametrin with the mortality rate to 99% and 100%, but has no effect on *A. gambiae sl*. A probable resistance to bendiocarb was observed and should be confirmed by further analysis; however, both vectors remain susceptible to malathion, with mortality rates of 100% and 99%, respectively.

**Conclusion:** This study highlights the insecticide resistance profile in the Tibati population of *An. gambiae sl* and *An. funestus,* and call for the identification of resistance mechanisms involved, in order to improve the implementation and management of future vector control measures against local vectors involved in malaria transmission.

**Key words**

Résistance, Insecticides, *Anopheles gambiae, Anopheles. Funestus*